



Engineering Graduate Student Information Literacy: Are We Meeting the Need?

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Abstract

Library instruction for engineering graduate students at the University of Michigan (U-M) has historically been ad hoc; librarians respond to requests for instruction, but to date they have not provided instruction as an intentional program of information literacy topics. Engineering librarians promote library services at department orientation sessions and have worked with the College of Engineering's Graduate Education Programs office to present instruction on topics including literature reviews, data management, finding funding, and reading retention. Attendance at and response to these instruction sessions suggest that a formal program of instruction can be beneficial to engineering graduate students. Considering that individual students approach the librarians for instruction on topics such as strategies for literature reviews, or that individual faculty members approach the librarians for instruction to the students in their labs on topics such as best resources for researching specific subjects or instruction on citation management applications, one might reasonably conclude that there is an unmet need for a broad instruction program. In this project, the engineering librarians of the U-M disseminated a Qualtrics survey to engineering graduate students on their needs for library instruction. The survey differentiated between students who are writing theses and those who are not. By looking at students who are doing research and those who are not as two separate populations, the survey may identify needs for instruction that go beyond common library instruction topics such as literature reviews and the library had not previously considered. This paper will summarize the results of the survey and discuss plans for implementation of an instruction program of information literacy topics.

Background

In fall semester 2017, a group of graduate students in the College of Engineering (CoE) at the University of Michigan (U-M) were awarded a community grant from the U-M Rackham graduate school. The students' grant proposal was a "Grad School Boot Camp," and it sought funding to sponsor a series of events on topics pertinent to succeeding in graduate school. For one of these events, the group contacted the library to ask for a presentation called "How to Conduct a Proper Literature Review." Clearly, these students saw engagement with the library as a step toward succeeding in graduate school.

At the same time, the engineering librarians at the U-M Art, Architecture & Engineering Library (AAEL) were looking for ways the library could better engage with CoE graduate students. The library's resources and services help students in many ways, such as support for literature reviews, citation management, data management, and publishing, but the librarians wondered how well students took advantage of these resources.

For fall semester 2017, the U-M CoE enrolled 3,637 graduate students in 15 departments and programs. This represented 27% of the total U-M graduate student enrollment of 13,415

students. Among the CoE graduate students, 1,968 students were enrolled in master's programs and 1,669 were enrolled in doctoral programs.

The three engineering liaison librarians undertake many efforts to make students aware of library resources and services: They present informational sessions at department and college-wide new student orientations, present in selected classes and department seminars, and regularly talk with students at departmental social events. The library also offers workshops sponsored by the college on topics such as finding funding, copyright, publishing, and reading of journal articles. Even so, as most new engineering resources have moved online, the engineering librarians felt that graduate students were unaware of library resources and services, and there was a need for a program of library instruction targeted toward the students.

CoE doctoral students and researchers are required by the college to complete a four-session Responsible Conduct of Research and Scholarship (RCRS) program if they are working on federally funded research projects. This program includes sessions on Authorship, Data Management, Conflict of Interest, and Professional Ethics. Although the librarians are present at and offer input to all of the Authorship and Data Management sessions, these sessions are broad overviews that only briefly touch on topics such as literature reviews and data management best practices. Further, this program applies only to students who will be doing research; it is not a requirement of non-thesis master's students.

Saunders et al. state that "Faculty members and even librarians often seem to assume that graduate students enter programs already having attained the information literacy skills necessary for the research and analysis required of their programs..." Through their study, they conclude, "The results of this study belie the assumption that graduate students have honed their information literacy skills through their prior education...[1]"

In 2017, the engineering librarians at AAEL surveyed CoE graduate students in order to learn about the students' needs for library instruction. Considering the graduate students' request for a workshop on literature reviews and the engineering librarians' anecdotal evidence about graduate students' needs for library instruction, in addition to information reported in the literature, it seemed apparent that more instruction was needed.

After the completion of the survey, the librarians then talked with eighteen students divided between two focus groups to ask for more in-depth feedback. This paper reports on the findings of the survey and focus groups. The survey and focus group results will be of interest to academic librarians and engineering educators and administrators interested in increasing information literacy for engineering graduate students.

Review of the Literature

A review of the literature shows that there is a need for more research into information literacy for graduate students, that the current methods of delivering library instruction to graduate students do not meet their specific needs, and that tailored sessions are necessary for success.

Information Literacy is crucial to college students' learning and success, yet "research on instruction and assessment for information literacy at the graduate level is less common" than the undergraduate level. Often, graduate students are "dealing with more specialized information which requires more sophisticated skills to access, evaluate, and use." Research has shown that "graduate students tend to be confident in their information literacy abilities, although that confidence is not always demonstrated in their practice." Studies show that "graduate students do indeed benefit from and often appreciate instruction for information literacy [1]." At the University of Iowa, Barton et. al. indicated a need "for the overall study of graduate student use of the library [2]." According to Smith and Whitman at Wichita State University, "information literacy skills ...are a critical component of a graduate education." They point out that undergraduates often have little formal instruction in conducting traditional research, so they are ill-prepared when graduate school begins. Their pilot program of delivering library instruction via in-person classes and recorded lectures to graduate students showed that students prefer the flexibility of choosing a delivery method, whether that was online, in print, or in person [3].

Ackerson, in studying science and engineering students at the University of Alabama, confirms that "Too often, the guidance offered by librarians is insufficient to support the complex information-gathering activities required of students at the graduate level [4]." After a study of graduate students' information behavior at Carnegie Mellon, George et al. concluded "Libraries need to create awareness among graduate students about the services and resources that are available and how to use them [5]." Vrkić and Pavlovski conducted a survey of engineering students and determined that most engineering students rely on general web searching and colleagues before consulting peer-reviewed library databases or librarians. To bridge this information gap, the "library needs to pursue...the implementation of information literacy into the curriculum." By customizing the type of instruction aimed at engineering students in this way, students "gain necessarily required information skills that could extend the time for development of creativity...[6]"

At the University of Iowa, engineering librarians developed a series of "express classes" of library instruction for engineering students, meant to take less than 30 minutes and focused on needs established by surveying the College of Engineering faculty, students, and staff directly. The most heavily-attended classes were for citation management, searching for standards, and PubMed database searching. This method of instruction was successful for them, as long as the sessions did not conflict with existing seminars in the College of Engineering [7]. The librarians at Taylor Library at the University of Ontario did an information needs assessment of their engineering and science graduate students and developed workshops to meet those needs. The most popular workshops were on citation management, keeping current with scholarly literature, and advanced searching strategies. The students overwhelmingly preferred online instruction options, and expressed a desire for both introductory and advanced levels of the topics [8]. After a survey of physical science graduate students at the University of Oklahoma, Brown recommended that "...future library instruction be tailored to meet the students' specific needs. Students are more receptive at the beginning of their academic careers, yet they require expert information-seeking ability as they progress in their program. Therefore, separate programs should be planned for the beginner, intermediate, and advanced researcher [9]."

Survey Methods

Librarians administered an online survey of CoE graduate students in November 2017 using Qualtrics. The engineering liaison librarians announced the survey by email to graduate students in their liaison areas. The survey was open for three weeks. Librarians sent second email announcements after the first two-week period of the survey. Survey respondents were self-selecting and anonymous, and the library did not offer incentives for completing the survey.

Some U-M CoE graduate master's degree programs do not require students to complete master's theses, and so the survey began with simple demographic questions to determine a) the student's department or program; b) whether the student was working toward a master's or PhD degree; and c) for a master's student, whether the student would be completing a master's thesis.

Non-thesis master's students were asked a shorter set of questions than were asked of students who would be writing master's or PhD theses. This decision was part of the survey design, where the librarians concluded that many of the survey questions would not apply to non-thesis students.

The survey asked students about literature reviews, citation managers, data management, databases used, knowledge of copyright, and finding research funding. These topics were chosen because each represents an area of expertise in the library, and are typically the subjects taught by engineering librarians. Each question was followed up by "Are you interested in learning about...?" All survey respondents were invited to fill in the blank, "Describe any research needs that you need help with that are not being met." Finally, the survey invited students who agreed to be contacted to be part of a focus group to provide their contact information.

Please consult Appendix A for the complete survey.

Survey Results

With 392 surveys completed from an engineering graduate student population of 3,637 (1,968 master's students and 1,669 PhD students), the survey response rate was 10.7%. Divided by degree program, 242 (14.5%) of the PhD students responded, and 150 (7.6%) of the master's students responded. Most of the master's students who responded to the survey, 130 (86.7%), were on a non-thesis track. (Please note that most survey questions were response optional, and therefore total numbers of responses in the results reported below may be different from the total number of surveys completed.)

What year are you in your PhD studies?

Year in Program	Number of Responses
Year One	50
Year Two	46
Year Three	49
Year Four	42
Year Five	34
Year Six	12
More than Six Years	3

Figure 1. PhD student breakdown by year

A breakdown of survey responses by department is shown in Figure 2. The response rate corresponds to the department size.

What department do you belong to?

Department	Number of Respondents	Department	Number of Respondents
Electrical Eng + Computer Science	82	Chemical Engineering	26
Mechanical Engineering	68	Integrative Systems + Design	24
Civil + Environmental Engineering	38	Climate + Space Sciences Eng	15
Aerospace Engineering	32	Nuclear Eng + Radiological Sciences	14
Materials Science + Engineering	32	Naval Architecture + Marine Eng	3
Industrial + Operations Engineering	29	Interdisciplinary Graduate Programs	3
Biomedical Engineering	26		

Figure 2. Survey respondents' breakdown by College of Engineering Department

After answering demographic questions, students answered questions about their library research practices. Those questions and answers are shown below. A more complete discussion of the implications of the survey results can be found in the survey analysis section of this paper.

Please note that within this section on survey results, percentages may not add to 100 due to rounding.

“How effective are you at doing a literature review?”

- Extremely effective – 13 (4%)
- Very effective – 71 (21%)
- Moderately effective – 181 (54%)
- Slightly effective – 61 (18%)
- Not effective at all – 8 (3%)

“What databases do you search when doing a literature review?” (choose all that apply)

- Google Scholar – 305
- Web of Science – 99
- Scopus – 61
- PubMed – 49
- Other – 46
- Engineering Village, INSPEC – 13
- Engineering Village, Compendex – 13

Students who selected “other” were invited to name the other databases that they used. Responses are summarized in Figure 3.

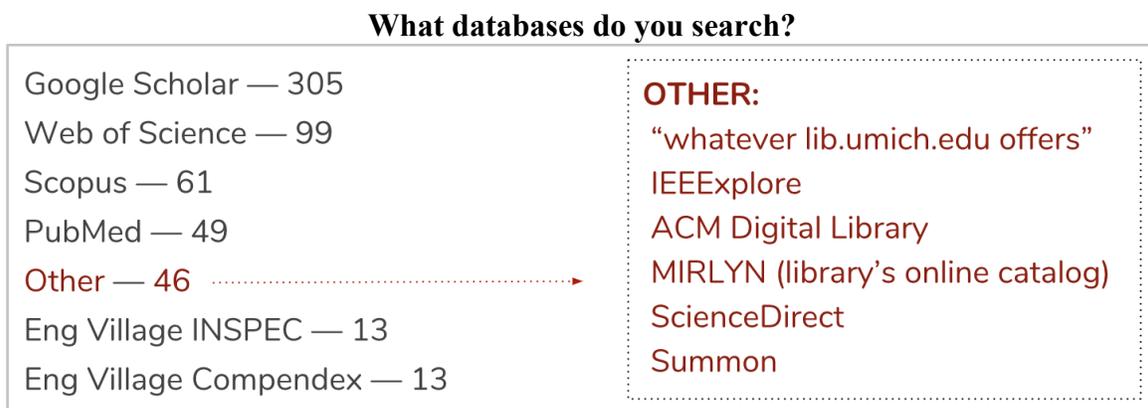


Figure 3. Survey respondents’ database use.

“Are you interested in learning how to do a literature review search?”

- Yes – 166 (50%)
- Maybe – 118 (35%)
- No – 51 (15%)

“What citation management systems do you use to manage citations and documents?” (select only one)

- Zotero – 39 (12%)
- Mendeley – 135 (43%)
- EndNote – 38 (12%)
- RefWorks – 18 (6%)
- Other – 84 (27%)

Students who selected “other” were invited to name their citation managers. Frequent responses

are summarized in Figure 4.

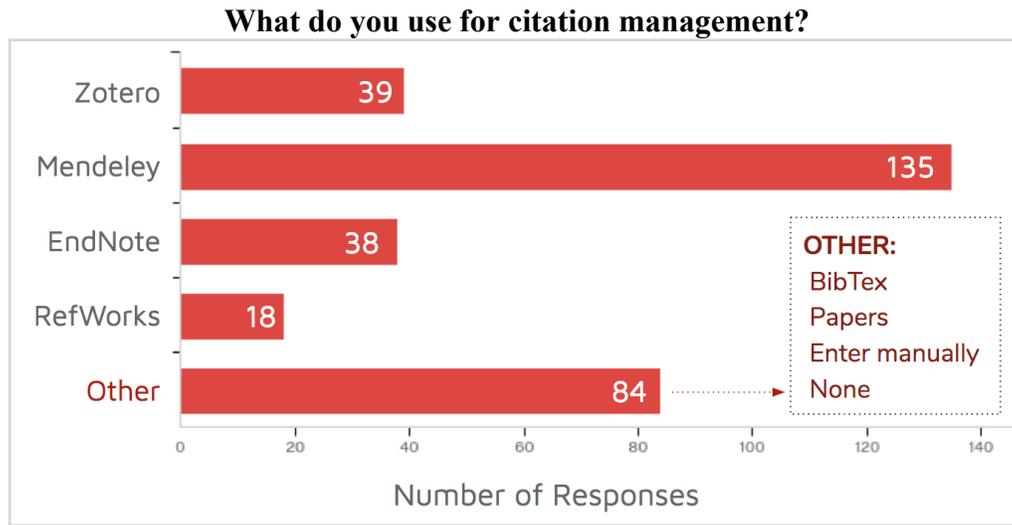


Figure 4. Survey respondents' top use of citation managers.

“Are you interested in learning to use citation management systems?”

Yes – 156 (48%)
Maybe – 80 (25%)
No – 90 (28%)

The next part of the survey was administered only to students on a research track, defined as PhD and Thesis-track master's students.

“Do you need to find funding for your research?”

Yes – 68 (29%)
No – 164 (71%)

“Are you interested in learning about how to find funding?”

Yes – 154 (66%)
No – 78 (34%)

“Are you confident the research data you are collecting is saved appropriately?”

Yes – 90 (39%)
Maybe – 108 (47%)
No – 32 (14%)

“Are you confident you can analyze results when you are ready to write about them?”

Yes – 138 (60%)
Maybe – 83 (36%)
No – 9 (4%)

“Are you interested in training on how to collect data in a format that adheres to grant funding regulation?”

Yes – 121 (53%)

Maybe – 71 (31%)

No – 38 (16%)

“Are you aware of the best journals to publish in your research area?”

Yes – 168 (73%)

No – 61 (27%)

“Are you interested in having training on how to find journals that are important in your area?”

Yes – 141 (62%)

No – 87 (38%)

“Are you aware you can negotiate your copyright license when publishing?”

Yes – 58 (25%)

No – 170 (75%)

“Are you interested in having training on how to negotiate a publishing contract?”

Yes – 113 (50%)

Maybe – 90 (39%)

No – 25 (11%)

The last question was asked of all students, both students on a research track and the non-thesis master’s students: “Describe any research needs that you need help with that are not being met.” Forty students responded to this fill-in-the-blank question. Common themes in the responses fell in these categories:

- Access to Articles
- Finding Funding
- Data Management
- Return physical engineering books to the library from offsite storage

Below are some of the interesting responses:

- Research in fields that I have little or no expertise: how to quickly find the background information I need
- Effective way to store data in a single location
- Finding OLD articles, ie pre-internet, some journals I need are not online
- Training on how to get out of the research game
- ...my research sometimes does not have a particular "best" journal, but rather a couple of journals from different disciplines/fields that are potentially "best"

Survey Analysis

By asking graduate students to reply to this survey, the engineering librarians were able to gain some information on how students are conducting library research and what services they wanted from the library.

The engineering librarians had openly questioned whether they were providing enough information literacy and other research instruction to engineering graduate students, and results of the survey seemed to indicate that graduate students would make use of more instruction. Many students indicated they wanted additional training in areas like data management, literature reviews, and finding funding, even if their research did not actively involve those activities. The library typically offers training in popular citation management software like Zotero, EndNote, RefWorks, and Mendeley. The survey showed that engineering students may also have a need for instruction in BibTeX, which the librarians would not have known if students had not written in this response.

While it was not surprising to see that most respondents reported using Google Scholar for their research, there were some surprises to the question about database usage. One of the databases always presented in instruction sessions by librarians is Engineering Village, and the librarians were surprised to learn that it ranked sixth on the list of databases consulted by students.

The engineering librarians looked at analyzing data from different departments and years of PhD program but these data did not provide any obvious correlation. For instance, one question might be whether first year PhD students reported that they were less effective at literature searches than higher year PhD students reported. Since obvious conclusions could not be made these data were not analyzed further.

Results of the survey were presented to U-M Library staff at a forum for staff in public services, and at a research data services monthly meeting, to share results and answer related questions.

The results of the survey led to more questions. For instance, one might wonder why responses to the questions about receiving training were consistently majority yes/maybe. Were students answering this in the affirmative simply because the survey was prompting them to consider that training might be available? In other instances, the librarians found themselves wanting to hear more in-depth responses from the students.

Because of this, it was decided to recruit students to participate in focus groups.

Focus Group Methodology

There were 178 students who indicated on the survey they would be willing to be contacted in the future with additional questions or be part of a focus group. These students were invited via email to attend one of two focus groups held the first week of December. The goal was to have at least ten students in each focus group, to get a breadth of ideas, yet keep the focus group size manageable. After determining availability, fifteen students were formally invited to each focus

group, and there were nine students in each focus group. Three of the eighteen students were master's students, and the rest were PhD students. Focus groups were held at lunch time, and pizza was provided with funding from the library.

Please consult Appendix B for the focus group questions.

Focus Group Analysis

Information on each student's home departments and degree were gathered at the beginning of the focus groups. Results are below in Figure 5.

Departmental and Degree Breakdown of Focus Groups			
Electrical & Computer Engineering	1		
Chemical Engineering	1		
Materials Science & Engineering	2	PhD	15
Civil & Environmental Engineering	3	Masters (non-thesis)	1
Mechanical Engineering	3	Masters (thesis)	2
Industrial & Operations Engineering	2		
Climate & Space Sciences Engineering	1		
Aerospace Engineering	2		
Computer Science Engineering	1		
Nuclear Engineering & Radiological Sciences	2		

Figure 5. Focus Group Students by Department

The majority of the focus group students were aware that there was a specific liaison librarian to each of their departments, although not all knew exactly who that person was. Often in instructional sessions the librarians will ask students if they know they have a liaison, and many do not. It was therefore heartening to hear that graduate students knew about their liaisons from previous orientations, workshops, and seminars.

All but four of the students had conducted a literature review as a routine part of their research, although the reviews varied in their type and scope, with none of them having done a full systematic review. All of the students were interested in formal training in how to conduct

literature reviews, because they felt they were just making it up as they went along. Formal training would ensure they were using their time wisely.

Every attendee used Google Scholar during their literature searches, either as a starting point or after they had grown frustrated with the library's results from the article aggregator (Summon). Of interest to the librarians in this part of the discussion was the perceived difficulty in using the library's search omnibox, seen as too complicated to use compared to Google Scholar. Many students confessed to giving up on finding an article if it wasn't in Google Scholar or the library's aggregator because "inter-library loan seemed too hard," despite the fact that the library's inter-library loan form auto-completes citation information from databases. Most attendees also didn't understand the difference between subject-specific databases like Engineering Village's INSPEC or Web of Science and the Summon article aggregator. They were keen to learn about the advantages, but had never had formal training.

In addition to the librarians learning things from the students during the focus group, the students also learned from each other. One of the PhD students, in his fifth year of study, talked about using Google Scholar's alert function for new colleagues he meets in his department and prominent members of his field he would be seeing at upcoming conferences. This allows him to easily stay current on his field of research and gives him an advantage when networking. The other students were actively interested in this idea and wanted to learn how to do it.

There was no consensus in preference for a specific citation manager, and the students seemed to be influenced heavily by what their fellow researchers or lab mates were using. They did have a strong desire for more training of bibliographic and file organization principles in general, including folder hierarchy, file naming best practices, and exporting/importing between citation managers. Some of the students used BibTeX, and the ones who didn't were interested in additional training. Currently the library does not offer any instruction in BibTeX; that expertise needs to be developed.

Some students needed help with large datasets while working on them and wanted to know what resources were available to them to work with large data. They were also interested in deep-level analysis of data (statistics, R, etc).

About six months prior to the focus group meetings the majority of the engineering print books had been moved from the library to offsite storage. The loss of the ability to serendipitously browse the stacks was felt strongly by both focus groups.

The focus groups met the first week of December, very close to the end of the term. Students suggested holding future focus groups at a different time, when their attention and free time was less fragmented. They also suggested workshops for things like literature reviews and citation

managers would be better received after their first term, when they had active research projects and reference points for the topics being presented.

Implications for the Future

The librarians plan to share these survey results with CoE administration, the CoE Engineering Faculty Library Advisory Committee, and departmental graduate chairs. It seems clear from the survey results that CoE graduate students can benefit from added library instruction. Based on consultations with administrators and department chairs, the engineering librarians plan to put in place an instruction program that will touch on all of the subjects covered in the survey, starting in the Fall 2018 semester. Initial ideas for assessment include an annual survey of graduate students, a graduate student advisory group, and adding library-related questions to the exit interviews of graduate students.

Conclusion

Research on library instruction asserts that students enter graduate programs lacking some of the essential library research skills that they need to succeed in graduate school. Based on these survey and focus group results, the engineering librarians at the University of Michigan agree with this assertion. It appears that engineering graduate students at this institution will welcome the prospect of instruction in areas such as literature searches, citation management, and data management as they pursue their graduate degrees. Further, instruction on finding funding for research can help graduate students to prepare for their careers as researchers. Focus group results indicate that many graduate students have specific research questions that can be resolved through greater engagement with the library.

Before conducting this survey, the engineering librarians at the University of Michigan have had only their personal experiences to use when talking with administrators about a need for a library instruction program for engineering graduate students. These survey and focus group results provide an important first step in creating a comprehensive program of library instruction aimed specifically at engineering graduate students. With information gained through this project, the librarians are well positioned for offering timely instruction that can ultimately help CoE graduate students to be more successful both in graduate school and beyond.

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Appendix A - Qualtrics Survey

Grad Student Research Lifecycle Needs

The engineering librarians at the _____ are interested in your input. We are conducting this survey of engineering graduate students to learn more about your research practices and to identify areas where library services and workshops can help you as you work toward your graduate degrees. All information you provide will be secure and anonymous. We would appreciate it if you will take five minutes to respond to the survey.

Please select your department:

- Aerospace Engineering
- Biomedical Engineering
- Chemical Engineering
- Civil and Environmental Engineering
- Climate and Space Sciences Engineering
- Electrical Engineering and Computer Science
- Industrial and Operations Engineering
- Integrative Systems & Design
- Materials Science and Engineering
- Mechanical Engineering
- Naval Architecture and Marine Engineering
- Nuclear Engineering and Radiological Sciences
- Interdisciplinary Graduate Programs
- Other _____

What is your status?

- Master's
- PhD

What track are you on?

- Thesis
- Non-Thesis

What year?

- 1st
- 2nd
- 3rd
- 4th
- 5th
- 6th
- 6+

How effective are you at doing a literature review?

- Extremely effective
- Very effective
- Moderately effective
- Slightly effective
- Not effective at all

What databases do you search when doing a literature review?

- Google Scholar
- Web of Science
- Scopus
- Compendex/Engineering Village
- INSPEC/Engineering Village
- Pubmed
- Other _____

Are you interested in learning how to do a literature review search?

- Yes
- Maybe
- No

What citation management systems do you use to manage citations and documents?

- Zotero
- Mendeley
- EndNote
- RefWorks
- Other _____

Are you interested in learning to use citation management systems?

- Yes
- Maybe
- No

Describe any research needs that you need help with that are not being met:

Can we contact you in the future with additional questions or to be part of a focus group?

- Yes
- No

Please provide your email address:

Survey continued below only for Thesis-track students

Do you need to find funding for your research?

- Yes
- No

Are you interested in learning about how to find funding?

- Yes
- No

Are you confident the research data you are collecting is saved appropriately?

- Yes
- Maybe
- No

Are you confident you can analyze results when you are ready to write about them?

- Yes
- Maybe
- No

Are you interested in training on how to collect data in a format that adheres to grant funding regulation?

- Yes
- Maybe
- No

Are you aware of the best journals to publish in your research area?

- Yes
- No

Are you interested in having training on how to find journals that are important in your area?

- Yes
- No

Are you aware you can negotiate your copyright license when publishing?

- Yes
- No

Are you interested in having training on how to negotiate a publishing contract?

- Yes
- Maybe
- No

Appendix B - Focus Group Questions

Library Focus Group Questions

- 1 - QUESTION: How many of you knew you had a liaison librarian for your department?
 - How did you find out about them?

- 2 - QUESTION: How are you using literature reviews in your research?
 - When you run into roadblocks in finding articles/tech reports what do you do?

- 3 - QUESTION: How are you navigating to databases used in your research?
(directly to database, VPN, library website, bookmarklet)
 - Do you have any issues when using databases?
 - Are you using more than one, if so why?

- 4 - QUESTION: Is there anything your citation manager cannot do? / Any problems with the citation manager you currently use?
 - Why do you use what you use?
 - What kind of citation training would you like to attend?

- 5 - QUESTION: Would you be interested in further training on any of these parts of the data lifecycle?
 - Collecting / saving / analyzing / satisfying grant requirements for open access

- 6 - QUESTION: Why do you want to learn to find funding?
 - For immediate needs or future needs?

- 7 - QUESTION: How many of you have published before?
 - How many of you are aware that publishers have negotiable contracts with regard to your copyright?

- 8 - Open Discussion
 - What research support do you need that the library might be able to provide?
 - When is a good time in the semester to learn about library functions?
 - How would you feel about a library session in conjunction with the RCRS required workshops?