

Assessing the User Needs of STEM Graduate Students: A Comparative Analysis

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Abstract

This paper reports on findings of a local version of the Ithaka S+R Graduate and Professional Student Survey administered at Auburn University during the 2018 spring semester. It offers a comparative analysis of the survey responses of Auburn STEM and non-STEM graduate students, with a focus on questions related to (a) patterns of information discovery and usage, (b) research skills that respondents believe contribute to academic and professional success, and (c) respondents' perceptions regarding the library's role in supporting different parts of the research cycle. The authors reflect on the implications that disciplinary differences in research practices and expectations have for research support services tailored to the specific needs of STEM students.

Introduction

Graduate students are significant contributors to research activity on university campuses, and their professional education is central to the mission of their home institutions. Supporting the research needs of this population is thus of prime importance for academic libraries. However, graduate students are not a monolithic group. As library services for graduate students have expanded from providing access to collections to offering support throughout the entire research cycle, understanding disciplinary differences in researcher practices and expectations has proven vital to effective liaison services.

At Auburn University, students enrolled in STEM fields make up a significant portion of the graduate student population. Auburn is a land-grant and public research university with graduate and professional programs in a number of STEM fields, including life and physical sciences, mathematics, engineering, agriculture, forestry, nursing, pharmacy, and veterinary medicine. In 2018, out of a total enrollment of 5,812 graduate/professional students, 1,958, or about 34%, were STEM students.¹ Given these campus demographics, Auburn University Libraries (AUL) faculty were interested in learning more about the specific research needs of STEM students and exploring how, or whether, these needs differed from those of non-STEM students.

In December 2017, prompted in part by ongoing discussions and self-studies around librarians' evolving liaison roles, AUL librarians decided to move forward with participation in two large user surveys: the Ithaka S+R Faculty survey and the Ithaka S+R Graduate and Professional Student survey.² Library staff recognized that a more in-depth understanding of the research practices of Auburn faculty and graduate students would help librarians prioritize the resources and services that would be of most benefit to these user groups. They selected the Ithaka S+R surveys because they found the surveys' focus on researcher practices and perceptions to be well aligned with these objectives.

Because demographic data gathered by the Ithaka S+R Graduate and Professional Student survey included participants' academic programs, the authors of this study saw an opportunity to conduct a comparative analysis of the user needs of STEM and non-STEM students. They decided to focus on three areas of particular relevance for their work as subject liaison librarians: graduate students' patterns of information discovery and usage; their perceptions about the research skills needed for academic and professional success; and their views regarding the library's role in supporting different parts of the research cycle.

Methodology

In spring 2018, AUL librarians and Ithaka S+R staff prepared to implement local versions of the two surveys. The Graduate and Professional Student survey consists of modules focused on students' goals for their

higher education experience; their information discovery practices and resource use for coursework and research; and their perceptions of the role of the library in supporting their scholarly work. Library faculty also elected to include two optional survey modules, one focused on graduate students' attitudes toward conducting original research and the other on graduate student roles and activities as members of research groups and labs on campus. (The latter module was administered only to STEM students.)

After obtaining approval for the study from Auburn University's Institutional Review Board (IRB), library staff requested names, emails, and basic demographic information from the campus Office of Institutional Research. Invitations to participate in the survey were emailed to graduate students by Ithaca S+R. Library staff also promoted the survey in the campus graduate student newsletter and through social media on the Graduate Student Council's Facebook page. As an incentive for participation, students who completed the survey could choose to be entered in a drawing to win one of two Apple iPads.

Ithaca S+R distributed email invitations to 5,524 Auburn University graduate and professional students on March 24, 2018. Students received four additional reminder emails before the survey closed on April 29, 2018. About 27% (n=1,488) of those receiving the email clicked on the survey link; about 24% (n=1,337) started the survey. The response rate for participants who completed the survey was about 20% (n=1,105). Due to the survey flow and skip patterns, not all graduate and professional student participants received every question in the survey.

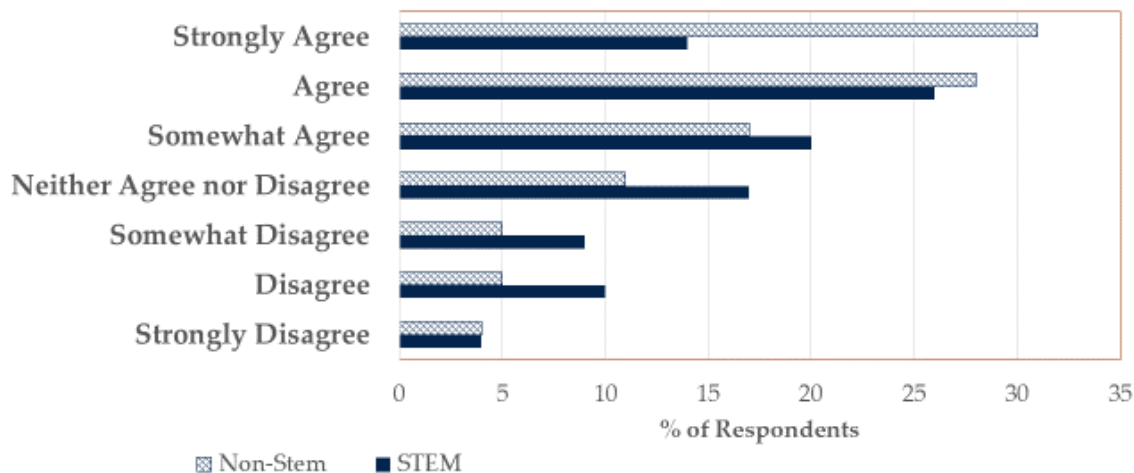
After receiving the Ithaca S+R Graduate and Professional Student survey report and cross tab stratifications of responses by demographic characteristics, the authors identified the specific subset of survey questions they thought were best aligned with their research focus. (See Appendices A, B, and C for lists of the survey questions and responses selected for analysis.) The subpopulation of STEM students was identified using responses to the question, "At this college or university, are you pursuing a degree in a STEM field or discipline?" The survey defines a STEM degree as "a science, technology, engineering or mathematics degree including computer/information sciences, life sciences, physical sciences, health sciences, agricultural sciences, and medical and veterinary fields." Findings of this study are discussed below.

Patterns of Information Use and Discovery

Ithaca S +R survey responses revealed both similarities and differences between STEM and non-STEM graduate students with respect to information use and discovery. Over half of STEM students (60%) and non-STEM students (59%) at the coursework stage of their programs found it "easy" or "somewhat easy" to access information needed for coursework and research projects. Among students seeking information for their dissertations, confidence levels were higher for STEM students but lower for non-STEM students. Sixty-six percent of STEM students and 56% of non-STEM students reported it was "easy" or "somewhat easy" to access information. STEM and non-STEM students diverged to a considerable degree on whether or not they viewed the library as "a starting point" for locating information, resources, or citations. Less than half of STEM students (41%) "agreed" or "strongly agreed" that the library was "a starting point" for their research while over half of non-STEM students (59%) held this view (see figure 1). Differences between the types of information used by STEM and non-STEM graduate students may possibly account for differences in their information seeking behaviors. At the coursework stage of their graduate programs, STEM students were more likely than non-STEM students to be making "regular" use of online video tutorials such as Khan Academy, Lynda.com, YouTube (26% STEM; 22% non-STEM), and online education resources such as Wikipedia and online study guides (41% STEM; 35% non-STEM), as well as other non-library resources. In contrast, non-STEM students at the coursework stage were making "regular" use of sources strongly associated with libraries: print books (48% non-STEM; 32% STEM), journal articles (75% non-STEM; 57% STEM), and historical documents (10% non-STEM; 7% STEM). However, there were also nuances between the two groups in the use of specific source types. For example, while there was a significant difference in the frequency of use of print books by STEM and non-STEM students, the gap closed considerably when students reported on their use of e-books. Over 25% of STEM students reported "regular" use of e-books, compared to 29% of non-STEM students. In the case of e-textbooks, the percentage of "regular" use by STEM students was the same as non-STEM (37% for both groups).

Figure 1

The library serves as a starting point for locating information, resources, or citations that I use for my coursework or research projects.



In addition, use of source types shifted as students transitioned from the coursework stage of their programs to the research stage (i.e., either master’s paper/capstone project or doctoral dissertation). For STEM students, “regular” use of study guides and online tutorials and education resources was lower while “regular” use of scholarly journals was higher and even surpassed use by non-STEM students (89% STEM; 82% non-STEM). Meanwhile, the gap between “regular” use of print books (29% STEM; 50% non-STEM) and historical documents (7% STEM; 22% non-STEM) was wider between the two groups.

One type of source in which the differences between STEM and non-STEM students was not great was use of data or datasets. At the coursework stage, 34% of STEM students reported “regular” use of data as compared to 33% of non-STEM students. At the research stage of graduate work, there was only a slightly wider margin of difference with respect to “regular” use of data (47% STEM; 42% non-STEM). A deeper dive into the survey results revealed a significant gap between humanities students’ use of data (28% at the research stage) and STEM students; however, regular use of data by social science students was very similar (49% at the research stage) to that of STEM students (see figure 2).

Research Practices and Perceptions

Both STEM and non-STEM graduate students anticipate that “research and analysis skills” will be “very useful” or “extremely useful” in helping them to secure their desired job or career (83% STEM; 80% non-STEM). A majority in both groups also “agree” or “strongly agree” that their instructors help them to develop the research skills needed to find and use academic sources of information (62% STEM; 59% non-STEM). A somewhat lower percentage of students in both groups indicate that library staff play a key role in this area. Among STEM students, this difference in perception is more pronounced. Just over 38% of STEM students, compared to 45% of non-STEM students, “agreed” or “strongly agreed” that library staff helped them develop research skills (see figure 3). Graduate students in the humanities, by contrast, were considerably more likely to see library staff as partners in research and, in fact, considered them to be of close-to-equal importance with their instructors in this regard. Over 58% of humanities students “agreed” or “strongly agreed” that library staff helped with research skills compared to 63% who “agreed” or “strongly agreed” that their instructors helped. Collaborating with faculty on original research projects provides graduate students with opportunities to be mentored by faculty, and a majority of both STEM and non-STEM graduate students regard it as “important” or “very important” to have this experience before they graduate. STEM students assigned greater importance to this than non-STEM students (67% STEM; 52% non-STEM).

A greater percentage of STEM students also found it to be “important” or “highly important” to be employed or receive college credit as a research assistant (51% STEM; 30% non-STEM). STEM students were also more likely to have had these experiences. Over 61% of STEM students reported collaborating with faculty on original research (compared to 40% of non-STEM students), and over 45% of STEM students were employed or received credit as a research assistant (compared with just over 22% of non-STEM students). Given the culture of collaborative research in the STEM fields, it is perhaps not surprising that STEM students view their instructors as key contributors to their development as researchers.

Figure 2

How often do you use each of the following types of sources of information in your research projects?

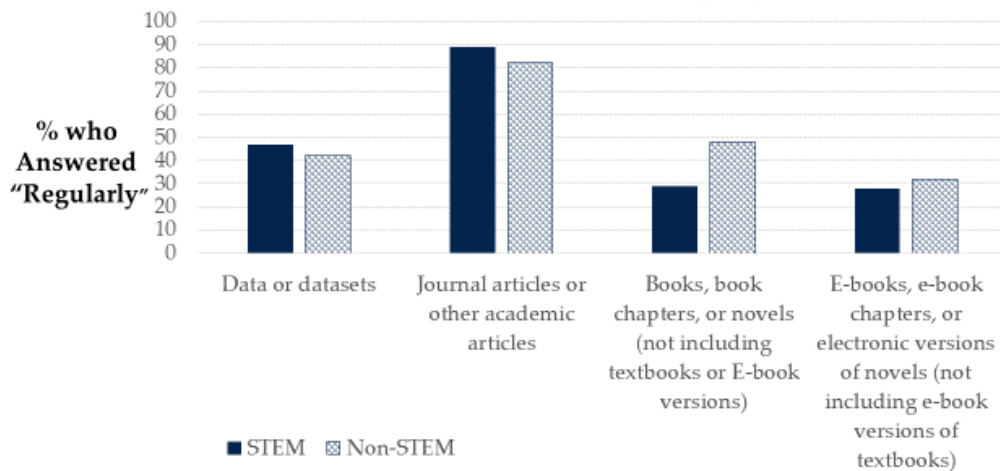
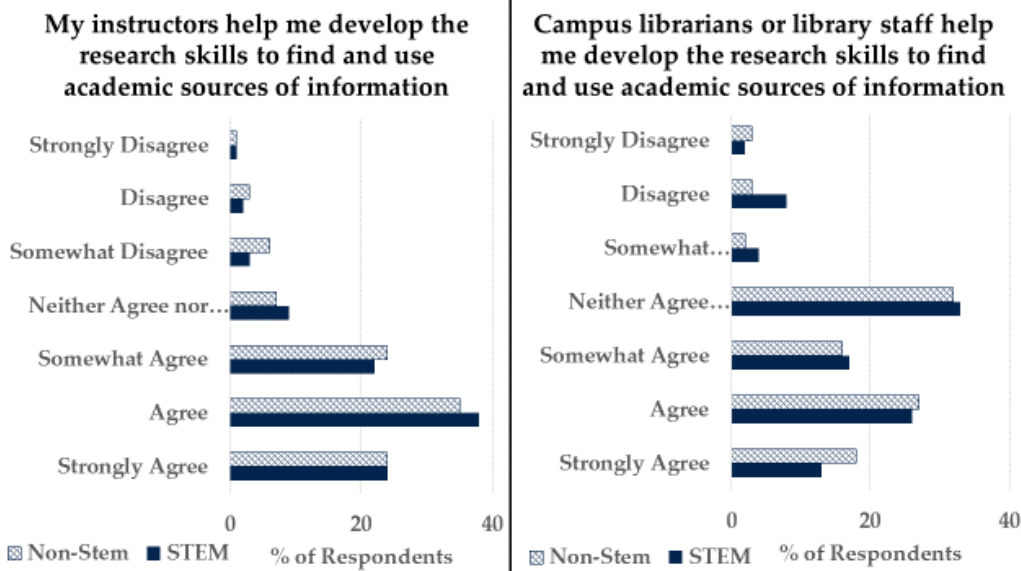


Figure 3

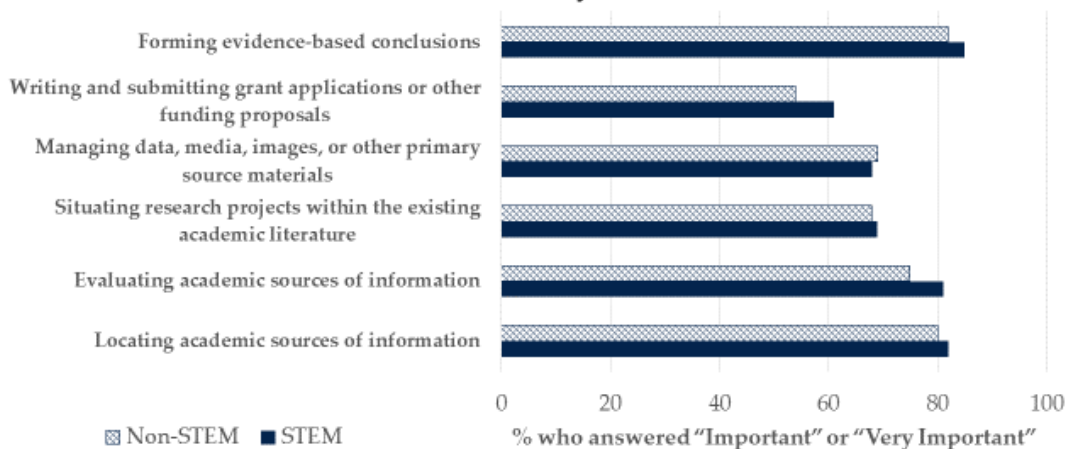


Conducting scholarly research calls for a variety of different research skills. More than eight in ten graduate students, both STEM and non-STEM, rated “locating academic sources of information,” “using information ethically (i.e., understanding the concept of intellectual property, copyright issues, and/or legal and ethical standards for the conduct of research),” “writing according to academic or discipline-specific standards,” and “forming evidence-based conclusions” as “important” or “highly important” research skills. They also

rated a number of other research skills as important. Over two-thirds of graduate students, both STEM and non-STEM, consider “evaluating academic sources of information,” “synthesizing or incorporating academic information into research projects,” “situating research projects within the existing academic literature,” “framing or developing original research questions,” and “analyzing data, media, images, or other primary source materials” to be “important” or “highly important” research skills. Of somewhat lesser importance to both STEM and non-STEM students were skills related to “writing and submitting grant applications or other funding proposals” and “managing data, media, images or other primary source materials.” In general, STEM and non-STEM students were very close in their ratings of the above research skills with the exception of grant writing skills, which STEM students were more likely to rate as “important” or “very important” (61% STEM; 54% non-STEM) (see figure 4).

Figure 4

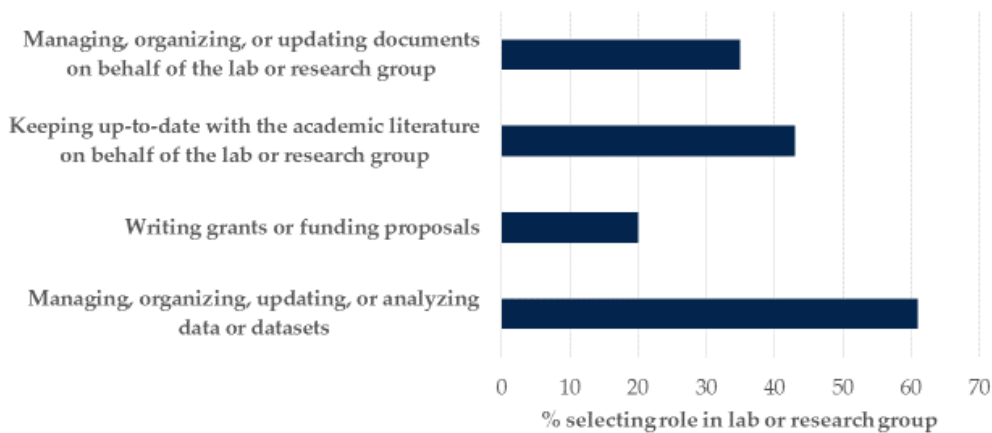
How important or unimportant is it to you to acquire each of the following research skills as a result of your experience at this college or university?



Auburn’s local version of the survey also includes a module consisting of questions answered only by STEM students. While this question set does not allow for comparisons with non-STEM students, it does provide context for STEM students’ responses about the skills needed to engage in research activity in their disciplines, including many of the skills listed above. For example, 57% of STEM students (n=381) responded that they worked in a lab or research group. This subgroup of STEM students answered questions pertaining to their roles in the lab which included “managing, organizing, updating, or analyzing data or datasets” (63% PhD; 58% master’s/professional); “keeping up to date with the academic literature on behalf of the lab or research group” (49% PhD; 33% master’s/professional); “managing, organizing, or updating documents on behalf of the lab or research group” (42% PhD; 26% master’s/professional); and “writing grants or funding proposals” (24% PhD; 13% master’s/professional) (see figure 5).

Figure 5

**Within your current lab or research group, which of the following describes your role(s) in the lab or research group? Please select all that apply:
(STEM students only)**



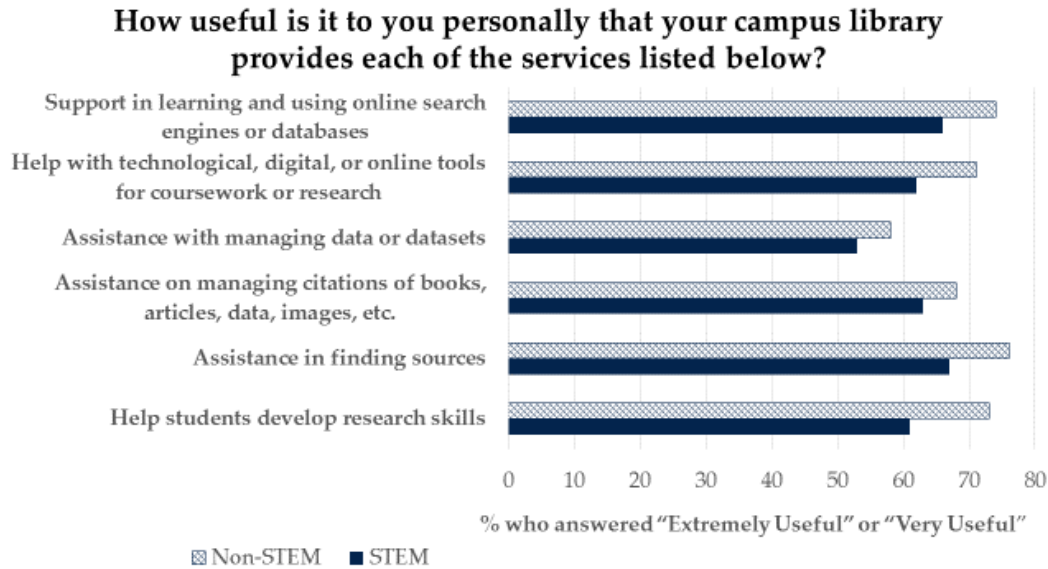
Additional questions probed STEM students’ perceptions regarding other skills required to do “cutting edge” work in their chosen job or career. PhD STEM students, in particular, assigned very high levels of usefulness (“extremely useful” or “very useful”) to: “proficiency in one or more programming languages” (65% PhD; 43% master’s/professional); “proficiency in specialized software programs or applications” (76% PhD; 59% master’s/professional); “proficiency in statistics or applied statistics fields” (79% PhD; 54% master’s/professional); and “proficiency in data science methodologies” (78% PhD; 58% master’s/professional).

Graduate Student Perceptions of the Library’s Role

The library role valued most by both STEM and non-STEM graduate students was that “the library pays for resources that I need for my coursework or research projects.” This provision of resources was seen as “very useful” or “extremely useful” by nine out of ten STEM (91%) and non-STEM students (91%). STEM and non-STEM students also held generally-similar views about the assistance provided by librarians/library staff with “managing citations of books, articles, data, images, or websites” (63% STEM; 68% non-STEM), “using information ethically” (61% STEM; 65% non-STEM), and “assistance or guidance with managing data or datasets” (53% STEM; 58% non-STEM).

STEM and non-STEM students differed to a greater extent in their perceptions of the usefulness of the library as the place that “stores, organizes, and keeps track of books, articles, data, images, or other resources,” with more non-STEM (83%) than STEM (76%) students viewing that role as “very useful” or “extremely useful.” Approximately three-fourths of non-STEM students view it as “very useful” or “extremely useful” that “the library helps students develop research skills” (73%) and that “librarians or library staff provide assistance or guidance in finding sources” (76%). In contrast, closer to two-thirds of STEM students respond “very useful” or “extremely useful” to these questions (61% and 67% respectively). Similar degrees of difference exist between the perceptions of STEM and non-STEM students with regard to the usefulness of librarians/library staff providing “help for learning about technological, digital, or online tools” (62% STEM; 71% non-STEM) and “support in learning and using online search engines or databases” (66% STEM; 74% non-STEM) (see figure 6).

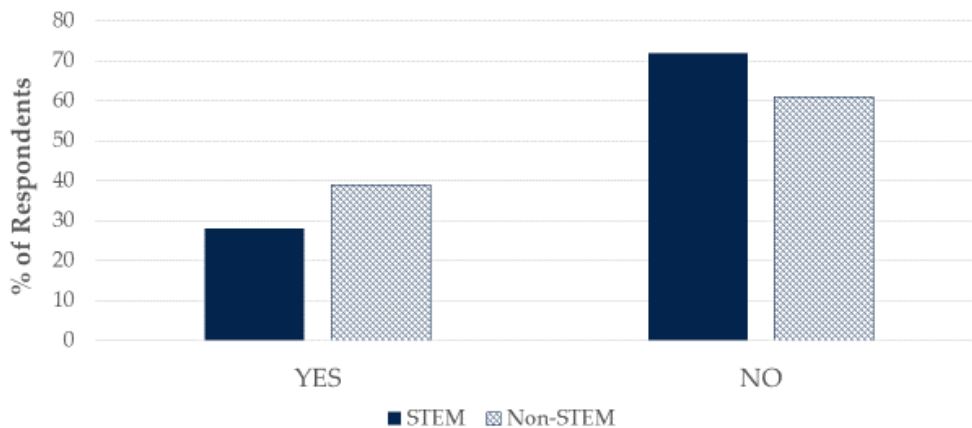
Figure 6



The fact that 39% of non-STEM students reported having “been directed by a faculty advisor, instructor, or professor to consult with a subject librarian,” compared to 28% of STEM students, may contribute to these differing perceptions about librarians’ roles (see figure 7).

Figure 7

Have you ever been directed by a faculty advisor, instructor, or professor to consult with a subject librarian or departmental library liaison at this college or university?



Attendance at library instruction classes may also factor into students’ perceptions. Although more than three-fourths of all students reported attending “a library information session, class, or section that was focused on finding sources of information for your major, field, or program of study,” the percentage was slightly higher for non-STEM students (75% STEM; 80% non-STEM). Moreover, while STEM students were more likely than non-STEM students to have “attended a library information session, class, or section that was taught during an orientation” (55% STEM; 44% non-STEM), non-STEM students were more likely to have “attended a library information session, class, or section that was taught by a librarian in a campus library building” (54% STEM; 65% non-STEM). It may be that course-integrated library instruction, provided at point of need, has a more positive impact on students’ perceptions than instruction provided

during information-packed orientations. Instruction that takes place in the library building itself may also serve to reinforce the perception of librarians as offering research support.

Custom Liaison Services: Next Steps

In addition to advanced, discipline-specific knowledge, graduate students in both STEM and non-STEM fields indicated that acquiring research skills was a key goal of their graduate education. Both groups place a premium on a broad range of research competencies that include not only the ability to find reliable sources of information but also other skills deployed throughout the research cycle, such as situating research projects within the existing academic literature, managing citations, using information ethically, managing data, and writing grant proposals. Variations between STEM and non-STEM students with respect to the perceived importance of these general research skills were not great. More noteworthy were the different perceptions STEM and non-STEM students had about the role that librarians played, or could play, in helping students to develop research skills. As the abovementioned responses indicate, STEM students were between 8 and 12% less likely than their non-STEM counterparts to view librarians as “very useful” or “extremely useful” in helping students to develop research skills, find sources, and learn how to use online search engines or databases. They were also 7% less likely than non-STEM students to “agree” or “strongly agree” that librarians had helped them to develop research skills.

Given these disparities, STEM students are prime candidates for targeted outreach. The collaborative research culture that exists in the sciences between students and instructors suggests that a promising avenue of approach may be to enlist the aid of STEM faculty. A STEM faculty member’s referral is likely to carry considerable weight with his or her students, and the survey data indicates considerable room for improvement in this area. While the STEM module of the survey provides basic information about the research activities of STEM students, follow-up studies would help to fill in more detail about the context in which disciplinary research occurs. This, in turn, would help to bring the specific information needs of STEM students into sharper focus. For example, it would be helpful to know how STEM students understand research skills such as “using information ethically” or “evaluating academic sources of information.” General research skills such as these are likely to have disciplinary dimensions that library instructors should attempt to address.

Additional research into disciplinary differences in information usage and discovery patterns would also help to inform library liaison work. As reported, less than half of STEM students (41%) “agreed” or “strongly agreed” that the library was “a starting point” for their research, compared to 59% of non-STEM students. How are STEM students locating the scholarly journal content that 89% are “regularly” using at the research stage of their programs? How heavily are students relying upon Google Scholar or scholarly networking sites such as ResearchGate when conducting research? Anecdotal evidence from Google Scholar workshops held on Auburn’s campus suggest that graduate students are often uncertain about the scope of the scholarly literature they are searching and frustrated when they find themselves unable to limit to discipline-specific content—both issues that could be addressed by the library’s subject databases.

Conclusion

As is so often the case with user surveys, responses to the Ithaca S+R Graduate and Professional Student Survey have generated additional research questions. Survey findings have also highlighted areas in which targeted liaison efforts could be of particular benefit to both STEM and non-STEM graduate students. AUL faculty plan to use the survey data to help better position themselves in graduate students’ academic and research workflows. Focusing on resources and services that have the greatest impact on these user groups’ practices and expectations will help to elevate the library’s profile as both partner in research and information content provider.

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Notes

1. STEM demographics are based on the US Immigration and Customs Enforcement (ICE) definition of STEM fields, <https://nces.ed.gov/pubs2011/2011226.pdf>, last modified April 2011, which is typically used by the Auburn University Office of Institutional Research, <https://auburn.edu/administration/ir>, accessed January 15, 2019.
2. Ithaka S+R is a non-profit organization that provides assistance with research and evaluation for higher education, libraries, and museums. Information about the Ithaka S+R faculty and student surveys is available at: <https://sr.ithaka.org/our-work/surveys>, accessed January 15, 2019.

Appendix A

Question/Answers Related to Patterns of Information Use and Discovery

Questions	Answers	STEM		Non-STEM		Total	
		Number	Percentage	Number	Percentage	Number	Percentage
How easy or difficult do you find it to access information and resources that you need for your coursework or research projects?	Very Difficult	1	0.30%	0	0.00%	1	0.17%
	Difficult	8	2.42%	8	3.28%	16	2.79%
	Somewhat Difficult	46	13.94%	30	12.30%	76	13.24%
	Neither Easy nor Difficult	42	12.73%	25	10.25%	67	11.67%
	Somewhat Easy	97	29.39%	69	28.28%	166	28.92%
	Easy	102	30.91%	75	30.74%	177	30.84%
	Very Easy	34	10.30%	37	15.16%	71	12.37%
	TOTAL	330	100.00%	244	100.00%	574	100.00%
How easy or difficult do you find it to access information and resources that you need to prepare or study for your PhD or other qualifying exams	Very Difficult	0	0.00%	2	2.90%	2	1.12%
	Difficult	2	1.83%	1	1.45%	3	1.69%
	Somewhat Difficult	9	8.26%	6	8.70%	15	8.43%
	Neither Easy nor Difficult	18	16.51%	8	11.59%	26	14.61%
	Somewhat Easy	27	24.77%	15	21.74%	42	23.60%
	Easy	47	43.12%	27	39.13%	74	41.57%
	Very Easy	6	5.50%	10	14.49%	16	8.99%
	TOTAL	109	100.00%	69	100.00%	178	100.00%

Questions	Answers	STEM		Non-STEM		Total	
The library serves as a starting point for locating information, resources, or citations that I use for my coursework or research projects.	Strongly Disagree	24	3.60%	18	4.27%	42	3.86%
	Disagree	63	9.45%	19	4.50%	82	7.53%
	Somewhat Disagree	60	9.00%	20	4.74%	80	7.35%
	Neither Agree nor Disagree	116	17.39%	45	10.66%	161	14.78%
	Somewhat Agree	133	19.94%	71	16.82%	204	18.73%
	Agree	176	26.39%	120	28.44%	296	27.18%
	Strongly Agree	95	14.24%	129	30.57%	224	20.57%
TOTAL	667	100.00%	422	100.00%	1089	100.00%	
In the courses you are currently taking, how often do you use each of the following types of sour... – Online video tutorials (such as videos available on Khan Academy, Lynda.com, YouTube, etc.)	Never	61	19.93%	37	26.43%	98	21.97%
	Rarely	77	25.16%	29	20.71%	106	23.77%
	Sometimes	103	33.66%	43	30.71%	146	32.74%
	Regularly	65	21.24%	31	22.14%	96	21.52%
	TOTAL	306	100.00%	140	100.00%	446	100.00%
In the courses you are currently taking, how often do you use each of the following types of	Never	41	12.35%	30	12.24%	71	12.31%
	Rarely	60	18.07%	51	20.82%	111	19.24%
	Sometimes	94	28.31%	78	31.84%	172	29.81%
	Regularly	137	41.27%	86	35.10%	223	38.65%

Questions	Answers	STEM		Non-STEM		Total	
sources— Online educational resources that are not videos (such as Wikipedia, study guides, etc.)	TOTAL	332	100.00%	245	100.00%	577	100.00%
In the courses you are currently taking, how often do you use each of the following types of sources— Books, book chapters, or novels (not including textbooks or e-book versions)	Never	90	27.19%	27	11.07%	117	20.35%
	Rarely	50	15.11%	34	13.93%	84	14.61%
	Sometimes	85	25.68%	67	27.46%	152	26.43%
	Regularly	106	32.02%	116	47.54%	222	38.61%
	TOTAL	331	100.00%	244	100.00%	575	100.00%
In the courses you are currently taking, how often do you use each of the following types of sources— Journal articles or other academic articles	Never	17	5.14%	5	2.05%	22	3.83%
	Rarely	37	11.18%	18	7.38%	55	9.57%
	Sometimes	88	26.59%	39	15.98%	127	22.09%
	Regularly	189	57.10%	182	74.59%	371	64.52%
	TOTAL	331	100.00%	244	100.00%	575	100.00%
In the courses you are currently taking, how often do you use each of	Never	217	65.76%	123	50.20%	340	59.13%
	Rarely	51	15.45%	62	25.31%	113	19.65%
	Sometimes	39	11.82%	35	14.29%	74	12.87%

Questions	Answers	STEM		Non-STEM		Total	
the following types of sources— Collection(s) of historical documents or records (such as rare books, handwritten letters or diaries, artifacts, etc.)	Regularly	23	6.97%	25	10.20%	48	8.35%
	TOTAL	330	100.00%	245	100.00%	575	100.00%
In the courses you are currently taking, how often do you use each of the following types of sources— e-books, e-book chapters, or electronic versions of novels (not including textbooks)	Never	106	32.12%	57	23.27%	163	28.35%
	Rarely	61	18.48%	45	18.37%	106	18.43%
	Sometimes	80	24.24%	72	29.39%	152	26.43%
	Regularly	83	25.15%	71	28.98%	154	26.78%
	Total	330	100.00%	245	100.00%	575	100.00%
In the courses you are currently taking, how often do you use each of the following types of sources— Electronic or e-book versions of textbooks or textbook chapters	Never	40	12.20%	35	14.34%	75	13.11%
	Rarely	62	18.90%	47	19.26%	109	19.06%
	Sometimes	104	31.71%	72	29.51%	176	30.77%
	Regularly	122	37.20%	90	36.89%	212	37.06%
	Total	328	100.00%	244	100.00%	572	100.00%
How often do you use each	Never	34	11.11%	18	12.77%	52	11.63%

Questions	Answers	STEM		Non-STEM		Total	
of the following types of sources of information in your research projects— Online educational resources that are not videos (such as Wikipedia, study guides, etc.)	Rarely	81	26.47%	32	22.70%	113	25.28%
	Sometimes	98	32.03%	49	34.75%	147	32.89%
	Regularly	93	30.39%	42	29.79%	135	30.20%
	Total	306	100.00%	141	100.00%	447	100.00%
How often do you use each of the following types of sources of information in your research projects— Journal articles or other academic articles	Never	2	0.65%	1	0.71%	3	0.67%
	Rarely	5	1.63%	2	1.42%	7	1.56%
	Sometimes	27	8.79%	23	16.31%	50	11.16%
	Regularly	273	88.93%	115	81.56%	388	86.61%
	Total	307	100.00%	141	100.00%	448	100.00%
How often do you use each of the following types of sources of information in your	Never	48	15.58%	10	7.14%	58	12.95%
	Rarely	74	24.03%	16	11.43%	90	20.09%
	Sometimes	98	31.82%	44	31.43%	142	31.70%
	Regularly	88	28.57%	70	50.00%	158	35.27%

Questions	Answers	STEM		Non-STEM		Total	
research projects— Books, book chapters, or novels that are not textbooks (not including e-book versions)	Total	308	100.00%	140	100.00%	448	100.00%
How often do you use each of the following types of sources of information in your research projects— Collection(s) of historical documents or records (such as rare books, handwritten letters or diaries, artifacts, etc.)	Never	144	46.75%	39	28.06%	183	40.94%
	Rarely	102	33.12%	38	27.34%	140	31.32%
	Sometimes	40	12.99%	32	23.02%	72	16.11%
	Regularly	22	7.14%	30	21.58%	52	11.63%
	Total	308	100.00%	139	100.00%	447	100.00%
In the courses you are currently taking, how often do you use each of the following types of sources— Data or datasets	Never	48	14.55%	31	12.65%	79	13.74%
	Rarely	59	17.88%	52	21.22%	111	19.30%
	Sometimes	102	30.91%	81	33.06%	183	31.83%
	Regularly	121	36.67%	81	33.06%	202	35.13%
	Total	330	100.00%	245	100.00%	575	100.00%
How often do you use each of the following	Never	17	5.52%	8	5.76%	25	5.59%
	Rarely	45	14.61%	23	16.55%	68	15.21%

Questions	Answers	STEM		Non-STEM		Total	
types of sources of information in your research projects— Data or datasets	Sometimes	100	32.47%	49	35.25%	149	33.33%
	Regularly	146	47.40%	59	42.45%	205	45.86%
	Total	308	100.00%	13	100.00%	447	100.00%

Appendix B

Questions/Answers Related to Research Practices and Perceptions

Questions	Answers	STEM		Non-STEM		Total	
		Number	%	Number	%	Number	%
How useful do you think each of the following factors will be in helping you get your desired job or career? – The research and analysis skills that I acquired or expect to acquire at this college or university	Not at all Useful	7	1.05%	6	1.42%	13	1.19%
	Not too Useful	21	3.14%	20	4.73%	41	3.76%
	Somewhat Useful	84	12.57%	57	13.48%	141	12.92%
	Very Useful	240	35.93%	166	39.24%	406	37.21%
	Extremely Useful	316	47.31%	174	41.13%	490	44.91%
	Total	668	100.00%	423	100.00%	1091	100.00%
My instructors help me develop the research skills to find and use academic sources of information for my coursework or research projects.	Strongly Disagree	3	0.93%	2	0.83%	5	0.89%
	Disagree	7	2.18%	7	2.89%	14	2.49%
	Somewhat Disagree	11	3.43%	15	6.20%	26	4.62%
	Neither Agree nor Disagree	30	9.35%	17	7.02%	47	8.35%
	Somewhat Agree	70	21.81%	58	23.97%	128	22.74%
	Agree	122	38.01%	84	34.71%	206	36.59%
	Strongly Agree	78	24.30%	59	24.38%	137	24.33%
Total	321	100.00%	242	100.00%	563	100.00%	
Campus librarians or library staff	Strongly Disagree	16	2.40%	12	2.86%	28	2.58%

Questions	Answers	STEM		Non-STEM		Total	
help me develop the research skills to find and use academic sources of information for my coursework or research projects	Disagree	38	5.70%	12	2.86%	50	4.60%
	Somewhat Disagree	28	4.20%	7	1.67%	35	3.22%
	Neither Agree nor Disagree	218	32.68%	133	31.74%	351	32.32%
	Somewhat Agree	111	16.64%	65	15.51%	176	16.21%
	Agree	172	25.79%	115	27.45%	287	26.43%
	Strongly Agree	84	12.59%	75	17.90%	159	14.64%
	Total	667	100.00%	419	100.00%	1086	100.00%
How important or unimportant is it to you to do each of the following before you graduate from this university— Collaborate on an original research project with one or more faculty advisors, instructors, or professors	Very Unimportant	51	7.67%	39	9.31%	90	8.30%
	Unimportant	21	3.16%	40	9.55%	61	5.63%
	Somewhat Unimportant	18	2.71%	12	2.86%	30	2.77%
	Neither Important nor Unimportant	65	9.77%	50	11.93%	115	10.61%
	Somewhat Important	64	9.62%	62	14.80%	126	11.62%
	Important	147	22.11%	77	18.38%	224	20.66%
	Very Important	299	44.96%	139	33.17%	438	40.41%
How important or unimportant is it to you to do each of the following before you graduate from	Very Unimportant	76	11.46%	62	14.73%	138	12.73%
	Unimportant	46	6.94%	62	14.73%	108	9.96%
	Somewhat Unimportant	26	3.92%	27	6.41%	53	4.89%

Questions	Answers	STEM		Non-STEM		Total	
this university— Be employed or receive college or university credit as a research assistant	Neither Important nor Unimportant	100	15.08%	85	20.19%	185	17.07%
	Somewhat Important	80	12.07%	59	14.01%	139	12.82%
	Important	131	19.76%	51	12.11%	182	16.79%
	Very Important	204	30.77%	75	17.81%	279	25.74%
	Total	663	100.00%	421	100.00%	1084	100.00%
Some students conduct or contribute to original academic research for course credit and/or for publication. At this university, have you ever— Collaborated on an original research project with one or more faculty advisors, instructors, or professors	Yes	411	61.99%	168	39.72%	579	53.31%
	No	252	38.01%	255	60.28%	507	46.69%
	Total	663	100.00%	423	100.00%	1086	100.00%
Some students conduct or contribute to original	Yes	299	45.03%	93	22.04%	392	36.10%
	No	365	54.97%	329	77.96%	694	63.90%

Questions	Answers	STEM		Non-STEM		Total	
academic research for course credit and/or for publication. At this university, have you ever— Been employed or received college or university credit as a research assistant	Total	664	100.00%	422	100.00%	1086	100.00%
How important or unimportant is it to you to acquire each of the following research skills as a result of your experience at this university— Locating academic sources of information	Very Unimportant	9	1.35%	4	0.95%	13	1.20%
	Unimportant	6	0.90%	6	1.43%	12	1.11%
	Somewhat Unimportant	4	0.60%	7	1.67%	11	1.01%
	Neither Important nor Unimportant	31	4.66%	17	4.05%	48	4.42%
	Somewhat Important	69	10.38%	50	11.90%	119	10.97%
	Important	212	31.88%	109	25.95%	321	29.59%
	Very Important	334	50.23%	227	54.05%	561	51.71%
	Total	665	100.00%	420	100.00%	1085	100.00%
How important or unimportant is it to you to acquire each of the following research skills as a result of	Very Unimportant	11	1.65%	9	2.14%	20	1.84%
	Unimportant	5	0.75%	5	1.19%	10	0.92%
	Somewhat Unimportant	9	1.35%	8	1.90%	17	1.57%

Questions	Answers	STEM		Non-STEM		Total	
your experience at this university— Using information ethically (i.e., understanding the concept of intellectual property, copyright issues, and/or legal and ethical standards for the conduct of academic research)	Neither Important nor Unimportant	22	3.31%	16	3.80%	38	3.50%
	Somewhat Important	70	10.53%	42	9.98%	112	10.31%
	Important	198	29.77%	110	26.13%	308	28.36%
	Very Important	350	52.63%	231	54.87%	581	53.50%
	Total	665	100.00%	421	100.00%	1086	100.00%
How important or unimportant is it to you to acquire each of the following research skills as a result of your experience at this university— Writing according to academic or discipline-specific standards	Very Unimportant	12	1.80%	10	2.38%	22	2.02%
	Unimportant	9	1.35%	7	1.66%	16	1.47%
	Somewhat Unimportant	12	1.80%	4	0.95%	16	1.47%
	Neither Important nor Unimportant	25	3.75%	20	4.75%	45	4.14%
	Somewhat Important	68	10.19%	43	10.21%	111	10.20%
	Important	197	29.54%	114	27.08%	311	28.58%
	Very Important	344	51.57%	223	52.97%	567	52.11%
	Total	667	100.00%	421	100.00%	1088	100.00%
How important or unimportant is it to you to acquire each of	Very Unimportant	10	1.50%	11	2.63%	21	1.94%
	Unimportant	4	0.60%	4	0.96%	8	0.74%

Questions	Answers	STEM		Non-STEM		Total	
the following research skills as a result of your experience at this university— Forming evidence-based conclusions	Somewhat Unimportant	3	0.45%	5	1.20%	8	0.74%
	Neither Important nor Unimportant	22	3.30%	18	4.31%	40	3.69%
	Somewhat Important	61	9.16%	38	9.09%	99	9.13%
	Important	173	25.98%	123	29.43%	296	27.31%
	Very Important	393	59.01%	219	52.39%	612	56.46%
	Total	666	100.00%	418	100.00%	1084	100.00%
How important or unimportant is it to you to acquire each of the following research skills as a result of your experience at this university— Evaluating academic sources of information	Very Unimportant	10	1.51%	7	1.67%	17	1.57%
	Unimportant	4	0.60%	8	1.90%	12	1.11%
	Somewhat Unimportant	5	0.75%	8	1.90%	13	1.20%
	Neither Important nor Unimportant	27	4.07%	26	6.19%	53	4.89%
	Somewhat Important	82	12.37%	55	13.10%	137	12.65%
	Important	228	34.39%	124	29.52%	352	32.50%
	Very Important	307	46.30%	192	45.71%	499	46.08%
	Total	663	100.00%	420	100.00%	1083	100.00%
How important or unimportant is it to you to acquire each of	Very Unimportant	24	3.61%	15	3.58%	39	3.60%
	Unimportant	13	1.95%	9	2.15%	22	2.03%

Questions	Answers	STEM		Non-STEM		Total	
the following research skills as a result of your experience at this university— Synthesizing or incorporating academic information into research projects	Somewhat Unimportant	7	1.05%	6	1.43%	13	1.20%
	Neither Important nor Unimportant	42	6.32%	21	5.01%	63	5.81%
	Somewhat Important	86	12.93%	39	9.31%	125	11.53%
	Important	201	30.23%	123	29.36%	324	29.89%
	Very Important	292	43.91%	206	49.16%	498	45.94%
	Total	665	100.00%	419	100.00%	1084	100.00%
How important or unimportant is it to you to acquire each of the following research skills as a result of your experience at this university— Situating research projects within the existing academic literature	Very Unimportant	19	2.85%	21	5.00%	40	3.68%
	Unimportant	22	3.30%	13	3.10%	35	3.22%
	Somewhat Unimportant	10	1.50%	8	1.90%	18	1.66%
	Neither Important nor Unimportant	58	8.70%	45	10.71%	103	9.48%
	Somewhat Important	101	15.14%	46	10.95%	147	13.52%
	Important	215	32.23%	103	24.52%	318	29.25%
	Very Important	242	36.28%	184	43.81%	426	39.19%
	Total	667	100.00%	420	100.00%	1087	100.00%
How important or unimportant is it to you to acquire each of the following research skills as a result of	Very Unimportant	20	3.02%	18	4.30%	38	3.51%
	Unimportant	16	2.41%	13	3.10%	29	2.68%
	Somewhat Unimportant	18	2.71%	8	1.91%	26	2.40%

Questions	Answers	STEM		Non-STEM		Total	
your experience at this university— Framing or developing original research questions	Neither Important nor Unimportant	44	6.64%	23	5.49%	67	6.19%
	Somewhat Important	89	13.42%	53	12.65%	142	13.12%
	Important	179	27.00%	106	25.30%	285	26.34%
	Very Important	297	44.80%	198	47.26%	495	45.75%
	Total	663	100.00%	419	100.00%	1082	100.00%
How important or unimportant is it to you to acquire each of the following research skills as a result of your experience at this university— Analyzing data, media, images, or other primary source materials	Very Unimportant	10	1.50%	9	2.15%	19	1.75%
	Unimportant	8	1.20%	10	2.39%	18	1.66%
	Somewhat Unimportant	10	1.50%	10	2.39%	20	1.85%
	Neither Important nor Unimportant	31	4.66%	26	6.21%	57	5.26%
	Somewhat Important	79	11.88%	42	10.02%	121	11.16%
	Important	194	29.17%	119	28.40%	313	28.87%
	Very Important	333	50.08%	203	48.45%	536	49.45%
	Total	665	100.00%	419	100.00%	1084	100.00%
How important or unimportant is it to you to acquire each of the following research skills as a result of	Very Unimportant	18	2.71%	21	5.01%	39	3.60%
	Unimportant	17	2.56%	17	4.06%	34	3.14%
	Somewhat Unimportant	29	4.37%	19	4.53%	48	4.43%

Questions	Answers	STEM		Non-STEM		Total	
your experience at this university— Preserving data, media, images, or other primary source materials for the long-term	Neither Important nor Unimportant	76	11.45%	52	12.41%	128	11.82%
	Somewhat Important	118	17.77%	74	17.66%	192	17.73%
	Important	178	26.81%	101	24.11%	279	25.76%
	Very Important	228	34.34%	135	32.22%	363	33.52%
	Total	664	100.00%	419	100.00%	1083	100.00%
How important or unimportant is it to you to acquire each of the following research skills as a result of your experience at this university— Writing and submitting grant applications or other funding proposals	Very Unimportant	30	4.50%	26	6.19%	56	5.15%
	Unimportant	26	3.90%	17	4.05%	43	3.96%
	Somewhat Unimportant	22	3.30%	17	4.05%	39	3.59%
	Neither Important nor Unimportant	70	10.49%	58	13.81%	128	11.78%
	Somewhat Important	109	16.34%	76	18.10%	185	17.02%
	Important	155	23.24%	93	22.14%	248	22.82%
	Very Important	255	38.23%	133	31.67%	388	35.69%
	Total	667	100.00%	420	100.00%	1087	100.00%

Appendix C

Questions/Answers Related to Graduate Student Perceptions of the Library's Role

Questions	Answers	STEM		Non-STEM		TOTAL	
		Number	%	Number	%	Number	%
The library pays for resources that I need for my coursework or research projects, from academic journals to books to electronic databases	Not Useful at all	6	0.90%	5	1.19%	11	1.01%
	Not too Useful	7	1.05%	6	1.43%	13	1.20%
	Somewhat Useful	48	7.20%	28	6.68%	76	7.00%
	Very Useful	175	26.24%	111	26.49%	286	26.34%
	Extremely Useful	431	64.62%	269	64.20%	700	64.46%
	Total	667	100.00%	419	100.00%	1086	100.00%
Librarians or library staff provide assistance or guidance on managing citations of books, articles, data, images, or websites for coursework or research projects (such as for a bibliography, works cited, or index section)	Not Useful at all	15	2.26%	12	2.86%	27	2.49%
	Not too Useful	71	10.68%	24	5.73%	95	8.76%
	Somewhat Useful	159	23.91%	100	23.87%	259	23.89%
	Very Useful	267	40.15%	153	36.52%	420	38.75%
	Extremely Useful	153	23.01%	130	31.03%	283	26.11%
	Total	665	100.00%	419	100.00%	1084	100.00%
Librarians or library staff provide assistance or guidance on using information ethically (such as to avoid plagiarism)	Not Useful at all	21	3.18%	16	3.81%	37	3.42%
	Not too Useful	68	10.29%	28	6.67%	96	8.88%
	Somewhat Useful	168	25.42%	102	24.29%	270	24.98%

Questions	Answers	STEM		Non-STEM		TOTAL	
	Very Useful	239	36.16%	149	35.48%	388	35.89%
	Extremely Useful	165	24.96%	125	29.76%	290	26.83%
	Total	661	100.00%	420	100.00%	1081	100.00%
Librarians or library staff provide assistance or guidance with managing data or datasets	Not Useful at all	30	4.52%	27	6.52%	57	5.29%
	Not too Useful	82	12.35%	37	8.94%	119	11.04%
	Somewhat Useful	198	29.82%	111	26.81%	309	28.66%
	Very Useful	234	35.24%	143	34.54%	377	34.97%
	Extremely Useful	120	18.07%	96	23.19%	216	20.04%
	Total	664	100.00%	414	100.00%	1078	100.00%
The library stores, organizes, and keeps track of books, articles, data, images, or other resources	Not Useful at all	10	1.50%	6	1.43%	16	1.47%
	Not too Useful	24	3.59%	14	3.33%	38	3.49%
	Somewhat Useful	126	18.86%	48	11.40%	174	15.98%
	Very Useful	266	39.82%	152	36.10%	418	38.38%
	Extremely Useful	242	36.23%	201	47.74%	443	40.68%
	Total	668	100.00%	421	100.00%	1089	100.00%
The library helps students develop research skills	Not Useful at all	13	1.94%	8	1.92%	21	1.94%
	Not too Useful	52	7.77%	28	6.73%	80	7.37%

Questions	Answers	STEM		Non-STEM		TOTAL	
	Somewhat Useful	197	29.45%	77	18.51%	274	25.25%
	Very Useful	212	31.69%	161	38.70%	373	34.38%
	Extremely Useful	195	29.15%	142	34.13%	337	31.06%
	Total	669	100.00%	416	100.00%	1085	100.00%
Librarians or library staff provide assistance or guidance in finding sources for coursework or research projects (such as books, articles, databases, websites, etc.)	Not Useful at all	10	1.50%	7	1.67%	17	1.57%
	Not too Useful	54	8.10%	23	5.49%	77	7.09%
	Somewhat Useful	157	23.54%	72	17.18%	229	21.09%
	Very Useful	271	40.63%	167	39.86%	438	40.33%
	Extremely Useful	175	26.24%	150	35.80%	325	29.93%
	Total	667	100.00%	419	100.00%	1086	100.00%
Librarians or library staff provide help for learning about technological, digital, or online tools for coursework or research	Not Useful at all	17	2.56%	12	2.88%	29	2.68%
	Not too Useful	67	10.08%	23	5.53%	90	8.33%
	Somewhat Useful	170	25.56%	87	20.91%	257	23.77%
	Very Useful	266	40.00%	176	42.31%	442	40.89%
	Extremely Useful	145	21.80%	118	28.37%	263	24.33%
	Total	665	100.00%	416	100.00%	1081	100.00%
Librarians or library staff provide support in	Not Useful at all	18	2.72%	12	2.89%	30	2.79%

Questions	Answers	STEM		Non-STEM		TOTAL	
learning and using online search engines or databases	Not too Useful	56	8.47%	18	4.34%	74	6.88%
	Somewhat Useful	154	23.30%	77	18.55%	231	21.47%
	Very Useful	252	38.12%	167	40.24%	419	38.94%
	Extremely Useful	181	27.38%	141	33.98%	322	29.93%
	Total	661	100.00%	415	100.00%	1076	100.00%
Have you ever been directed by a faculty advisor, instructor, or professor to consult with a subject librarian or departmental library liaison at this college or university (i.e., a librarian who specializes in your major, field, or program of study?)	Yes	184	27.88%	164	39.05%	348	32.22%
	No	476	72.12%	256	60.95%	732	67.78%
	Total	660	100.00%	420	100.00%	1080	100.00%
Have you attended a library information session, class, or section that was— Focused on finding sources of information for your major, field, or program of study?	Yes	281	74.73%	233	79.79%	514	76.95%
	No	95	25.27%	59	20.21%	154	23.05%
	Total	376	100.00%	292	100.00%	668	100.00%
Have you attended a library	Yes	206	54.93%	129	44.18%	335	50.22%

Questions	Answers	STEM		Non-STEM		TOTAL	
information session, class, or section that was— Taught during an orientation?	No	169	45.07%	163	55.82%	332	49.78%
	Total	375	100.00%	292	100.00%	667	100.00%
Have you attended a library information session, class, or section that was— Taught by a librarian in a campus library building?	Yes	203	53.99%	191	64.97%	394	58.81%
	No	173	46.01%	103	35.03%	276	41.19%
Total		376	100.00%	294	100.00%	670	100.00%