*Discovery Practices of Early Career Life Sciences and Engineering Faculty: a Qualitative Approach*

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**Abstract**

***This paper describes findings of a research project conducted at the University of Pittsburgh Library System to uncover processes used by early career researchers in the life sciences and engineering to locate information during the discovery phase and the role that social media and library-subscribed A&I databases play.***

Keywords: collection management; A&I databases; abstracting and indexing databases; information-seeking behavior; early career researchers; Life Sciences and Engineering.

# Introduction

The focus of the study described in this article was to gain an understanding of how early career researchers (ECRs) in life science and engineering disciplines seek information to support the discovery phase of their research activity. We chose to focus on ECRs because their research practices will shape our services in the years to come. With the rising costs of library subscriptions, shrinking library budgets, and rapid changes to the availability and discoverability of research material outside pay walls, it is important to re-evaluate how libraries spend their collections budgets to ensure the greatest value to the institution. In our study we were particularly interested to see what role traditional abstracting and indexing (A&I) databases play in the discovery process of our respondents and to assess the ongoing value of these databases in the current research information and discovery environment.

The findings of this study will help us gain a better understanding of the discovery practices of early career researchers and help us learn what is important to this group as we look at future library support.

**Literature Review**

***Collection Budgets***

Librarians have been warily charting the steadily increasing costs of library collections for many years, and particularly on subscriptions in the sciences. The most recent iteration, from a longitudinal study that compiles the additions and cancellations among ARL and Oberlin Group libraries, points to the cancellation of subscription content, both journals and databases, as a way to annually balance the budget due to financial crises and “ongoing challenges for public higher education budgets” (Klassen, 2020). The pressures of increasing subscription costs and shrinking budgets are forcing academic libraries, especially those that are publicly funded and support doctoral programs, to think more creatively about supporting access to discovery tools and content. Though more attention is often focused on journal subscription prices, A&I database subscriptions have also risen beyond normal inflation. Additionally, the yet unknown consequences of COVID-19 have cast even more uncertainty on the health of future collections budgets based on a recent survey from Ithaka (Ithaka S+R, 2020).

***Early Career Researchers (ECRs) and Discovery***

A wealth of information on this cohort continues to be published by the three-year longitudinal study known as the [Harbingers research project](http://ciber-research.com/harbringers.html) . This study focussed on soliciting feedback from 116 faculty from seven countries, and probed their current and changing habits with regard to information searching, use, sharing, and publication (Nicholas, 2017). This fascinating, yet sobering series of research articles portrays a changed landscape in which researchers are no longer focused on traditional discovery methods. Among the many important findings is that ECRs often cannot recognize where the information they are using is coming from. Since the content is predominantly found via Google, this obscures the many gateways researchers are passing through. Early Career Researchers usually don’t know when they are accessing content provided by the library and when it is available through a portal providing open access, or illegally posted content. (Nicholas, 2017). What is clear, however, is that the library’s role in providing content is dissipating as an increasing volume of new research is available outside paywalls. (Nicholas, 2017).

Discovery, for ECRs, does not usually begin via the library homepage. According to Nicholas (2017), Google, Google Scholar, Scopus, and Web of Science are the four main starting places. Although, Nicholas is quick to add that Scopus and Web of Science are less likely to be used in favor of Google. Yet another attraction for choosing to search Google and social media sites rather than library-subscribed discovery systems is that these are where the content that faculty are looking for is found. Whether this is due to the speed at which content is uploaded, or the lack of carefully curated keywords thesauri/silos, much of what researchers are looking for when they have a glimmer of a novel idea is not yet readily findable in the scholarly literature. (Marsolek, 2020).

One of the attractions of Google and Google Scholar, especially for ECRs in the sciences may, in part, be due to the ability to easily access content from a variety of sources known as “grey literature”, sources that are often not indexed in A&I databases. While this phrase covers a lot of ground, it has been defined as “manifold document types produced on all levels of government, academics, business and industry...that are protected by intellectual property rights...but not controlled by i.e., publishing is not the primary activity of the producing body” (Schöpfel, 2010).

 When asked why they use Google to seek out grey literature, all faculty (not just 'early career') mention accessibility, keeping up with trends and locating content not readily available due to the inherent delay in publishing research findings as motivating factors. Emphasizing the importance of the use of grey literature, a survey at one university revealed that researchers in the health sciences, natural sciences, and physical sciences were the three largest users of grey literature, and that the types of content that they were searching for included conference papers, dissertations and theses, technical reports, government documents, preprints, and working papers, and that this content was primarily found by searching Google or through professional contacts. (Cooper, 2019).

***Research is Social and Multidisciplinary***

Historically, sharing the results from their research has been a goal of the

research itself, and paths to publication have until recently followed the

traditional avenue that is limited to conference and publication. While these modes continue to be relevant, the adoption of Twitter, Facebook, ResearchGate, Academia.edu, have upended the traditional model and have become the accepted way of speeding up the dissemination of new research and making contacts with the aim of collaboration. More importantly for academic libraries, engaging professionally through social media platforms is helping to change people’s expectations about the sources, availability, and uses of information in all its forms, both in society at large and in the practice of science. (Tenopir, 2017)

**Materials and methods**

To gain a deeper understanding of the information discovery methods used by ECR life sciences and engineering researchers at the University of Pittsburgh, our study employed semi-structured interviews. Due to the highly individualized nature of the discovery part of the research process, qualitative methods such as interviews or focus groups can reveal complexity in data, and provide additional context, often missing in survey methods. Studies focusing primarily on quantitative analysis of this question have further identified the value of an interview-based approach and the gaps in understanding this methodology will elucidate. For instance, Niu and Hemminger (2012) acknowledge that interviews are necessary to “better understand the underlying motivation of information-seeking behavior among scientists” (p.17), and expound on trends in survey responses. And Monroe-Gulick, et al. (2017) indicated that “...the open-ended nature of focus group discussions and interview interactions enabled participants in the current study to provide context and insight into their needs, highlighting nuances of their research requirements in ways the libraries could not have anticipated when constructing a strictly quantitative survey” (p.782).

In our study, semi-structured interviews were used to collect data. The sample size was informed by Guest, Bunce and Johnson’s (2006) research which demonstrated that data saturation can be achieved at the point of about twelve interviews. Semi-structured interviews, as a data collection tool, allow for a deeper exploration of topics and emerging themes than a survey or a structured interview protocol would. The semi-structured approach uses an interview guide with questions that are clearly articulated but it encourages an interviewer to stray from that guide to follow new leads or seek clarification. If done well, it allows for establishing a rapport between an interviewer and an interviewee, encouraging them to be more forthright in describing their practices and articulating their perceived pain points.

The interview guide, found in Appendix 1, consisted of four parts: establishing rapport and building context; delving into specific information seeking behaviors; overcoming challenges in finding research information; and describing an ideal state or a solution. The first set of questions was an opportunity for the researcher to talk about their field of study, and their disciplinary norms for dissemination of research outputs. This encouraged development of a rapport and provided a friendly opening. Next, we sought to understand and quantify the ways that the researchers went about searching for information. For instance, what were their “go to” resources, how much time were they prepared to spend on searching, and how or when did they know they had “enough” information. The questions about challenges prompted the faculty member to make suggestions on ways the library can be more effective. The “ideal state” question allowed the researchers to reflect on their experiences and suggest ways to bring information seeking to the next level.

***Sampling***

This project focused on the discovery process of early career researchers in life sciences and engineering. Tenure stream classification was used as a proxy for research-active faculty, and early career researchers were defined as those who had completed their dissertations within the last ten years. Our choice of ECR definition (no more than ten years from PhD) was dictated by the employee structure in our institution. Most tenure-track faculty in STEM disciplines have mostly completed one or more post-doc appointments in other institutions, thus are several years beyond their PhD. Younger faculty are mostly employed in a non-tenure track and therefore not included in our cohort. Moreover, our decision to concentrate on tenure-track ECR researchers was dictated by our desire to understand information seeking practices of faculty who are likely to stay in our institution for the foreseeable future and who are disproportionately responsible for shaping research practices of graduate students. Our goal was to understand what the future is likely to look like, and to consider the library’s position to respond to the new and emerging trends. In order to identify researchers fitting the criteria for inclusion, a preliminary search of the University Faculty Information System (FIS) data was conducted and was supplemented with additional searches of the departmental websites. This search yielded a list of 86 researchers eligible to participate in the project. The initial list was further reviewed for departmental affiliation of researchers to exclude faculty from the Schools of Medical Sciences, who are served by a separate library system.

 The University of Pittsburgh IRB approval for the project was obtained in January 2020. In early February 2020, 77 researchers were invited to participate in a 60-minute in-person interview; the initial invitation was followed up by another one a week later. In the end, twelve interviews were scheduled and conducted throughout February - March 2020. Table 1 shows the departmental affiliation of the interviewees.

[insert Table 1]

***Analysis***
Once all of the transcripts were obtained, the project team discussed the ways to approach coding and data analysis. It was agreed to loosely follow the themes from the interview questions and code the text based on these themes. Initially, all team members reviewed the same interview transcript independently; then met to discuss the emerging themes and to agree on common vocabulary (codes). Next, each team member coded all remaining interviews independently and provided additional comments and observations. Team members then discussed their codes and notes to create an Excel table for capturing quotes and observations related to the emergent codes. The emergent codes informed the grouping of findings.

**Results**

***What finding/discovery resources are researchers using?***

We were not surprised to find that the most frequently mentioned discovery tool was Google and Google Scholar; though we did not expect that these would be used almost exclusively in the discovery process. All of the interviewees use Google or Google Scholar as their main discovery resource. They were all pleased with the breadth of coverage, ease of searching, and specialized features that Google makes available. One researcher commented, “I can find everything from the most elementary knowledge, all the way to the most cutting-edge stuff…. I find Google Scholar to be very convenient. It's fast and it's easy to use.” In a separate interview, another researcher agreed, “I just find it so much easier… I find it really intuitive.” A third researcher pointed out, “It's not probably the best approach but I usually will type in a search term first in Google Scholar, and I'll just get a sense of what is out there.” It is worth noting that at the University of Pittsburgh, for IP authenticated users, we have turned on links from Google to our full-text subscription content.

 In the interviews, we wanted to gauge the researchers’ reliance on the subscription-based A&I services. Of the commercial resources mentioned, Clarivate’s Web of Science was the primary one mentioned by the scholars we interviewed. Seven of twelve researchers mentioned using it. From our conversations, faculty tended to use it when they are ready to submit a grant or other review paper, and it plays an important role for validation and formalization of the discovery process. One researcher mentioned that they find Google has more references but believed that Web of Science has a higher standard for including journals. Another researcher noted,

*“The special use case for Web of Science for me is when you're not actually*  *necessarily going to read every paper because you're either doing an automated*  *content analysis type thing or whether you're trying to say the number of papers*  *on this topic has gone up over time or something like that. You're not going to*  *go through every one and you want to trust that that search is returning what*  *you actually think you're searching for. ...it's very, I would say, canonical,*  *normal, traditional in our field to see someone say, ‘We ran a Web of Science*  *search for this query string.’”*

 Scopus, another subscription database similar to Web of Science, was also mentioned, but the researchers we talked to were more likely to give it lacklustre reviews. “Yeah. I have used Scopus in the past, but I never found it different enough from Web of Science to justify using it. There is probably something to the fact that a lot of people quote Web of Science searches as opposed to Scopus searches”. Another researcher had a more generous perspective, “I hear a lot about Scopus. I'm sure it's great. I've never used it. Why, I don't know. I hear that it's even better than Web of Science. It's silly that I use Web of Science but I think that was just what I started using first and I stuck with it.” Additional feedback came from a scholar who helpfully noted, “Compendex and Scopus and Web of Science are kind of my three. I know that they're slightly different in certain ways, and one overlaps a lot, and you might be getting rid of one and that's totally fine”.

Our study sought to assess whether our subscription A&I resources were still necessary for the discovery process. In fact, we found that many freely available resources such as Google, play a large role in the discovery phase of researcher work. Another important venue for discovery is social media. Twitter was named as an important resource by nearly half of the interviewees. Even though they had to navigate away from the social/personal posts, the professional posts of other researchers were extremely helpful to them in a number of ways. One faculty member commented, “I'm very active on Twitter, and I'd say that's probably the main source that I see new papers in my field”. Twitter is able to provide the important service of identifying others working on related research, and thereby helping to expand our researchers’ information network. Additionally, Twitter was specifically mentioned as an important source for staying current, “I think that it's always a challenge to stay plugged in to what's changing and what new things are out there. Twitter is an obvious one”. Another researcher mentioned, “I really feel like it's an excellent place to make sure you don't miss anything.”

 Our respondents also pointed to the importance of attending meetings and conferences as a critical component for them to discover what is new in their fields and make important connections with others doing similar work. One interviewee talked about discovery in this context, “...how do I gather information? Certainly, just conferences are an incredibly useful way. If I hear an interesting talk, then I use this to look it up.” Another benefit mentioned is, “keeping abreast of the most recent advances that maybe haven't even reached the research literature.” A third respondent mentioned the serendipity of connecting via a meeting, “There was a guy in national parks, for example, who I got in touch with because a woman who worked with him came to my programmer's poster at ESA, for example. When I looked up his work, he's published a ton on this area.”

***What types of resources are important to the researcher to explore?***
We found that scholars are often using non-commercial resources in their discovery activity. Over half of the discovery tools they mentioned are freely available. We found that researchers have broad patterns of search activity and visit a wide array of sites. Often, these sites go beyond traditional academic research venues, and include governmental, media and social media sites depending on their research focus.

 Not surprisingly then, we found that research outputs are incredibly varied. Researchers acknowledge the need to consult a variety of types of sources and formats which are traditionally not covered in an academic database. For instance, in addition to journal articles, scientists cite data, software, grants, tweets, Citizen Science Lab, videos, presentations and patents. One researcher summed it up this way “So there's really a lot of outputs that you're seeing. Scholarly journal, papers and articles and then conferences invited talks as well as using this as a teaching opportunity or engagement for your students in your lab. Then also sparking kind of interest in education in the community in schools.” Researchers need to access this grey literature as specified above and Google, unlike traditional A&I services, surfaces these documents.

 Many of the researchers we spoke with are engaged in applied research fields, and multidisciplinary areas. This also impacts both the types of output they and their colleagues produce and the ways they go about discovery. As one respondent noted, “Probably one thing that is useful about Twitter in that case is if there are people or groups who I didn't know were working in a particular area that's a good way to find out that they are working on it. Because especially in these applied areas, you could have groups that actually do a lot of work and don't publish that many peer-reviewed papers.”

 For many, the discovery process is linked to their engagement with their discipline and staying current. This currency relates not just to recently published findings, but extends to early stages of the research process. One early career researcher summed this up, “now being faculty it's different than being a graduate student; it's more important to see things before they happen than it used to be. Knowing that something is getting started is more important to me than it used to be.”

***What difficulties do researchers have in fulfilling the discovery phase of the research life cycle?***

Several themes emerged about the research process in general when we asked researchers about barriers they encountered. The researchers bemoaned that retrieval was not precise enough; it often retrieved large amounts of information that was not useful. Also, they mention that some of the retrieved content lacked scientific rigor. They often had to dig deeply to find valuable citations and could not rely on platform tools to winnow information. Faculty expressed several ideas for improvement, such as creating a star system to highlight the best research articles, “...so that people don't waste their time reading papers that don't really matter, but they can just scrape off the five- star stuff.” Also, “...it would be so much better if the information providers, they can sort out or, in a sense, predict what we want....[or at] the very least, they can give us the most highly cited paper under certain keyword...”; and suggest alternative terms “...if there were something online that you could put in words and it gave you words in relevant fields or something.” In reviewing the results of their searching, they find they still need to do a lot of work to unearth the best sources and tease out the validity of each piece of research. They are concerned that there is generally a low barrier to publication. One researcher summarized these sentiments, “...I tend to see the body of research literature as having a finite, not insignificant but finite fraction of sort of gold nuggets of really meaningful information [...] I'm of the opinion that the barrier to publication has become low enough with the propagation of many, many, many journals that a lot of research results that get published are underbaked...” However, they still indicated the importance to dig deeply to uncover the best sources.

***What is the role of the library?***

Our respondents did not see librarians playing a significant role in the discovery process, and they felt that deep subject expertise is needed to uncover relevant information. The fragmented landscape of information sources makes it more difficult for librarians to assist researchers in the research process. As one respondent commented: “it's become a lot harder for the libraries to assist in the research process, the more specialized the research process has gotten. Because, although people who work in libraries are excellent, I wouldn't expect them to actually be able to help me do a lot of this. Because the knowledge that's necessary to know even what type of search to run is not something I would expect to be housed in the library anymore.” This perception influences the relationship between researchers and librarians, potentially limiting the role of the library.

 However, at least one other role that faculty see for the library is in the realm of preservation. From one researcher’s perspective, digital preservation is, “an area that actually doesn't require a lot of content expertise and is a huge pain for people to deal with. Even for us, that's a huge pain to try to have archival storage of our data. I think you should all help us with that. […] and the stuff is disappearing like crazy.”

 Additionally, despite findings from some previous studies (Nicholas 2017), our respondents recognized the role of library providing full-text content. They still rely on the library as the source of the full text content for materials they need and are often satisfied with the library’s ability to provide these resources. As one respondent said, “I mean, Pitt Libraries have access to everything I read regularly, but you'll end up in these obscure journals where it wasn't part of the bundle. I actually wouldn't consider that a major barrier.”

**Discussion**

Insights gained from the interviews leave us to consider new ways that the library can enhance researchers’ discovery work. It is clear that two major forces are particularly relevant to the information discovery phase of the research process. The first is the diversity of information sources relevant to research. Today, content is found not only in library stacks, or in licensed digital resources, but in open access publications, open repositories, researchers’ personal sites, government and policy pages, and increasingly in social media. Relevant material also exists in raw data, and other artifacts of research that exist outside formal scholarly literature but are core components of an expanded scholarly record made possible by digital research. As a result, material is scattered across an array of platforms, is poorly structured, and often lacks any formal curatorial approach. Although researchers may not see a role for librarians in the discovery process, information professionals have a thorough understanding of discovery methods and how to enhance discoverability of content and promote persistent means to access that content.
 The second influence stems from current trends inside scholarly research. We are in an age of growing complexity and rich specialization, and the ability to understand a disciplinary landscape requires deep training in the field. The impact of this trend is exacerbated by two further issues: increasing interdisciplinarity, requiring an understanding of context across multiple fields, and the impact of artificial intelligence and machine learning on many disciplines.

**Conclusions and Recommendations for Future Research**

While the initial impetus for our research was to discover to what extent early career researchers in life science and engineering at the University of Pittsburgh are using the expensive A&I databases purchased by the library, we intentionally created an interview tool that would also gather specific information on how they manage the process of discovery when embarking on a new research project. Although the sample size was statistically sound according to the guidelines outlined by Guest, Bunce, and Johnson, it was smaller than we would have liked. However, preliminary data from the triennial Ithaka S+R US Faculty Survey that we fielded in November 2021 appears to confirm our findings.1 What we learned through the 12 interviews, though, ultimately gave us a fresh perspective of how the discovery phase of the research process has changed due to the ubiquitous presence of social media and the role that it plays in scholarly research: Google Scholar, Twitter, and other social media platforms are now the essential preferred tools for discovery. As we realized the extent to which newer researchers have seamlessly adopted a process that depends on identifying indexing and abstracting content that is outside of the traditional academic library subscriptions, we revisited a list of requests from faculty for niche proprietary licensed content.

The process of doing semi-structured interviews provided the opportunity for us to hear firsthand the struggles and successes of ECR faculty as they navigate through the landscape of scientific studies. There is much opportunity for future research. For instance, work is needed to explore if we would see similar behaviors with ECRs on our campus from other disciplines. It would be interesting to probe the current discovery practices of this cohort from both arts & humanities and the social sciences. Likewise, we would like to understand these behaviors from researchers in other STEM disciplines and among more senior researchers. Also, now that we have developed and tested this survey, it can be used again to occasionally check in with the next wave of ECRs and other user communities. The quickly changing landscape of scholarly discovery necessitates ongoing study of evolving researcher practices. This landscape includes not only where researchers look for information but also the type of content they find relevant. In the discovery stage, apart from peer reviewed literature, our respondents indicated a reliance on a range of content from grey literature to conversations on social media. Keeping abreast of scholarly practices will provide us with an opportunity to regularly gauge how well the library is meeting their needs.

Acknowledgments: This research was conducted as part of ARL Impact Project.

1 In November 2021, Pitt’s University Library System fielded an Ithaka S+R Faculty Survey. It yielded the response rate of 17%, with slightly over 900 respondents.

To a question “*When you explore the scholarly literature to find new journal articles and monographs relevant to your research interests, how do you most often begin your process*?”, 80% of early career engineering faculty pointed either to Google Scholar or a general search engine (vs. 13% beginning their searcher in specialized databases and 8% in a library website or catalog), 54% of faculty in science disciplines begin their searches in Google Scholar or a general search engine (vs. 31% in specialized databases and 13% in a library catalog or website).

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**Appendix 1: Interview Guide**

1. Building context: Current Research Area of Focus [NOTE: This provides the foundation and context for the rest of the interview, and helps establish a conversational tone and build rapport]
	1. Broadly speaking, describe your research area of interest.
		1. What is your primary research question or objective?
		2. How long have you been researching this area?
		3. What got you interested in this research area (or topic or issue)?
	2. Describe for me the current project(s) you are working on to address this research objective.
		1. What do you hope will be the outcomes or “products” from this/these projects? (what are the artefacts and how are they communicated?)
	3. Is there a lot going on in this research area right now?
		1. How much is published or written about on this topic or issue? (is this new, breakthrough, or established area?)
		2. How do you keep up with what is going on in the field? (where do they look? Print Sources, people, conferences, routines, other)
2. Information Seeking – Attitudes & Behavior
	1. Through your research process you may need to find information. For instance, fow do you typically go about doing this? [NOTE: Listen for activities related to gaining information]
		1. What type of information are you looking for/do you need?
		2. What is the best source for this information?

Where/how do you access this source? [NOTE: Listen for library and probe]

What makes this the best source? [Possible responses: Easy/fast, convenient, free, most complete. Probe to clarify meaning for participant.

* 1. What is the worst source for this information?
		1. What makes this the worst source?
	2. I noticed you have not mentioned X. Do you ever use it (for instance, in teaching, research, promotion, other)? [Probe as required: Google Scholar, Research Gate, SciHub, SCOPUS, WOS,, various databases (probe for which and how they are accessed)]
	3. How do you know when you have what you need for your research purposes? (How much is enough?)
		1. What do you do when you cannot find “enough” information?

Overcoming Challenges & Opportunities for the Library

* 1. You have talked about the best and the worse sources for discovery of information you need. How would you describe your biggest challenge to gaining the information you need?
		1. What would remove or ease these challenges?
	2. What, if any, role could the library play in easing these challenges or facilitating your information gathering?

 “Ideal” Information Gathering

* 1. Before I let you go, I have one final question. We have talked a lot today about your research process and, specifically, how you gain information to inform your research. If you could create an “ideal” scenario of the information-gathering process for you and your work, what would it be. There are no rules here. I am simply asking you to imagine an “ideal” way to discover information.