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Research Students in the Electronic Age: Impacts of Changing Information Behaviour\textsuperscript{1} on Information Literacy Needs

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Abstract

Because of the rapid uptake of information and communication technology (ICT), understanding the ways in which information seeking has changed over the past decade is crucial to gaining a picture of how information literacy (IL) needs may also be changing in the electronic age. This qualitative research took an interpretivist/constructivist approach in examining the ways in which access to electronic information seeking affects the IL needs of 15 research students in an Australian university setting. An ethnographic technique, the interview, was used for data collection. Three particular areas related to information seeking and use were selected: (a) information source use, because of the burgeoning availability of electronic sources; (b) knowing when to stop collecting information, because the Internet has made greater quantities of information more easily available than in the past; and (c) managing information following its collection, which has also been affected by the vast amount of information that is now accessible. The conclusion points to enhanced roles for both supervisors and academic librarians, with the need for the latter to become perceived as educators within their university communities.

Introduction

Undoubtedly the advent of electronic access to information has gradually wrought major changes to human information behaviour, related to source use in all walks of life. This is no less the case with students undertaking university studies. The central question of this article is: what are the implications of these changes for information literacy needs, with a particular focus on research students²? Within this broad question, there are three particular areas of interest: the selection of sources; the transition from information gathering to information use; and the management of
information. Another framing question will be: How can librarians and research supervisors help research students to optimise their source choices, become more confident about when to move from searching to using the information which has been gathered, and learn better management skills related to their research?

There has been considerable exploration of information literacy in the educational sector in Australia, with a key researcher being Bruce (1997) who has emphasised that users “experience” information in different ways. This experiential approach fits well with the interpretivist/constructivist approach used for the research in this article (discussed further below).

Another key term is “information behaviour”. Until the end of the 20th century, this was not commonly used in the literature. Rather the favoured term was “information-seeking behaviour”. It was seen to encompass information needs, use of information sources and information use (following retrieval). As Williamson (1995, p.24) pointed out, attempts to discover preferences for information sources had figured prominently in studies of information-seeking behaviour. The term now favoured is “information behaviour”. Fisher, Erdelez and McKechnie (2005) conceptualized information behavior as “including how people need, seek, manage, give and use information in different contexts” (p.xix). Since information seeking usually involves the use of information sources, source use (important to this article) is still encompassed in this definition. Knowing when to stop collecting information and managing information following its collection, other key foci of this article, are also encompassed in the Fisher et al definition.

The elements of information behavior identified by Fisher et al have also been used to define the attributes of information literate people. Webber and Johnston (2006) provide an overview of key definitions of information literacy in which they
use the term “information literates”. They also note wide reference to the American Library Association’s (1989) statement: “To be information literate, a person must be able to recognize when information is needed and have the ability to locate, evaluate and use effectively the needed information.” (n.p.) This definition appears in the American “Information literacy competency standards for higher education” (ACRL 2000, n.p.) and in its Australian derivation, the Australian and New Zealand Information Literacy Framework (Bundy 2004, p.3). The Framework identifies six core standards as the basis of “information literacy acquisition, understanding and application by an individual” (p.11). The first standard includes the ability to know when to stop gathering information; use of appropriate sources is covered by the second and third standards; and the fourth standard explicitly addresses management of information (p.11).

Understanding the ways in which the nature of tertiary learning has changed over the past decade, because of the deployment of information and communication technology (ICT), is crucial to trying to obtain a picture of how information literacy needs may be changing in the electronic age. Provision of study materials, staff-student communication, teaching practices and models of learning are all being recast through the spread of ICT within the university sector (McCann, Christmass, Nicholson & Stuparich 1998). Such changes have been significant in the emphasis that library and information professionals are now giving to the meaning of information literacy, and its place within the learning process (Bundy 2004). Indeed the concept of literacy itself is being rethought (Snyder 2002; Lankshear, Petters & Knobel 2000; Selwyn 1999). Not only is there a heightened need for critical approaches to online information retrieval, given the questionable authority of much information on the web (Devlin 1997; Kellner 1998; Lee 1999; Singh 2001), but “an
understanding of the relations among ideas is as important as, if not more important than, mastery of the ideas themselves.” (Luke 2000, p.73). Moreover student use of more traditional learning materials requires further reflection in relation to the recent burgeoning of electronic sources.

A number of empirical studies focusing on undergraduates’ changing information behaviour in the electronic age have been undertaken (see, e.g., Tenopir, Hitchcok & Pillow 2003). In contrast, with a few exceptions (e.g., Macauley 2001, Heinstrom 2002, Barrett 2005, George et al 2006 and Junni 2007), there is little recent research that has focused specifically on research students. Barrett (2005) highlighted the paucity of research focusing on information-seeking behaviour of graduate students especially since the widespread influence of the Internet but, since this time, the research of George et al (2006) and Junni (2007) has been published. The focus of both of these most recent studies is on source use and information searching; the latter on the effect of the Internet on the type and quantity of information students’ use as references in Masters theses. Neither addresses questions related to the other two areas covered by the present article.

Aims of the Research

In order to contribute to this still under-researched area, we set out to study Australian research students. We chose students from the Faculty of Information Technology (IT)³ at Monash University⁴ believing that, while these students are likely to be highly computer literate and skilled users of electronic information, they may not have been exposed to effective methods of finding and evaluating information. While we covered a wide spectrum of information-related questions in our research⁵,
outlined in the “data collection” section below, the present article focuses on the impact of the now wide availability of information in electronic format. The particular issues to be emphasised are (1) the types of sources of information now being used by students (discussed under the heading “Source Use in the Electronic Age”); (2) how they know when they have collected enough information – an issue that appears not to have been considered with regard to research students (discussed under the heading “Knowing When to Stop”); and (3) how they manage the information collected (discussed under the heading “Management of Information”).

The first question particularly looks at the use of electronic resources vis-a-vis print and personal information sources, together with views about, and preferences for source use. The perceived authority of online sources is included in this discussion. The second question arises because the advent of the Internet has brought the problem of greater quantities of information being more easily available than was case in the past. A crucial question is how research students judge that they have “enough information.” According to Berryman (2006), this concept is beginning to be explored from different perspectives in the field of information-seeking behaviour but “there is still much we need to understand about what contextual influences shape the judgement of enough information” (p.1). The third issue also relates to the greater quantities of information now available and concerns the strategies for managing information in the electronic age.

From this point, the paper proceeds to discuss further relevant literature, the philosophy and method, the findings of the study specific to the questions outlined above, and the conclusion which includes a discussion of the implications for academic librarians.
As mentioned above, there are three recent significant studies - George et al (2006), Barrett (2005) and Junni (2007) - in which research students were the focus.

George et al (2006) investigated the information seeking behaviour of 100 graduate students at the Carnegie Mellon Institute. Overall the study found that graduate students’ information behaviour is influenced by people. They preferred online sources, used the Internet and the library’s intranet to search online, and also used print resources from their own and other university libraries. Factors influencing behaviour included “convenience, speed and time restrictions; knowledge of services and sources; and course requirements” (n.p.). An examination of disciplinary differences in use of sources revealed that the fourteen computer science students reported the highest level of Google searches as well as searches for websites. They were also the least likely to question the quality of information found on the Internet. The groups with which the computer science students were compared were from art/architecture (16 students), business and policy (11), engineering (26), humanities (20) and sciences (13). Those from the humanities undertook Google searches least of all the groups and searches for websites only marginally more than the lowest group (art and architecture students). They were also the most critical group with regard to the quality of information found on the Internet (n.p.).

These contrasting findings between computer science and humanities students are interesting in light of Barrett’s (2005) study of 10 graduate humanities students in Canada. Barrett found that “several participants described a generation gap in their departments, in that graduate students and younger faculty members tend to utilize electronic information technology far more that older faculty members” (p.326). The
students saw IT as one of a variety of tools appropriate to their research (depending on the nature of the project). Several participants saw electronic information resources as readily available and “increasingly taken to be highly authoritative,” searchable databases as more efficient than print indexes, and remote access to full-text journals as convenient (p.326).

Juni (2007) also found a difference amongst the students in the three discipline groups in her sample - economics, psychology and mathematics – with regard to the reference lists for their Masters theses, the amount of the Internet resources they used, how they sought and obtained publications, and how they selected their sources. For example, psychology students used significantly more journal articles than economics students who, in turn, used significantly more than mathematics students. Mathematics students particularly relied heavily on monographs and course literature. The implication was that this denoted a difference in Internet use since “the Internet has not affected the availability of monographs or course literature. Rather the Internet has mostly increased the supply of available articles from scholarly journals” (n.p.).

Numerous studies have indicated the crucial importance of interpersonal sources to all types of information seekers and topics. In the academic area, Mills (2003) discussed how university academics access personal sources for teaching and research information, while the survey by Heinstrom (2002) of 305 Finnish Masters thesis students found considerable use of informal information sources. In the latter study, teachers and supervisors followed books and journals as the most used sources of information, while fellow students were relied upon by nearly 40% of the sample, and friends by one quarter. Indeed, some students mentioned people as their most precious information sources.
Barrett (2005) and George et al (2006) both confirmed that interpersonal sources are still crucial in the electronic age. Barrett found that his graduate student researchers had several forms of interpersonal contact, “providing ongoing support, guidance and feedback” (p.4). The supervisor was the most important contact. Other contacts were specialists beyond the student’s institution, fellow graduate students, conference attendees and librarians. George et al devoted several pages of their article to key interpersonal sources: academic staff, fellow students, and university library personnel and other help.

**Knowing When to Stop**

The problems arising from over-abundance of information, particularly since the advent of the Internet, are widely discussed in the literature (see, e.g., Case 2002; Allen and Shoard 2005). Allen and Shoard (n.p.) cited Edmunds and Morris (2000) in saying that “there is a perception in the literature that information overload has been exacerbated by the recent rapid advances in information and communication technology.” Lyman and Varian (2003) found that “although the Internet is the newest medium for information flows, it is the fastest growing new medium of all time.” In 2003, the volume of information on the Web had at least tripled since 2000 (pp.7-8). Moreover, they estimated that new stored information, in a variety of formats, including print, grew about 30% a year between 1999 and 2002 (p.1). Case (2002, pp.98-100) discussed the possible consequences of information overload: the information selectivity or filtering that people undertake, the anxiety they may suffer or the halt they may call to research when faced with an overwhelming amount of information, for example.
On the other hand, the concept of “enough information” and how people determine when they should stop collecting information has received little research attention to date (Berryman 2006, p.1). One of the exceptions is Limberg (1999) who used two descriptive categories, “information overload” and “enough information” in her phenomenographic study of 25 Swedish high school seniors undertaking a task. Kuhlthau (2004, p.199) raised the problem of what is “enough information”, calling it a “deceptively simple question” and exploring it in different work contexts. Despite the evidence of the plethora of information now available to them, it seems to be a question that has not been addressed in relation to research students.

What theories in the literature can be used to shed light on the question of how research students might determine when they have “enough information”? One possibility is the concept of “optimal foraging”, where hunter-gatherers or animals adapt their behaviour to survive. This concept was related to human behaviour by Smith and Winterhalder (1992) and extended by Sandstrom (1994) and Pirolli and Card (1995) to help explain the environmental factors that influence humans’ information choices. “Information foraging” was applied by Pirolli and Card to “activities associated with assessing, seeking and handling information sources” (p.2). They emphasised, as did Sandstrom, the weighing of costs and benefits undertaken by information seekers. This idea can also be applied to the issue of “knowing when to stop”, where information seekers weigh up the cost in time or effort against the likely return to be gained from continuing the search.

The issue of time availability is crucial. Barrett (2005) found that decisions to concentrate more on writing up projects than seeking further information were very much affected by time constraints. He quoted one participant as talking about the
clock running out. Other participants talked about having to “arbitrarily cut off” or reading “only what was crucial as the deadline approached” (p.5).

Management of Information

H. Bruce et al (2004) identified several studies that have explored how people manage information in their daily lives or in their professions. They defined the goal of information management as “increas[ing] the likelihood that, whenever the information is needed, the individual will remember where it is and be able to re-find it.” Their own study investigated how information professionals, researchers, managers and students keep and re-find information from the Internet. The most popular method for researchers and for students was to save web pages as “Bookmarks” or “Favorites”. Both of these groups next favoured doing nothing about storing or recording information, but searching again when the information was needed. Level of use of personal information software varied from more than a quarter of the researchers to only 10% of students.

Reflection on finding and managing information was a focus of a Swedish course designed to help PhD students develop their information literacy (Pilerot 2004). Pilerot noted that doctoral students need to manage larger amounts of research information than other university students do. Although most of the eighteen students in the case study were comfortable with their information searching and using skills, many used between 30 and 50 folders of articles and reference lists to manage their growing collections despite half of the group having had experience with personal information software before the course. Most students preferred printed versions of references as they could be annotated easily. In the logs used to assist them to search,
manage and use information “as a coherent process” (p.95), they revealed that they had problems handling large amounts of information.

An earlier study investigating information management skills of research students by Genoni and Partridge (2000) included supervisors as well as their students. The ten students, from several humanities disciplines, including information studies, were at various stages of research ranging from early to near completion. The researchers considered development of advanced information management skills to be essential information literacy “in the context of higher degree research” (p.225). They found that early in the research process few students had the ability to make the conceptual links necessary to organise their material well, few used electronic information management packages, or were aware of software features that would facilitate refinding information when it was needed and that providing advice on information management was generally not seen as part of a supervisor’s role. The conclusion was that, despite student and supervisor expectations, “many students who undertake postgraduate research are poorly prepared for the personal research information management tasks which await them” (p.233) and, even after some time in the research world, many students did not develop understanding and effective methods of handling the information they collected.

**Research Philosophy and Method**

For this study, the researchers adopted an interpretivist/constructivist approach in an attempt to understand the information literacy needs of research students, as well as the values, beliefs and the “meanings” they construct around the issues of information needs, information seeking, and knowledge integration.
The study was undertaken with the approval of, and in compliance with, the procedures deemed appropriate by the Monash University Standing Committee on Ethics in Research Involving Humans (SCHER).

The Sample

The 15 students were purposively selected using a limited form of theoretical sampling which did not extend, due to time constraints, to returning to the field to fill conceptual gaps and holes (Charmaz 2003, p.265). First introduced by Glaser and Strauss (1967), the concept of theoretical sampling involves the selection of participants who represent the major categories of people relevant to the research. With theoretical sampling, there is no compunction to sample multiple cases which do not “…extend or modify emerging theory” (Henwood and Pidgeon, 1993, p.25). In our case, the major category was “students undertaking a research degree”, with type of degree and place of study for undergraduate degrees (Monash University or elsewhere) being considered as sub-categories, and gender and age being of some, though limited, importance. We decided to include only research students from one faculty (Faculty of Information Technology at Monash University) so that the sample was relatively homogeneous for other key dimensions. It would have been interesting to have selected students with diverse backgrounds but, because we could only use a small sample, we felt that points of consensus on key issues would be difficult to obtain if we were comparing, e.g., humanities students with IT students. The literature cited above indicated that these two groups, particularly, would be quite different in their needs and skills.
The sample was obtained through lecturers making the project known to their students. It included two Honours⁶, three Research Masters and ten PhD students of whom nine were female and six male. Six were aged in their 20s, seven were in their 30s, 40s, or 50s, and two were aged 60+. Nine students gained their undergraduate degrees from Australian universities. Of these students, four had studied at Monash University. Six students gained their undergraduate degrees from non-Australian universities.

**Data Collection**

An ethnographic technique, the interview, was used for the data collection. The initial step was to develop a semi-structured interview schedule. All four team members were then involved in piloting and re-piloting the interview schedule. The final schedule included eleven questions, some with prompts so that data were not missed if particular points were not spontaneously mentioned by interviewees. The questions ranged across topics such as selection, defining and redefining the research topic; sources of information; knowing when sufficient information has been collected; the use of, and getting help with, online resources; determining the authority of online resources; the management and assimilation of information; the role of previous study and experience; and the ways in which information seeking could be improved, including the role that librarians might play.

With regard to the individual interviews, all four team members, in different combinations of two, took turns in doing the interviews which lasted about one hour. With the permission of the participants, the interviews were audio-taped.
Data Analysis

The audiotapes of the interviews were transcribed by an experienced transcription typist. Although the analysis as undertaken does not constitute a “grounded theory”, it was influenced by the “constructivist grounded theory” approach of Charmaz (2003). Charmaz says that, unlike the original grounded theory (Glaser and Strauss 1967) and particularly the later version written by Strauss and Corbin (1990), constructivist grounded theory is not “objectivist.” It “recognises that the viewer creates the data and ensuing analysis through interaction with the viewed” and therefore the data do not provide a window on an objective reality (p.273). Charmaz therefore recognises that researchers’ backgrounds will influence their interpretations of the data. They cannot avoid being influenced by “disciplinary emphases” and “perceptual proclivities” (p.259). This means that, although there is every effort made to look at “how ‘variables’ are grounded – given meaning and played out in subjects’ lives” (Dawson & Prus 1995; Prus 1996, as cited by Charmaz 2003, p.272), there is acceptance that “we shape the data collection and redirect our analysis as new issues emerge”(Charmaz 2003, p.271).

All four researchers were involved in the analysis of the data, initially independently. They made margin notes on their individual transcripts, highlighting words which they thought would be potential themes or categories within themes. At this point they compared their analyses and found there was almost total agreement about the main themes. Passages of data were labelled with categories and linked to one of the themes. Examples of themes, categories, and related quotations are presented in Table 1.
Table 1

Examples of Themes, Categories and Quotations: “Knowing when to stop”

<table>
<thead>
<tr>
<th>Themes</th>
<th>Categories</th>
<th>Quotations</th>
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<tbody>
<tr>
<td>Feelings of information overload</td>
<td>Reaching saturation point</td>
<td>“...you get to a saturation point, I guess, where you have 400 or so references”</td>
</tr>
<tr>
<td></td>
<td>Not knowing when to stop</td>
<td>“I don't know the cut off point and I guess I'll just keep reading...”</td>
</tr>
<tr>
<td>Strategies used for deciding when enough information had been collected.</td>
<td>(1) Looking for redundancy (repetition) of information</td>
<td>“(1) It's when they start repeating and nothing new is coming.”</td>
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<tr>
<td></td>
<td>(2) Reliance on the supervisor</td>
<td>“(2) ...that's something you use your supervisor for to say &quot;That's enough&quot;.”</td>
</tr>
<tr>
<td></td>
<td>(3) Starting the writing process</td>
<td>“(3) I don't think I know I have enough information. What helps me is when I start writing ...”</td>
</tr>
</tbody>
</table>

Findings

Participants were asked about various aspects of their study and research, from the initial definition of a research topic to the seeking of relevant sources, their organization and use. We also enquired about previous study and experience, the role of students’ present supervisors in their information use and management, and the ways in which information seeking could be improved, including the role that the library might play. In this article, the discussion focuses on the three specific topics, outlined above: research students’ use of sources of information; how they determine
when they should stop collecting information and how they manage the information they have collected.

Use of information sources

Our findings indicated that the Internet and other electronic search tools had exerted considerable influence on the way participants in our study searched for information and, resulting from this, had an impact on the kinds of sources selected. In keeping with a recent study of a broad population of US tertiary students (OCLC 2002), we found that search engines such as Google were popular amongst our sample, even when students were aware of, and used, the library-provided databases. Indeed, given its familiarity, speed, and a large number of potential “hits”, Google was for many of our participants the yardstick against which other search tools were assessed, as comments such as the following attest:

“I think our library database search engine isn’t as good as it could be. Sometimes I’ll put in a keyword and it will come up with a whole heap of stuff that isn’t very relevant whereas Google would give me [something] more relevant … You’ve got better chances of finding something.”

This student also said: “I didn’t realise until recently that the library had a lot of electronic papers online and all of that”.

Not all information used by participants was electronic. For many, the question of what kind of source to use in their research was less one of media form (digital or non-digital) than the nature of the documentary formats predominant within their disciplines. As the studies by George et al (2006) and Junni (2007) found, disciplinary differences could help shape the worth and accessibility of sources for participants.
For example some of the sub-disciplines, clustering in and around information technology, placed differing weights upon the relative worth of books or book chapters as compared to journal articles or conference papers. For those students who needed access to the latest research findings in their field, even electronically-published journal articles could sometimes be considered too slow in terms of keeping up with the “cutting edge” of debate – and hard copy books even more so. In such circumstances, it was argued by one student, the best source of relevant materials took the form of working papers or draft conference papers, often available from an individual academic’s personal web page.

While most participants were conscious of the need to find information appropriate to the topic, regardless of media form (digital or non-digital), there were participants whose passion for electronic information knew no bounds. One Honours student informed us that “it’s great having the Internet because you can find almost anything”. Another having decided in high school that it was “very annoying going through books”, had a strong and almost exclusive preference for online materials. More typical of those interviewed were students who relied heavily upon electronic sources, both from the wider Internet and from academic journals to which the university subscribed.

The strongest argument in favour of online sources was convenience. As one of those interviewed put it, “I’ve got a library at home because I’ve got a computer terminal”. Through online access, materials could be downloaded and printed out around the clock: in such cases there was no need to travel to campus, let alone queue to use photocopiers. And with many students engaged in paid work, being able to fit study into the home/work routine was of crucial significance:
“Because I’m working full time now and I was working part time before, it’s not always possible to get to the library to go through the catalogue, but I can go through the catalogue from home. I can also use some of the search engines to find leads that I wouldn’t find any other way … Because I’m working full time, a lot of the reading I do is either in the early hours of the morning or the very late hours of the night.”

One of the more interesting findings of the study was that a number of the students interviewed did not necessarily make hard and fast distinctions between different kinds of electronic sources. Instead, they appeared to conflate, under the general rubric of “online”, both academic journals accessible through the library and a host of sites found through Google. This raises the matter of the authority of online sources, a topic concerning which participants offered considerable variation in responses. On the one hand, one Honours student suggested, “most of my research has come from people who work at universities or who are lecturers or have some sort of tertiary qualification. So because of that I don’t really question the reliability of the source”. On the other hand, a few participants insisted upon the academic peer review and citation as one crucial filter in this regard: “The information I’m gathering has gone through peer review processes”.

As other studies have found, people are still important to research students in the electronic age. The supervisor was a key resource for most participants, although not all. At one extreme stood a student whose supervisor was of little importance in producing an Honours thesis: indeed, she recalled, “I hardly spoke to her”. Nor were the thoughts of other academic staff or fellow students deemed relevant, with the student choosing instead “to keep to myself”. Then again, the other Honours student drew attention to the input provided by her supervisors, particularly in the structuring
and design of the thesis itself. Even students who appeared competent in finding their own information still acknowledged the role of supervisors in helping to provide a framework for the research project, as well as an ongoing reference point and sounding board for their work. For example, one student emphasised the help provided by a supervisor in “narrowing down” a PhD research topic when she had become “a bit lost” after “going through many different things”. A student working in the field of information management reported that she would sometimes ask her supervisors for leads concerning information sources, while also turning occasionally to online forums. Another participant mentioned the usefulness at times of “bounc[ing] ideas off” other research students, both informally and within the context of a research methods class. Academic staff were crucial to this student too, above all for their experience, which allowed them to “point out to me where I’ve missed” aspects of intellectual debates.

Knowing when to stop gathering information

Researchers, whether seasoned or novice, have real difficulties in determining if they have accrued sufficient relevant information. As Kuhlthau (1991) pointed out, bringing information “collection” to an end is often bound up with providing “focus” to a project, something that is not easy in research. With the burgeoning availability of information in the electronic age, the task of “knowing when to stop” has undoubtedly become even more of a Sisyphean task.

Participants were asked how they knew if they had gathered enough information. A majority said that they did not know when to stop the information searching phase of their research. They made comments such as “it is very difficult”
or “you get to a saturation point I guess where you have 400 or so references but you
never know whether you've missed something.” Another student expressed his
apparent dismay at the unending aspect of the information search in his research area:
“I don't know the cut off point and I guess I'll just keep reading until I finish the
project. The literature review won't finish until the day I put the final full stop on the
thesis.” He continued to ponder about how widely he should read in relation to
peripheral information: “And one of the questions I have is the limit on how widely I
read too, because it is all very well to research the problem but there are all the
peripheral things I could draw in.” The sense of information overload, as discussed by
Case (2002) is evident in these comments.

Strategies students used to help them to know when to stop included looking
for repetition of information. As one participant said “it’s when they start repeating
and nothing new is coming.” Another participant reported asking her supervisor
about when she would know when to stop searching and had been told that it is “when
you start to read the same thing.” Limberg (1999) found that several of her Swedish
students mentioned this approach.

Other students also used their supervisors’ advice as they contended with
information overload, one stating “that's something you use your supervisor for: to
say ‘that's enough’.” Students, deep in the research process, clearly found it useful to
have a mentor who could apply the brakes of objectivity on a search phase that might
be ballooning out of control. One student, whose supervisor told her: “you're very
good at gathering data but not so very good at writing up,” commented that “that's
always a very strong nudge in the ribs.”

There were other approaches as well. One participant felt that starting the
writing process definitely helped in knowing when to stop searching: “I don't think I
know I have enough information. What helps me is when I start writing…I have to be able to write it down for me to know what I'm thinking.” Another student’s approach was to set a date for completion of the search phase of research. While this might appear mechanistic, this could also be an example of the weighing of costs and benefits as discussed by Sandstrom (1994) and Pirolli and Card (1995). In the student’s words:

“That's very difficult, very difficult. At the moment I've made a decision that it's going to be June 2003 and I'm not reading any more until I've written. And then that can make it lose its shape a bit. In the end you have to write and it has to have some sort of coherence to it.”

Another example of this kind of approach is evident in the following quote:

“You read more and you read more…I've read ten or twenty books that tell the same thing…so I'm looking for the definition and I am not quite satisfied. But now I have to tell myself after ten books, ‘Enough books’. Otherwise it is never ending.”

Yet again a participant, researching in a technical area, where there was a dearth of published literature available, made the decision to draw a line under his search efforts, and move on to the next question or phase of research:

“Once I feel I've got a reasonably sufficient and satisfactory answer then I just move on. Then maybe six months down the track I might just happen to come across another paper that is actually relevant too and I might go back and try and incorporate it.”

This approach was similar to that of other students who felt they had a good understanding of their topics, and had enough evidence to answer each question, and so had an ability to stop searching: “If you feel you can give enough references and
got enough evidence for something you're writing for your thesis I think that would be the place I can stop.” Limberg (1999) also found that this was an approach used by some of her students.

A student, who also set up timelines and a structured approach for himself, found that talking to other people in the relevant research area can provide a useful indicator as to whether enough information has been gathered:

“I set myself three months for searching for information…One day I would do the search, another day I would do all the reading…I just try my best to retrieve all the work that has been done in this area. That's why I say it is not much…Otherwise I try to talk to people.”

Similarly, one of Macauley’s (2001) participants noted that working alone too much could lead one to “re-invent the wheel.” (p.166)

Barrett’s (2005) findings lead to the expectation that students would be very concerned about the deadlines they faced. While there was some mention of the finite nature of the time available, e.g., “You are doing something for the PhD in a limited amount of time so you have to know when [to stop]...and write the things formally for your thesis,” this issue did not arise as often as expected.
Management of Information

Genoni & Partridge (2000) noted that research students are “faced with far more challenging tasks in terms of storing, structuring, collating and recalling…information” than has been the case in their undergraduate or learning phase of information-seeking. Management of information is a perennial problem for research students, allied to knowing when to stop searching. As the amount of material collected grows so does the need for a reliable method for organizing it.

The study participants’ abilities in this area ranged from a fairly formal organizational approach to trust in memory as a method of storage and retrieval. As one participant said: “The easiest I find is to just keep it all in my head and most of the time I will remember.” This is in line with Genoni & Partridge’s (2000) findings related to research students’ awareness of information management issues (p.225).

On the other hand, more than half of our participants used EndNote or other software tools for electronic management, including entering short summaries of content. This is in keeping with the higher level of use of personal information software by researchers cited by H. Bruce et al (2004), mentioned above. One student developed his own database for keeping track of his material. “I print out or photocopy all the articles. I index them. I have a little access data base which I key in the titles and keywords and all the authors and then I can do cross referencing of the authors to see if they've been cited in other papers.”

This quote highlights another quirk of searching in the digital age. Because of their need for easier reading than is provided by a computer screen, most students made paper copies of information they had obtained electronically. This led to the need for methods of both electronic organization and for physical storage – the latter
often being stacks of paper on the floor, with post-it notes attached giving brief summaries of specific papers. A variation on this situation was bemoaned by one of the students: the task of keeping her online folders synchronised with her hard copy folders – in fact she was finding it easier to locate hard copies at a particular stage of her research. Another aspect of the need that was felt for both print and electronic versions is reflected in the words of the student who described the downside of online searching for her: “It is a kind of problem with online searching that it is more time consuming in that you look at the paper, you think that it is okay, you downloaded it, you printed it and then when you're reading it is not much help.”

There was one complication that can easily arise for research students: the changes in focus that often occur in the earlier stages of a research project for a higher degree. One participant alluded to difficulties in re-organising materials when he faced that situation: “The articles changed as the nature of the topic changed - I've discarded great lumps of documentation and put in new stuff. I've got a categorisation I'm not completely happy with and I'll possibly re-categorise.”

**Discussion**

The three areas we have chosen to highlight in this article are all linked to human information behaviour and information literacy in the electronic age. We have confirmed the findings of other studies that have indicated that the online environment is now very important to research students. While we were unable to take a comparative approach, and could focus on students studying in one Faculty only, albeit with some differences in subject matter playing a part, we have some comparative data available from the George et al (2006) and Barrett (2005). From
these studies, it seems likely that the students in our study would have been higher
users of electronic sources than comparable research students studying humanities at
Monash University at the time of our study. For example, George et al (2006) found
that the computer science students in their study reported the highest level of Google
searches (93%), compared to 50% by humanities students (n.p.), while Barrett found
that, although there was increasing use of electronic sources amongst his 10 graduate
humanities students, the students saw information technology as one of a variety of
tools appropriate to their research, depending on the nature of the project (p.326). In
the case of our study, despite the frequent use of electronic resources, many students
attempted to use the most appropriate sources available. On the other hand, there
were other students, e.g. the two studying for Honours, who not only used electronic
sources almost exclusively but also appeared undiscriminating in their use of them.

A startling finding made by George et al was that not one of the fourteen
computer science students in their study spoke about the possible questionable quality
of information found on the internet (compared to 30% of humanities students).
While we found variations amongst our IT sample with regard to the issue of judging
the authority of electronic sources, it is also clear that not all research students took a
critical, evaluative approach to electronic information. This was particularly the case
with the Honours students, both of whom were young and relatively inexperienced
compared with the Masters and PhD students. Related to this is lack of distinction
between various kinds of electronic sources in the minds of some students.

The results of Chapman (2002), who surveyed a cross-section of
undergraduates, postgraduates and academic staff in one Australian university,
confirm these findings. The last of her three “skills-based problems”, experienced
across all user types regardless of experience or level of skill (including academic
staff) was “inability to identify and select authorised (sic) information” (n.p.). She described “the reluctance of many unskilled and unsuccessful Internet searchers to give up time to undertake training to become efficient and effective users” as “one of the more disturbing issues arising from the research” (n.p.).

It is interesting to note the continuing importance of personal sources of information in the electronic age. For as long as information-seeking behaviour/information behaviour research has been undertaken, the role of people as sources of information has continually emerged.

The question of “knowing when to stop” seemed a vexed one for the students in our study many of whom prefaced their responses to our question with phrases such as “that’s difficult” or “I don’t know”, although they then went on sometimes to talk about strategies that they could have or had used. Since it seems that this issue has not been previously explored with research students, and is only beginning to be examined closely with other groups, we do not have comparative findings. Nevertheless, ways of assisting students to gauge how to judge when to stop the collection process will become even more crucial as the amount of available information continues to burgeon. This issue deserves wider investigation. In the meantime, the following is a summary of the main strategies used by the participants in this study: looking for repetition of information (redundancy); the advice of the supervisor; beginning the writing process; setting a date for the completion of the search phase of the research; gauging there is enough information to answer a particular question; talking to other people who might help “the reinvention of the wheel”. A looming deadline will often provide the incentive to stop the search!

Like Genoni and Partridge (2000), we believe that development of advanced personal information management skills is essential for information literacy in the
higher degree context. While a higher proportion of our research students used software tools for electronic management than Genoni and Partridge found, they were not always aware of the full capabilities of the software. Reliance on memory was a key strategy for information management all too often. Since most students still set considerable store by having print copies available to them, there is also the problem of managing the print versions along with the electronic. This parallel management of electronic and hard copy documents is hardly a problem unique to researchers, and is a common challenge facing many organizations today. While personal information management has become a topic of growing interest amongst information professionals, more work needs to be undertaken in examining how the issue is dealt with in practice. If there is unlikely to be “one best way” for research students to address the question, the fact remains, as Marshall and Jones (2006, p.68) pointed out, that “[a] good match between how something is kept and its envisioned role or function is essential for using the material effectively and enjoyably.”

**Conclusion**

What are the implications of the study for assisting research students with information literacy in the electronic age? We suggest that both librarians and supervisors can do more in all three areas discussed in this article, but that they may not necessarily share equally in the opportunities in each case. For example, supervisors will have greater opportunity to provide research students with strategies for “knowing when to stop” than librarians, but the latter need to be aware of this issue and include advice on strategies as part of any information literacy instruction
(ILI) tailored to research students. The list of strategies, suggested by participants in our research (discussed above) may provide a starting point here.

Because of their training, librarians are in a strong position to assist researchers with selection of information sources and management of information, as well as other components of information literacy. If information literacy is seen as a whole of institution responsibility then, within this institutional framework, policy initiatives can enable librarians to be supported in their efforts to make students and academic staff aware of their specialised skills in the field. We see institutional approaches as essential if the expertise available in academic libraries is to be used to advantage in the promotion of information literacy.

Chapman (2002) concluded that the reluctance of her research participants to undertake training in electronic source use “encourages the library to collaborate with academic teaching staff to ensure the training is included in the curriculum” and “to promote the training effectively by emphasising the advantages and efficiencies to be gained” (n.p.). We endorse those views. Librarians need to become perceived as educators within their university community so that this involvement in the curriculum can take place. Their inclusion in the induction of new academics is a vital step towards this. They must also make the effort to share what they learn about the needs of research students within their organisations and through publishing their research results.

In a recent article focussing on the “affordances” offered to graduate students at the Library of the University of Alberta (Sadler and Given 2007), the researchers concluded that librarians were using ILI and the web site almost exclusively to communicate with their graduate students (p.135). The study in fact indicated that participants were not aware of ILI, did not read notices on the library home page, and
that personal contact of graduate students with librarians is “possibly the most
effective tool the academic library has at its disposal” (p.135). Sadler and Given
noted the difficulty of this, but concluded that “academic librarians must focus their
energies on promotional dialogue with faculty and students” (p.135).

The message from the Sadler and Given research is that, in promoting ILI
through the curriculum, as we recommend, librarians need to communicate directly
with supervisors and their research students, attempting to include the former in their
programs as well as the latter. In this way, supervisors also will improve their
information literacy skills and are more likely to use the opportunities offered by their
contact with their students, not only to point them towards the library, but to give
them direct assistance in areas vital to the success of their studies.

It is essential that the importance of information literacy continues to be
promoted so that it becomes more widely recognised as an essential graduate attribute
within tertiary education institutions. It will then become accepted policy to
incorporate information literacy education more explicitly within the general
curriculum. Students will be more aware earlier in their studies of the need to select
appropriate sources of information, to evaluate information no matter where it has
been obtained, and to develop good practice in managing information.

Studies such as the one we report are useful in highlighting the particular
needs of research students. Staff development programs for academic staff who
supervise research students can be enriched by raising awareness of the students’
information literacy development needs and discussion of ways to address them.
Librarians’ involvement is recommended in these programs and in those aimed at
assisting research students to develop skills which will help them make the most of
their research experience.
Endnotes

1 The English spelling of the word “behaviour” is used unless it is part of a quote with American spelling.

2 The term “research student” has been used in preference to “graduate student” because, in Australia, many Masters students do course work only and our intention was to focus on students who, as with PhD students, undertake research and are then assessed solely or primarily on the basis of the thesis they have produced.

3 In Australia, the word “Faculty” does not refer to full-time teaching employees as in America. Rather it refers to the larger administrative group which brings together a number of departments, or schools as they are often called, from related disciplinary areas.

4 The research was funded by a Monash University Small Grant.

5 A paper briefly discussing all of the issues covered by the research has already been published (Wright, Williamson, Bernath and Sullivan 2006). Additional issues included in that paper, but not covered in the present articles, are: selection of research topics, and online search tools and search strategies.

6 Although Honours students are classified as undergraduates in Australia, they must undertake research and write a thesis (unlike course-work Masters students). This means that it is appropriate to classify them as research students.
References


Genoni, P, & Partridge, J. (2000). Personal research information management: information literacy and the research student. In C. Bruce and P. Candy (Eds.), *Information literacy around the world: Advances in programs and research*. Wagga Wagga, NSW: Centre for Information Studies, Charles Sturt University.


http://informationr.net/ir/5-1/paper68.html


