Library Use and Academic Self-Efficacy of Engineering Students

by

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Abstract

Previous research has shown that academic self-efficacy is an important predictor of students' performance in college. Engagement with the academic library may too promote student success, but engineering students may not use the library as much as students in other disciplines. The purpose of this study was to determine (a) how engineering students use the library, and (b) how their library use relates to academic self-efficacy after controlling for demographic factors. I conducted a survey of 414 undergraduate students in the University of Michigan College of Engineering in order to information about students' engagement with the University of Michigan Library, attitudes towards school and studying reflecting academic self-efficacy, and demographic characteristics such as gender and race. In agreement with the previous studies, I found that engineering students use the library heavily as a place to study but that levels of engagement with other library resources and services are relatively low. In addition, statistically significant differences in library use were detected along lines of gender, race/ethnicity, national origin, and first-generation status. Although I discovered several significant associations among variables measuring library use and academic self-efficacy, these relationships were likely the result of unmeasured confounding factors such as family income and co-curricular participation, and this study provided limited evidence in support of the hypothesis that engagement with the academic library promotes engineering students' self-efficacy. Recommendations for practice in engineering librarianship are also discussed.

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Introduction and Motivations

In recent years, academic libraries have come under increased pressure to demonstrate their value through systematic assessment and evaluation. In this new push towards creating a "culture of assessment" within academic libraries, research studies demonstrating the impact of library resources and services have proliferated in the scholarly and professional literature. Such studies have linked academic library engagement to gains in information literacy (Koufogiannakis & Wiebe, 2006; Luetkenhaus et al. 2017; Ukachi, 2015); higher academic achievement (Bowles-Terry, 2012; Soria, Fransen, & Nackerud, 2013, 2017); and improved retention (Haddow, 2013; Oliveira, 2017; Soria, Fransen, & Nackerud, 2013). However, predictor variables and outcomes studied in the context of library assessment are often too narrowly defined to provide insight about student experiences during college more broadly (Lindauer, 1998). In addition, few theoretical models or empirical studies in higher education research explicitly include library use as a factor that might contribute to desired student outcomes. While some large-scale higher education surveys such as the College Student Experiences Questionnaire (CSEQ) Research Program and the National Survey of Student Learning (NSSL) have included items relating to library experiences on their survey instruments, these limited measures capture only a few facets of student library use. Secondary analyses of national survey data focusing on the impact of library use on the student experience more broadly have yielded mixed results (Kuh & Gonyea, 2003).

Self-efficacy refers to the set of beliefs individuals hold about their own abilities to "organize and execute courses of action" required to perform desired tasks (Bandura, 1997, p. 3). Research has shown that self-efficacy can be a better predictor of individuals' future achievements than their previous accomplishments alone (Bandura, 1997) and a meta-analysis of studies in higher education revealed that academic self-efficacy had a significant positive relationship to both academic performance and persistence (Multon, Brown, & Lent, 1991). Self-efficacy also has conceptual ties to libraries, which are regarded symbolically as a site of self-motivated learning and self-improvement (Leach, n.d.). Specifically, academic libraries can be seen to foster student self-efficacy by providing access to scholarly resources and physical spaces that facilitate learning, supporting students as they build information literacies and academic competencies, and reducing stress and anxiety around coursework and other facets of college life (Leach, n.d.). While numerous studies have investigated the relationships between library use and *information* or *library* self-efficacy (e.g., Beile & Boote, 2004; Ren, 2000; Tang & Tseng, 2017), none aside from Waldman (2003) have focused on library use and overall academic self-efficacy despite the theoretical connections between the two.

Engineering education research is a growing field of scholarly inquiry concerning the education and professional development of engineers. While it is widely recognized in the engineering

education research community that academic self-efficacy is a critical predictor of key outcomes including persistence (Lent, Brown, & Larkin, 1984), academic engagement (Wilson et al., 2015), and academic achievement (Mamaril et al., 2016), the influence of engagement with the academic library on engineering students' self-efficacy is not known. Prior studies (as well as stereotypes among students and librarians alike) have suggested that engineering students use the library at a lower rate than students in other majors (Bridges, 2008; Collins & Stone, 2014; Nackerud et al., 2013; Whitmire, 2002). To date, however, there have been no in-depth studies profiling engineering student library use, let alone studies of the relationships between library use and academic outcomes for this population.

In the present work, my overarching aims are to investigate how engineering students use the library during college and whether library use relates to their academic self-efficacy, guided by an initial hypothesis that library engagement promotes academic self-efficacy among this population. These aims will be examined through five research questions which will inform best practices in engineering librarianship and help engineering education stakeholders understand how library engagement fits into the larger picture of college success and professional development for engineering students.

Literature Review

Prior to identifying my research questions, I reviewed scholarly literature in library and information science as well as higher education and engineering education research. I discovered that studies of academic library use fell into two major categories, considering library use as either a *predictor* of collegiate outcomes, such as persistence Oliveira (2017) and GPA (Soria, Fransen, & Nackerud, 2013, 2017), or as an *outcome* of student background characteristics such as gender (Stone & Collins, 2013; Whitmire, 2001, 2003) and race/ethnicity (Kuh & Gonyea, 2003; Long, 2011; Whitmire, 2003). Likewise, academic self-efficacy has been treated as both a predictor (Chemers, Hu, & Garcia, 2001; Gore, 2006; Lent, Brown, & Larkin, 1984) and an outcome (Concannon & Barrow, 2009; Fantz, Siller, & Demiranda, 2011; Marra et al., 2009) in higher education and engineering education research. Some attention has also been paid to student library use as a function of academic major; these studies have consistently found that engineering students use library resources and services less than students in other majors (Bridges, 2008; Collins & Stone, 2014; Nackerud et al., 2013; Whitmire, 2002).

Below, I describe and synthesize relevant literature on (a) the effects of academic library use on academic outcomes, (b) pre-college factors affecting academic library use, (c) engineering student use of the academic library, (d) the effects of academic self-efficacy on collegiate outcomes, and (e) academic self-efficacy as it has been applied to engineering education research.

Academic Library Use

Effects of Library Use on Academic Outcomes

Studies of the effects of academic library use on collegiate outcomes have revealed generally positive (albeit weak) relationships. The most widely studied outcomes have been student retention and grade point average (GPA). For example, Soria and colleagues (2013) found that students who used at least one library service during their first year of college had a higher average GPA compared with library non-users with a medium effect size based on Cohen's *d* (3.18 for library users vs. 2.98 for non-users) as well as higher first to second semester retention (97.1% for library users vs. 95.7% for non-users). More recently, the same authors reported that students' use of books and online library resources had significant positive relationships to academic outcomes (e.g., academic skills, academic engagement, and engagement in scholarship), while enrollment in library courses was positively related to first-semester GPA (Soria, Fransen, & Nackerud, 2017). In a literature review regarding the academic library's role in student retention, Oliveira (2017) identified three major library-related factors which appear to contribute to student persistence: exposure to library instruction, use of the library as social learning space, and general use of library materials. Bell (2014) commented that "when librarians become part of a student's support network, the student improves in ways that lead to better academic performance" (p. 12) and suggested that "checking out books, consulting with librarians, clicking on database articles, and engaging in other library-related learning and scholarly activities may actually help students achieve the self-efficacy that leads to academic persistence" (p. 13).

Not all such studies have had positive findings, however. In an analysis of College Student Experiences Questionnaire (CSEQ) data collected from over 300,000 students between 1984 and 2002, Kuh and Gonyea (2003) did not find evidence to support the hypothesis that library use (operationalized as using the library to read or study, asking a librarian for help, reading in the reserve or reference section, and using an index or database) during college contributed to gains in information literacy, what students perceive that they have gained overall in college (e.g., gains in writing ability, job or work skills, and quantitative problem solving ability), or general satisfaction with the college experience after controlling for other individual and institutional factors. Nonetheless, the authors highlighted the fact that students who reported that their college emphasizes information literacy did improve more in this area than other students (Kuh and Gonyea, 2003). In addition, Haddow (2013) found that retained students used electronic library resources at a higher rate than withdrawn students but otherwise reported no significant associations between library use and retention.

Pre-College Factors Affecting Library Use

Several studies have shown that students from different backgrounds use the library differently during college. Variables that have been studied include race and ethnicity, gender, age, and national origin. Whitmire (2001) demonstrated that pre-college characteristics, such as gender, race, and initial critical thinking scores were correlated with library use during the first two years of college, but were no longer statistically significant by junior year. However, one pre-college factor, high school library use, was strongly correlated with library use in college for all three years of the study.

With respect to race and ethnicity, Kuh and Gonyea (2003) found that Hispanic, Latino, and Black students were the most frequent library users, with White students using the library the least. The authors suggested that students of color may consider "the academic library to be a safe haven, a place that supports and nurtures academic success in collaboration with peers of the same racial and ethnic background, much in the same way the campus union provides a venue for social gatherings" (Kuh & Gonyea, 2003, p. 267). Whitmire (2003) reported similar findings in a secondary analysis of 1996 CSEQ data, with students of color using the library to read or study, asking a librarian for help, and reading basic references or documents more than white students, while white students used the library catalog more than students of color. The author also found that the specific background characteristics and college experiences associated with academic library use differed by racial group (Whitmire, 2003). In a qualitative study of Latino students' perception of the academic library at a large Midwestern public university, Long (2011) found that Latino students saw the library primarily as a study space and that few made use of library collections or had ever asked a library staff member for assistance.

National origin also appears to play a role in academic library use. In a United Kingdom-based study, Stone and Collins (2013) found that students from continental Europe generally used the library more than students from the United Kingdom and that students from the United Kingdom used the library more than students from China, but in most cases, the effect sizes were very small. Noting that national origin appears to be more important than ethnicity in predicting library usage, the authors suggest that students from different countries may "receive different early training on how to find and use information resources, and that the cultural differences in this learned behaviour are perhaps more important than differences between ethnic groups" (Stone & Collins, 2013, p. 31-32). Jiao and Onwuegbuzie (1998) noted that while non-native English-speaking students in American universities may visit the library more frequently than native English speakers, they also experience higher levels of library anxiety, in particular due to anxiety about library technology.

Gender seems to have mixed effects on library use during college. Whitmire (2001) noted that female undergraduate students used the library more often, but the relationship was weak. Stone and Collins (2013) reported that women used the library more across all dimensions studied (e.g., number of items borrowed, number of e-resources accessed, number of hours logged into library computers) except visits to the physical library, with small effect size. In contrast, Whitmire (2003) found that gender was a significant predictor of academic library use for Native American, Asian American, and white undergraduate students, with male gender being associated with increased use of the library, but the effect of gender was not significant for African American or Latino students.

Engineering Students and the Academic Library

College students from different fields of study have distinct information needs and use the library differently. Whitmire (2002) applied the Biglan typology of academic disciplines to a study of the effects of disciplinary differences on academic library use and information-seeking behavior. The author found that students in fields classified as hard (as opposed to soft), applied (opposed to pure), and non-life (as opposed to life), such as engineering, engaged in information-seeking behavior least frequently (Whitmire, 2002). Bridges (2008) reported that students from the engineering college used the virtual library (i.e., self-reported use of online library resources and/or the library website from a remote location) less than students from the liberal arts college. However, the author did not find evidence to support the hypothesis that engineering students used the physical library less often than others (Bridges, 2008). Similarly, Nackerud et al. (2013) reported that only 47% of undergraduate students in a College of Science and Engineering used digital library resources such as databases and online journals, compared with 74% of students in the College of Education and Human Development and 65% of undergraduate students overall. In a United Kingdom-based study, Collins and Stone (2014) found that computing and engineering students used the library significantly less than the reference group of social science students in terms of the number of items borrowed, visits to the library, hours logged into library computers, PDF downloads, and e-resources accessed. The authors noted that computing and engineering students were generally similar in terms of library use, although engineering students were more likely to use the physical library and less likely to download PDFs compared with computing students (Collins & Stone, 2014). In contrast, Soria (2013) found that undergraduate students who aspired to careers in engineering and programming considered libraries and research to be significantly more important compared with students in other disciplines.

Academic Self-Efficacy

Self-Efficacy and Academic Outcomes

Numerous studies have investigated the relationships between academic self-efficacy of college students and academic outcomes, with generally positive results. In one early such investigation on a sample of 42 undergraduate students enrolled in a STEM-focused career planning course, Lent and colleagues (1984) found that students with higher self-efficacy in terms of educational requirements and job duties earned higher grades and persisted longer in scientific and technical fields compared with their low self-efficacy peers. In addition, the authors found a moderate positive correlation between self-efficacy and measures of academic aptitude and achievement, such as college GPA, math PSAT scores, and high school class rank (Lent, Brown, & Larkin, 1984). A longitudinal study of first-year college students by Chemers, Hu, and Garcia (2001) found that academic self-efficacy was strongly related to both performance and adjustment. Specifically, students with higher academic self-efficacy were more likely to perceive their academic work as more of a challenge than a threat, had higher academic expectations for themselves, and had better academic performance (Chemers et al., 2001). Gore (2006) found that the closely related concepts of college self-efficacy and academic self-confidence were both significant (albeit weak) predictors of GPA. Based on the results of a separate yet related study, Gore (2006) also reported that regression models containing both ACT score and academic self-confidence were better predictors of college GPA and persistence than models with ACT score alone. More recently, Honicke and Broadbent (2016) conducted a systematic review synthesizing 12 years of research on the relationship between academic self-efficacy and academic performance. Across 59 studies, the authors found that academic self-efficacy had a moderate positive correlation with academic performance, but also identified a number of mediating and moderating factors such as deliberate goal-setting and negative emotions (Honicke and Broadbent, 2016).

Self-Efficacy in Engineering Education Research

Self-efficacy has been widely studied in the context of engineering education as both predictor and outcome. Considering self-efficacy as an outcome, Concannon and Barrow (2009) investigated the relationships between student characteristics (e.g., gender, ethnicity, years enrolled in the program) and four dimensions of engineering-related self-efficacy. The authors found no significant differences in mean self-efficacy score by gender, ethnicity, or transfer status, but did note that students in their fifth year of study had lower self-efficacy than fourth year students (Concannon & Barrow, 2009). In addition, Concannon and Barrow (2009) noted significant interactions among student characteristics and self-efficacy subscales, with women showing lower coping self-efficacy than men and African American students having lower career outcome expectations compared with White students. Marra and colleagues (2009) examined

changes in women engineering students' self-efficacy over time, observing statistically significant gains in three out of six self-efficacy subscales (coping self-efficacy, engineering self-efficacy II, and math outcomes expectations) and a negative change for one subscale (feelings of inclusion). With respect to non-demographic predictors, Fantz, Siller, and Demiranda (2011) found that certain pre-college hobbies and experiences, such as taking a technology class and engaging in computer programming as a hobby, were positively related with engineering undergraduate student self-efficacy.

Several studies have shown support for the theory that high self-efficacy contributes to positive outcomes in engineering, such as persistence and GPA. Among a variety of demographic and social cognitive predictors, Hackett et al. (1992) found that self-efficacy was among the strongest predictors of college academic achievement in engineering. In a longitudinal study of students in introductory engineering courses, Lent and colleagues (2008) found that self-efficacy was an antecedent of outcome expectations (e.g., agreeing that an engineering degree would lead to earning a large salary), interest in engineering-related activities, and persistence goals. Marra et al. (2009) reported that women students' self-efficacy was positively correlated with an intent to persist in their current degree. This finding is in agreement with Lent, Brown, and Larkin (1984) who found that students with higher self-efficacy persisted in scientific and technical majors longer than those with low self-efficacy. In a multi-institutional study of undergraduate STEM majors, Wilson et al. (2015) reported that high self-efficacy consistently and significantly contributed to engagement with STEM coursework. In addition, low self-efficacy was significantly related to negative emotional affect across institutions (Wilson et al., 2015). More recently, Mamaril and colleagues (2016) found that various dimensions of engineering self-efficacy were significant predictors of GPA in engineering coursework but not of intent to persist in engineering.

Although self-efficacy is occasionally studied in library and information science research, it is typically operationalized as *information literacy* self-efficacy (i.e., belief in one's own ability to locate, understand, and evaluate information sources) as opposed to more general academic self-efficacy. While it has been widely established that engineering students use the library less than their peers in other majors, little is known about patterns of library use within engineering sub-disciplines or how engineering students' library use relates to academic outcomes and attitudes.

Research Questions

The overarching aims of this work are to understand how engineering students use the library during college and whether library use relates to their academic self-efficacy. Since both library

use and self-efficacy have been shown to interact with demographic characteristics, such as gender and race, I chose to incorporate these factors into five research questions:

> RQ1. How do undergraduate students in the College of Engineering use the University of Michigan Library?
>
> RQ2. How do engineering student demographic characteristics (e.g., gender, race) relate to the use of library resources and services in college?
>
> RQ3. How do engineering student demographic characteristics relate to academic self-efficacy?
>
> RQ4. How does the use of library resources and services relate to academic self-efficacy?
>
> RQ5. Does the use of library resources predict academic self-efficacy above and beyond demographic characteristics alone?

Methods

Instrument Development

The survey instrument, a Qualtrics-based online self-administered questionnaire, consisted of questions about three major topics: library use during college, academic self-efficacy, and demographic characteristics. Consistent with best practices in questionnaire design and evaluation (see Bradburn, Sudman, & Wansink, 2004; Fowler, 1995), I drew on preexisting questions from the literature when possible and conducted focus groups and individual "think-aloud" cognitive interviews with members of my target population prior to survey administration.

Focus Groups

Between November 8 and November 11, 2018, I conducted three focus groups comprised of students from the University of Michigan College of Engineering. The purpose of these focus groups was to gather initial information about how undergraduate students in the College of Engineering understand and use the library to inform the creation of a self-administered online questionnaire. To recruit focus group participants, I posted fliers on both North and Central Campus and sent out emails to engineering student organizations with a link to a screening survey, offering a $20 incentive for participation. In total, nine female undergraduate students, two male undergraduate students, and one female master's student participated in the focus groups, representing five academic years and a variety of engineering majors. The focus group protocol is included as an Appendix.

Several themes emerged across the semi-structured focus group interviews. In general, participants viewed the University of Michigan Library primarily as a space for working and studying. A majority of participants reported using the Shapiro Undergraduate Library and/or the Art, Architecture, and Engineering Library at the Duderstadt Center as central meeting places for project teams and other forms of group collaboration, common in engineering coursework and co-curricular activities. Many students also mentioned visiting the library alone to study, complete problem sets, use computers, and print documents, although the time spent at the library engaged in these activities seemed to vary widely across individuals. Whether the students primarily visited Shapiro Library or the Duderstadt Center seemed to depend on where they live, with students living on Central Campus indicating a preference for Shapiro and those on North Campus preferring the Duderstadt Center. Some students had also visited or studied at other libraries during college, including the Law, Kresge, and Bentley Historical Libraries. Few recalled attending any sort of library orientation or instructional session held in the library, although some mentioned attending a session with a librarian as part of their Engineering 100 course. Engineering 100 is a required first-year course that is designed to serve as an introduction to the field of engineering, and students may choose among several sections which map onto different majors or broader areas of interest, such as health or the environment. Students in the first two focus groups made minimal use of online library resources, with a majority reporting that they had never searched for a scholarly article or used the library website during college. Participants in the third focus group, in contrast, were avid users of the library's electronic resources, including links to databases and the Library Search tool. Overall, first-year students reported the lowest use of and knowledge about the University of Michigan Library and its resources, although more first-year students recalled visiting the library during orientation.

Existing Instruments

I drew on a number of general academic self-efficacy (i.e., not engineering-specific or information literacy-specific) measures from the literature, including those constructed and published by Byrne, Flood, and Griffin (2014); Kim et al. (2010); Mamaril et al. (2016); Micari and Drane (2011); and Pintrich and de Groot (1990). I selected only items that were relevant to undergraduate education at an elite university, and I adapted the borrowed items to reflect the context of the College of Engineering whenever necessary. I pretested a set of 25 adapted items with members of the target population (described below) with the goal of eliminating ambiguous or confusing items, or selecting the clearer item between two similar options. The final 15 self-efficacy items are displayed alongside their sources and original versions (when applicable) in Table 1.

Cognitive Interviews

Prior to survey deployment, I pretested my all sections of my questionnaire by conducting six hour-long cognitive interviews with undergraduate students in the College of Engineering. The purpose of these interviews was to learn more about how members of my target population understand and respond to the survey questions, and to detect potential problems with comprehension or the response process. I employed a "think-aloud" protocol in which participants attempted to narrate their thought processes as they came up with answers to the survey questions. I also asked probe questions about the interpretation of particular words or concepts.

Following each cognitive interview, I assessed the participant feedback and removed or made changes to problematic items. For example, I decided to remove an item about feeling confident about studying effectively on one's own after several students who otherwise reported high levels of academic self-efficacy said they were not confident in this area. They explained that in engineering, students often work together to solve problem sets or complete assignments and that studying or working collaboratively is strongly encouraged my professors, so confidence in one's ability to study alone was not relevant. Other changes included changing the order of two items in the library use section, adding questions about taking a course in which the primary instructor was a librarian and having a job at the library, and added clarifying language for several items.

Measures

Descriptions of variables within the three major sections of the survey (library use during college, academic self-efficacy, and demographic characteristics) are described below. The full survey instrument is included as an Appendix.

Library Use

Questions about library use measured six categories of library engagement: (a) doing work or studying in the library, (b) getting help from someone who works at the library, (c) searching online for scholarly research articles, (d) visiting the University of Michigan Library website, (e) having a job at the University of Michigan Library, and (f) taking a course in which the primary instructor was a librarian (e.g., ALA 105). This block of questions employed a branched structure so that respondents were not shown questions that were irrelevant to them. For example, if a respondent reported that they never did work or studied in the library, they were not shown any other questions about doing work or studying in the library.

Students who reported doing work or studying in the library during college were shown three follow-up questions. First, students were asked whether they thought they spent more, less, or about the same amount of time in the library compared with other students in the College of

Engineering. Next, students were asked to estimate the percentage of time spent doing work or studying in the library in each of the following contexts: with others working together (e.g. as part of a project team or study group), with others but working independently, and alone. Finally, students were asked to estimate the number of hours they spent doing work or studying in the library in a typical week. For this question, respondents selected from six options, ranging from "I do not go to the library in a typical week" to "More than 40 hours."

Students who reported getting help from someone who works at the library at least once during college were then asked to indicate whether or not they had received help in each of the following ways: in person (e.g., at the information desk or an appointment with a librarian), online (e.g., via email or online chat), over the phone, and/or by text message.

Those who indicated that they had searched online for a scholarly research article during college were then asked to select the reason(s) why they had searched for articles: for a class or assignment, for an extracurricular club or activity (e.g., a design team), for academic research outside of coursework (e.g., in a lab), for a job or internship, and/or "just for fun."

Similarly, respondents who said that they had visited the University of Michigan Library website (https://www.lib.umich.edu) were then asked which of the following features or services they had used when they visited the website: looked for library materials using the search bar, used a research guide, followed links to databases, used the Ask a Librarian feature, looked for information about the library (e.g., hours, location), and/or reserved a study room in the library.

The final two categories of library engagement, having a job at the University of Michigan Library and taking a course in which the primary instructor was a librarian, had no follow-up questions associated with them. These items were included because of their potentially confounding effects on the rate of reported library use.

Academic Self-Efficacy

In total, the questionnaire included fifteen academic self-efficacy items, displayed in Table 1. The response scale for all items was a five-point Likert-type scale measuring how true respondents thought each statement was of themselves. The five scale points were labeled "Not at all true of me," "Slightly true of me," "Somewhat true of me," "Mostly true of me," and "Completely true of me," corresponding to values from 1 ("Not at all true of me") to 5 ("Completely true of me"). (Note: numerical codes were not shown to respondents.) The order of items within this block of questions was automatically randomized using Qualtrics to reduce systematic context effects (Oldendick, 2008). Consistent with strategies employed by the original scale authors, several reverse-worded items were included; these items are denoted with an asterisk (*) below and were reverse-coded prior to data analysis.

Table 1. Academic self-efficacy measures; * denotes reverse-coded items.

Final Item	Source	Original
I believe it is possible for me to get good grades in college.	Kim et al. (2010)	I believe it is possible for me to make good grades.
	Mamaril et al. (2016)	I can earn a good grade in my engineering-related courses.
I think I am a good student compared with others in the College of Engineering.	Pintrich and de Groot (1990)	Compared with others in this class, I think I'm a good student.
I work hard to get a good grade even when I don't like a class.	Pintrich and de Groot (1990)	[Unedited] I work hard to get a good grade even when I don't like a class.
I am determined to do what it takes to succeed in college.	Kim et al. (2010)	I am determined to do what it will take in order to succeed with my goals.
I prefer to take classes that are challenging so I can learn new things.	Pintrich and de Groot (1990)	I prefer class work that is challenging so I can learn new things
My study skills are excellent compared with other students in the College of Engineering.	Pintrich and de Groot (1990)	My study skills are excellent compared with others in this class.
* I wait to study until the night before the exam.	Kim et al. (2010)	[Unedited] I wait to study until the night before the exam.
I always meet the deadlines for my assignments.	Byrne et al. (2014)	I feel confident in my ability that I can meet the deadlines for my assignments.
I am confident that I will be able to learn the basic concepts covered in my classes.	Micari and Drane (2011)	I'm confident I can learn the basic concepts taught in this course.
I'm confident I can understand the most complex material in my courses.	Micari and Drane (2011)	I'm confident I can understand the most complex material presented by the instructor in this course.
	Mamaril et al. (2016)	I can master the content in even the most challenging engineering course.
I feel confident in my ability to ask questions in class.	Byrne et al. (2014)	I feel confident in my ability that I can ask questions in class.
* I avoid speaking up in class.	Kim et al. (2010)	I avoid speaking in class.
When I do poorly on an exam or assignment, I try to learn from my mistakes.	Pintrich and de Groot (1990)	Even when I do poorly on a test I try to learn from my mistakes.
I hold myself to a high academic standard.	original	[N/A]
I make an effort to attend all of my classes.	original	[N/A]

Demographics

The questionnaire included questions about a number of potentially confounding demographic variables. Questions about academic experiences (e.g., first term of enrollment in the College of Engineering and academic major) were placed at the beginning of the survey for screening purposes, while demographic measures appeared at the end in order to reduce the influence of stereotype threat on potentially sensitive questions about library use and study habits (see Steele 2010). Demographic measures included domestic vs. international student status (dichotomous), in-state vs. out-of-state status (dichotomous; shown to domestic students only), first-generation student status (dichotomous), gender (categorical), and race/ethnicity (categorical).

For statistical analysis, gender and race/ethnicity were recoded as dichotomous indicator variables. The "gender minority" indicator takes on a value of 1 for students who indicated that their gender was female, non-binary/third gender, or another written-in gender and 0 for male students, while the "URM" indicator is 1 for students belonging to an underrepresented ethnic/racial minority (i.e., American Indian or Alaskan Native, Black or African American, Hispanic or Latino, Native Hawaiian or Pacific Islander) and 0 for students who do not belong to an underrepresented minority. Note that students who wrote in "Arab" or "Middle Eastern" were considered to be URM students.

Survey Administration

Targeting 300 to 400 complete responses to my survey, I obtained a simple random sample of 1,600 students enrolled solely in the College of Engineering (i.e., not enrolled in a dual-degree program) with sophomore standing or higher who had completed at least one semester in the College of Engineering (i.e., first enrolled in the College of Engineering prior to the Winter 2019 semester). Excluded from the sampling frame were the 18 students who had participated in focus groups and individual cognitive interviews.

On Tuesday, January 15th, 2019, sampled students received an email inviting them to complete the Qualtrics-based questionnaire for a chance to win one of ten $15 Amazon gift cards. Those who had not completed the survey received reminders via email on Thursday, January 17th, Tuesday, January 22nd, and Friday, January 25th. The two-week data collection period closed on Tuesday, January 29th. A total of 449 students began a survey session, of whom 4 did not consent to participate and 9 were deemed ineligible because they were not full-time undergraduate students at the University of Michigan. Of the remaining 436 eligible students, 414 (95.0%) completed the survey, resulting in an overall completed response rate of 25.9%. A summary of demographic characteristics for the sample is shown in Table 2. Although the demographics of the students who were invited to complete the survey but did not do so are not known, women are overrepresented in the study sample with respect to the College of

Engineering undergraduate population as a whole, where they comprise 27% of the student body (Michigan Engineering Facts & Figures, 2019).

Table 2. Self-reported demographic characteristics of study sample (*N* = 414)

	***N* (%)**
Gender	
Female	188 (45.4)
Male	218 (52.7)
Non-binary or third gender	4 (1.0)
Some other gender (write-in)	1 (0.2)
Prefer not to say	3 (0.7)
Race/Ethnicity	
American Indian or Alaskan Native	7 (1.7)
Asian	130 (31.4)
Black or African American	13 (3.1)
Hispanic or Latino	16 (3.9)
Native Hawaiian or Pacific Islander	5 (1.2)
White or Caucasian	267 (64.5)
Some other race (write-in)	5 (1.2)
Prefer not to say	3 (0.7)
Origin	
International student	31 (7.5)
Domestic student	383 (92.5)
In-state	228 (59.5)
Out-of-state	155 (40.5)
Parental Education	
First-generation college student	52 (12.6)
Not first-generation	362 (87.4)

Analysis

Visualizations were created within Qualtrics, and descriptive and inferential statistics were carried out using Stata/IC 15.1 (StataCorp. 2017. Stata Statistical Software: Release 15. College Station, TX: StataCorp LLC).

In order to answer RQ1 *(How do undergraduate students in the College of Engineering use the University of Michigan Library?)* I tabulated descriptive results for survey items pertaining to library use and examined correlations among the various dimensions of library use considered in this work.

To answer RQ2 *(How do engineering student demographic characteristics (e.g., gender, race) relate to the use of library resources and services in college?)* I first performed a series of independent samples tests of proportions (z-tests) to detect differences across demographic groups (gender, race/ethnicity, international vs. domestic, first-generation) in terms of dichotomous library use dimensions. I then used independent samples t-tests to compare group means for hours spent studying in the library in a typical week and the percentage of time spent working collaboratively, non-collaboratively, and independently in the library. Next, I ran chi-squared tests of independence to look for differences by group with respect to the question about spending more, less, or about the same amount of time studying or doing work in the library compared with other students. Finally, I ran chi-squared and Fisher's exact tests of independence to look for differences in library use across academic majors in engineering.

I answered RQ3 *(How do engineering student demographic characteristics relate to academic self-efficacy?)* first by conducting exploratory factor analysis (EFA) with promax rotation on the academic self-efficacy survey items to reduce the number of dimensions. I then performed independent samples t-tests to look for differences in group mean across the dichotomized demographic characteristics. I also performed multiple linear regression with the self-efficacy dimensions as outcomes and demographic indicators as predictors.

To answer RQ4 *(How does the use of library resources and services relate to academic self-efficacy?)* I first ran a series of independent samples t-tests comparing mean academic self-efficacy scores across each of the academic self-efficacy dimensions using dichotomized indicators of library use as grouping variables, including the original six basic library use dimensions included in the questionnaire along with new analytic indicators. Specifically, I classified all students who took the survey as either "regular users" or "non-users" of the library as a place to study or do work, with those who had never studied or done work in the library and those who reported that they did not go to the library in a typical week as "non-users". In addition, I modified the variables about reasons for searching for scholarly articles, modes of asking for help at the library, and library website actions to include all students, not just those who were shown the question as a result of the branched structure.

In order to understand how demographic characteristics, library use, and academic self-efficacy all fit together to answer RQ5 (*Does the use of library resources predict academic self-efficacy above and beyond demographic characteristics alone?*) I constructed a series of multiple linear

regression models with each of the academic self-efficacy dimensions as outcomes. I selected as predictors variables that I believed, for either theoretical or empirical reasons, might relate to academic self-efficacy, which included five demographic indicators and twelve library use measures.

Prior to building regression models to answer RQ5, I converted the answers to the question about the number of hours spent studying or doing work in the library to a numeric format, wherein students were assigned a value equal to the maximum of the bin they selected: 0 if they had never studied in the library or said they did not visit the library in a typical week, 5 if they said they spent less than 5 hours in a typical week, 10 if they said they spent 5-10 hours in the library in a typical week, etc. The three students who reported spending more than 40 hours per week studying or doing work in the library were assigned an estimated value of 50. This conversion made the regression coefficient more readily interpretable (now corresponding approximately to an increase of 1 hour) and accounted for the unequal spacing between bins.

In addition, I created a new analytic variable corresponding to the number of semesters the student had completed as a student in the College of Engineering based on the reported first semester enrolled. Students who enrolled in Fall 2018 had completed one semester in the College of Engineering by the time the survey was administered in Winter 2019 and were assigned a value of 1, students who enrolled in Winter 2019 were assigned a value of 2, etc. A higher score on the "number of semesters" variable is associated with more semesters completed in the College of Engineering.

Limitations

As with any research, this study had several limitations that may reduce the generalizability or validity of the findings. First, the non-experimental research design means that I cannot establish causality between the various predictors and outcomes considered in this study. For example, I could not claim that higher use of online library resources *causes* differences in academic self-efficacy or vice versa, only that there is a *correlation* or *association* between the two. Second, because I only included students majoring in engineering in my study, I am unable to draw comparative conclusions about relative library use between engineering students and other undergraduate students at the University of Michigan. In addition, I cannot compare my findings directly to previous studies that included students in a variety of disciplines, not just engineering. Third, my survey was deployed at only one institution. The University of Michigan College of Engineering is a highly selective engineering college that may not be representative of engineering schools more broadly. Fourth, the survey sample obtained was not completely representative of students in the College of Engineering in that a disproportionately large number of gender minority students responded to my survey. The College of Engineering is about 27%

female, compared with 45% of the survey sample. This result is consistent with Porter and Whitcomb's (2005) finding that female students are more likely to respond to student surveys. Fifth, for students who are non-native English speakers and particularly international non-native English speakers, differences in comprehension of survey questions may have led to measurement error. Sixth, library use is a "socially desirable" behavior that is known to be overreported on surveys. Bradburn, Sudman, and Wansink (2004) describe a 1950s study comparing self-reported library membership with library records in which the authors found that people overstated library card ownership by 10 to 20 percent. Because I did not compare students' self-reported library use with more objective metrics of engagement, I am unable to estimate the degree of overreporting in the present study. Finally, I operationalized demographic categories of gender, race/ethnicity, national origin, and first-generation status independently, which omits the nuances of intersectionality (see Crenshaw, 1990). In reality, humans are not a set of discrete demographic indicators which exist or act independently of one another. Nonetheless, it is my hope that by including some demographic indicators, my analyses may shed light on the experiences of particular groups of students and help to identify areas where further research (or intervention) is needed.

Results

In this section, I first present a summary of responses to survey questions measuring library use (RQ1). Second, I present descriptive and inferential statistics regarding the relationships between library use and student characteristics, including demographics (RQ2) and academic major. Third, I summarize responses to questions measuring academic self-efficacy and display EFA results for these items, then present t-tests and linear regression coefficients reflecting relationships between demographics and academic self-efficacy (RQ3). Fourth, I present descriptive and inferential statistics exploring relationships between use of library resources and academic self efficacy (RQ4). Finally, I present linear regression coefficients for models that include both demographic characteristics and library use as predictors of academic self-efficacy (RQ5).

Library Use

Descriptive Results

Studying in the Library

A total of 404 students (97.6% of respondents) reported that they had studied or done work at the library at least once during college. Out of the 404 students who have ever studied at the library, 62 (15.3%) were infrequent users who did not visit the library in a typical week. Of the remaining 342 library users (82.6%), 129 (37.7%) reported spending less than 5 hours; 119 (34.8%) reported spending 5 to 10 hours; 81 (23.7%) reported spending 11 to 25 hours; and 21

(6.1%) reported spending 26 or more hours studying or doing work in the library in a typical week. This distribution is presented in Figure 1.

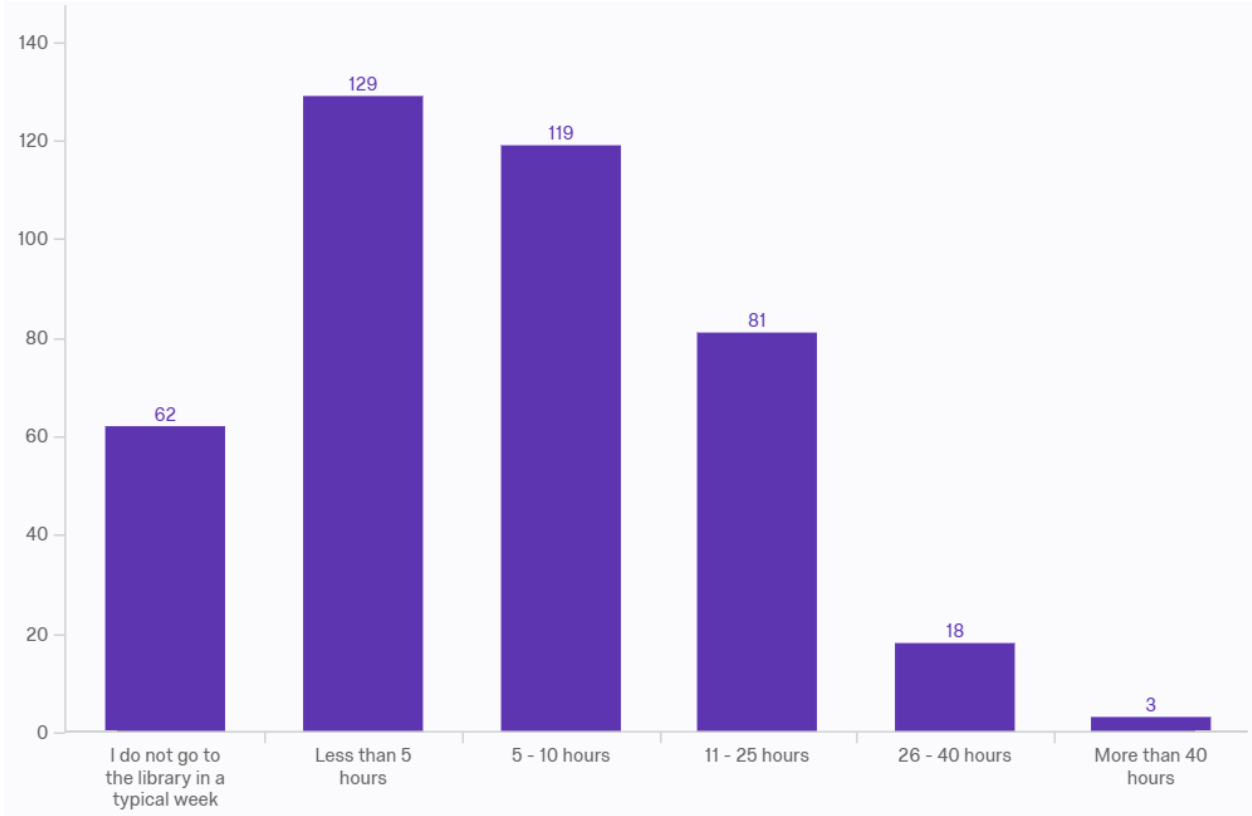

Figure 1. In a typical week, how many hours do you spend studying or doing work at the library?

Table 3. Cross-tab of time spent in the library and perception of self compared to others

	I spend less time	**Same amount**	**I spend more time**	***Total***
I don't go in a typical week	56	4	1	*61*
Less than 5 hours	98	26	1	*125*
5-10 hours	53	56	9	*118*
11-25 hours	5	46	28	*79*
26-40 hours	0	6	11	*17*
More than 40 hours	0	1	2	*3*
Total	*212*	*139*	*52*	*403*

A majority of respondents (212 students, 52.5% of those who had ever used the library to do work or study) indicated that they thought they spent less time doing work or studying in the

library compared with other students in the College of Engineering. Only 52 (12.9%) thought they spent more time in the library, with the remaining 139 (34.5%) believing they spent about the same amount of time in the library compared with their peers. Table 3 displays a cross-tab of the number of hours students spent in the library in a typical week and whether students thought they spent more, less, or about the same amount of time in the library compared with others. On average, students estimated that they spent 36.0% (*SD* = 27.2%) of the time in the library with others working together (e.g., on a group project), 23.9% (*SD* = 20.1%) with others but working independently (e.g., with friends), and 40.1% (*SD* = 27.3%) by themselves.

Getting Help

A total of 139 students (33.6%) reported getting help from someone who works at the library at least once during college. Out of the 139 students, 121 (87.0%) said they had received help in person, 31 (22.3%) online, 8 (5.8%) over the phone, and only 1 (0.7%) by text message, as shown in Figure 2. Although students were prompted to respond "yes" or "no" for each mode, many students skipped over one or more of these subquestions, although it is probably reasonable to assume that those who skipped over a question had not received help through that mode.

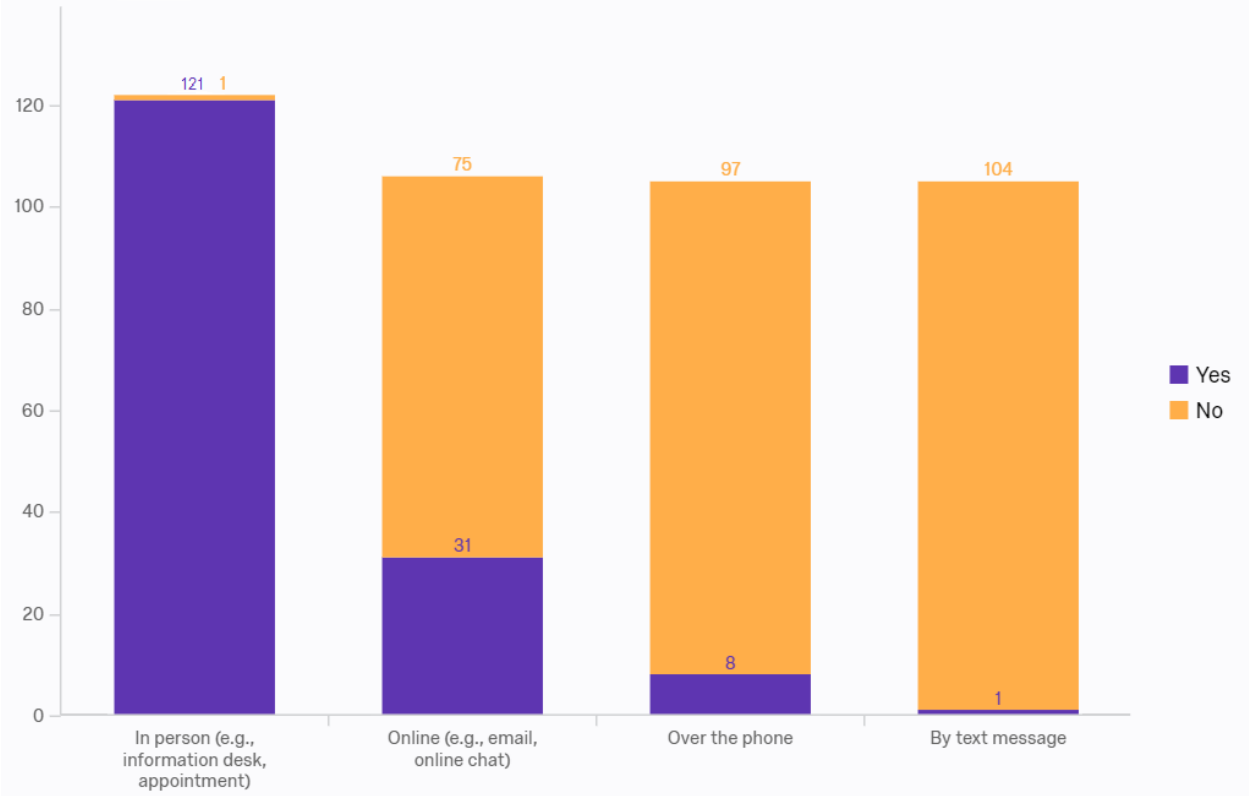

Figure 2. How have you gotten help from someone who works at the library?

Searching for Scholarly Articles

Two-thirds of students ($N = 276$) responded that they had searched for a scholarly article at least once during college. The most commonly reported reason for searching for a scholarly article was for a class or assignment, with 232 students (84.1% of those who had ever searched for an article) reporting doing so for this reason. The next most common reasons were academic research outside of coursework (107 students, 38.8%) and "just for fun" (73 students, 26.4%), as shown in Figure 3.

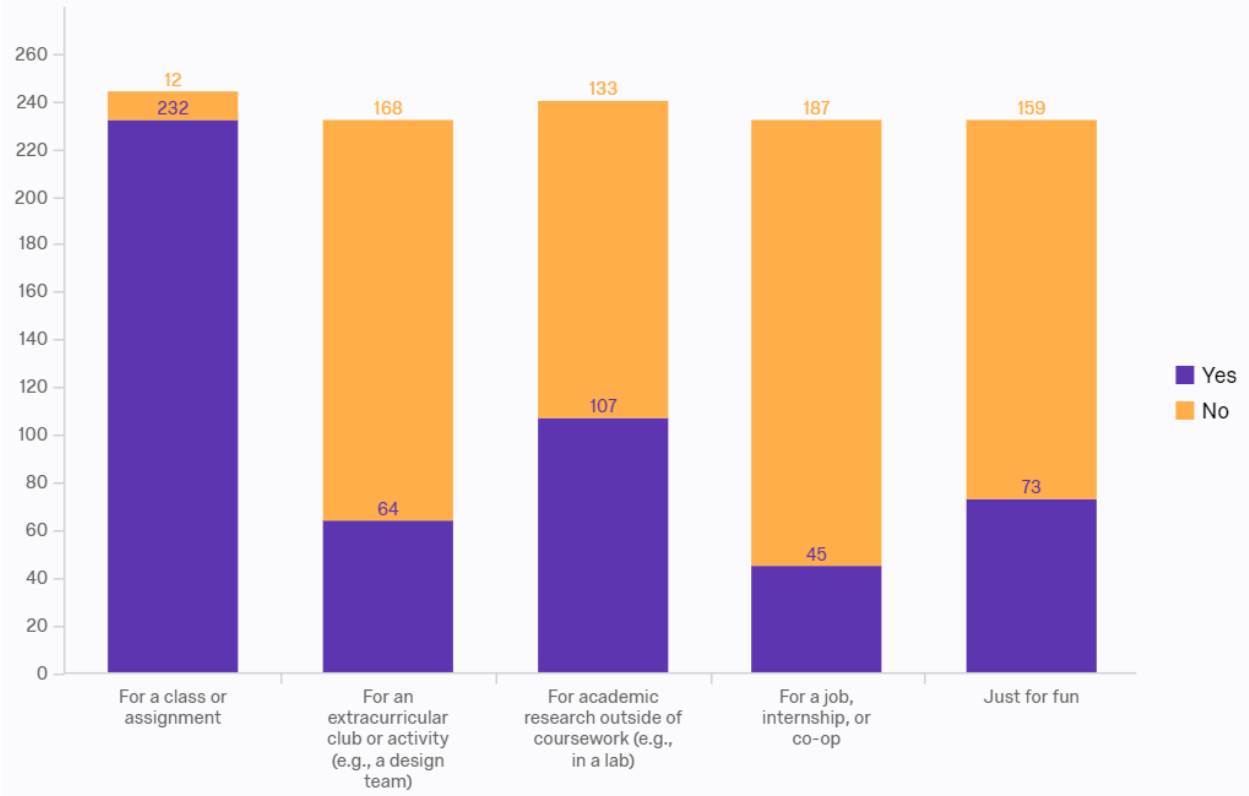

Figure 3. For what reasons have you searched online for a scholarly article?

Visiting the Library Website

A total of 262 students, or 63.3%, reported visiting the University of Michigan Library website at least once during college. Students engaged in a variety of activities on the library website, selecting a mean of 3.05 activities out of the six options provided. The most commonly reported website activities were using the search bar to find articles and other library materials (207 students, or 79.0% of those who used the website), looking for information about the library (153 students, 58.4%), and following links to scholarly databases (136 students, 51.9%), shown in Figure 4.

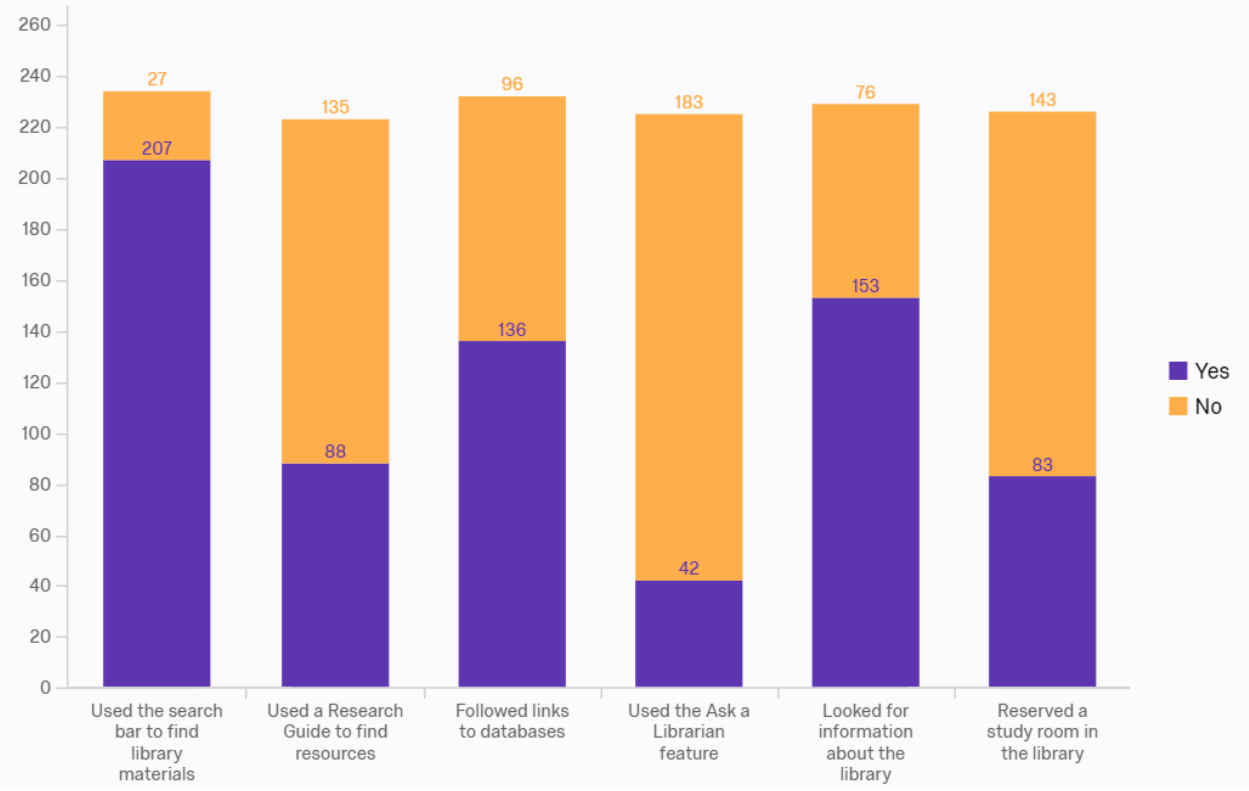

Figure 4. What have you done on the University of Michigan Library Website?

Table 4. Correlations among library use indicators

	1	2	3	4	5	6
1. Studied or did work	--					
2. Got help	+0.112*	--				
3. Searched for articles	+0.122*	+0.188***	--			
4. Visited website	+0.141**	+0.256***	+0.482***	--		
5. Had a job	+0.021	+0.026	+0.093	+0.100*	--	
6. Took a course	+0.024	+0.069	+0.035	+0.045	+0.109*	--

Note: * denotes $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

Other Engagement

The other two indicators of library engagement were having a job working at the library and taking a course in which the primary instructor was a librarian, such as Applied Liberal Arts (ALA) 105, Digital Research: Critical Concepts & Strategies. Both of these types of engagement

were uncommon, with only 7 students (1.7%) reporting that they had a job working at the library during college and 9 students (2.2%) reporting that they took a course with a librarian.

Correlations

Table 4 displays Pearson's correlation coefficients among the six indicators of library use. Correlations ranged in magnitude from near 0 to 0.48 (between searching for a scholarly article during college and visiting the library website). In all cases, the direction of the correlation was positive, suggesting that those who use the library in one dimension are more likely to use the library in other ways as well.

Table 5. Sample proportions and two-tailed p-values for two-sample tests of proportions between library use and dichotomized demographics variables ($N = 414$).

	Gender minority			URM			International			First-generation		
	0	**1**	***p***	**0**	**1**	***p***	**0**	**1**	***p***	**0**	**1**	***p***
Studied in the library	0.963	0.990	0.079	0.976	0.977	0.948	0.982	0.903	0.006 **	0.975	0.981	0.805
Got help from library	0.307	0.367	0.197	0.311	0.545	0.002 **	0.334	0.355	0.815	0.340	0.308	0.647
Searched for article	0.638	0.699	0.186	0.678	0.568	0.143	0.684	0.452	0.008 **	0.680	0.577	0.142
Visited the website	0.583	0.689	0.025 *	0.619	0.750	0.088	0.653	0.388	0.003 **	0.641	0.577	0.371
Had job at the library	0.023	0.010	0.316	0.016	0.023	0.752	0.016	0.032	0.491	0.011	0.058	0.015 *
Course with a librarian	0.023	0.020	0.860	0.016	0.068	0.025 *	0.018	0.065	0.089	0.017	0.058	0.057

Note: * denotes $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$. Shading corresponds to significance levels, with darker shading representing higher levels of significance.

Demographics and Library Use

Several significant differences in library engagement were found across demographic categories of gender, race/ethnicity, national origin, and first-generation status. With respect to gender, I found that a greater proportion of gender minority students reported visiting the library website at least once during college compared with male students and that gender minority students spent a larger percentage of time in the library working non-collaboratively with others (both $p < 0.05$). With respect to race/ethnicity, I found that a greater proportion of URM students had gotten help from the library ($p < 0.01$) or had taken a course with a librarian ($p < 0.05$) compared with non-URM students, and that among regular library users, URM students spent more hours

per week in the library on average ($p < 0.01$). With respect to national origin, I found that international students were less likely to report studying in the library, visiting the library website, or searching for a scholarly article (all $p < 0.01$) and that they spent a greater percentage of their time in the library working alone. Finally, I found that first-generation students were more likely to have a job working in the library and more likely to believe that they spent more time in the library than other students in the College of Engineering (both $p < 0.05$). The details of these analyses are presented below.

Across Library Use Dimensions

I performed a series of independent samples tests of proportions in order to look for differences in library use across six major areas (i.e., studying or doing work in the library, getting help from someone who works at the library, searching for a scholarly article, visiting the library website, having a job at the library, and taking a course with a librarian) by demographic characteristics. Self-reported demographics were recoded dichotomously into four indicators: gender minority status (1 = female, non-binary/third gender, and write-in options; 0 = male), underrepresented minority (URM) status (1 = American Indian or Alaskan Native, Black or African American, Hispanic or Latino, Native Hawaiian or Pacific Islander, and some write-in responses; 0 = all other races, including White and Asian), international student status (1 = international student; 0 = domestic student), and first-generation college student status (1 = first-generation college student; 0 = not first-generation). Sample proportions and p-values are displayed in Table 5.

I found at least one significant difference for each of the four demographic indicators across the six dimensions of library use. Male students were less likely to report visiting the library website compared with students of other genders, with 58.3% of male students and 68.9% of gender minority students reporting ever visiting the website ($z = 2.24$, $p < 0.05$). Compared with non-minority students, a greater proportion of URM students reported asking someone at the library for help (54.5% of URM students vs. 31.1% of non-URM students, $z = 3.12$, $p < 0.01$) and taking a course in which the primary instructor was a librarian (6.8% of URM students vs. 1.6% of non-URM students, $z = 2.23$, $p < 0.05$). International students differed from domestic students across three dimensions. Specifically, international students were less likely to report studying in the library (90.3% of international students vs. 98.2% of domestic students, $z = 2.74$, $p < 0.01$), searching for a scholarly article (45.2% of international students vs. 68.4% of domestic students, $z = 2.64$, $p < 0.01$), or visiting the library website (38.8% of international students vs. 65.3% of domestic students, $z = 2.95$, $p < 0.01$) during college. Finally, a greater proportion of first-generation college students reported having a job working at the library (5.8% of first-generation students vs. 1.1% of continuing-generation students), $z = 2.44$, $p < 0.05$.

Hours Spent Studying in the Library

I conducted a series of chi-squared tests of independence to look for relationships between the dichotomized demographic indicators and the self-reported number of hours per week typically spent studying in the library, a categorical variable ranging from 1 ("I don't go to the library in a typical week") to 6 ("More than 40 hours"). No significant relationships were found to gender, national origin, or first-generation status. However, the chi-squared test revealed a significant difference in the pattern of self-reported library study hours between URM ($N = 43$) and non-URM ($N = 361$) students, $\chi^2(5) = 16.54$, $p < 0.01$. The largest contributor to the chi-squared statistic was the relatively large proportion of URM students reported doing work or studying in the library for 11-25 hours per week compared with non-URM students.

A t-test comparing the mean score for this item revealed no significant two-sided difference between URM ($M = 2.66$, $SD = 1.10$) and non-URM students ($M = 2.93$, $SD = 1.26$), $t(402) = 1.47$, $p = 0.14$. The data told a different story, however, when I excluded students who reported that they did not go to the library in a typical week. When these library non-users were excluded, the mean score for non-URM students was 2.94 ($SD = 0.93$) compared with a mean score of 3.44 ($SD = 0.86$) for URM students, $t(341) = 2.97$, $p < 0.01$. I repeated this group mean comparison excluding library non-users for the other demographic variables and found no significant differences across lines of gender, national origin, or first-generation status at the $p < 0.05$ level.

Collaborative, Non-Collaborative, and Solo Time

I asked students who reported ever studying or doing work in the library during college to estimate the percentage of time they spent in the library working collaboratively with others, non-collaboratively with others, and independently. I ran a series of independent samples t-tests to compare group means (in terms of percentages of time) for each of these three contexts across gender, race/ethnicity, national origin, and first-generation status. Several statistically significant differences in group means emerged. With respect to gender, male students reported spending a smaller percentage of time working non-collaboratively with others compared with students of other genders: a mean of 21.8% ($SD = 19.0\%$) of the time for male students and 26.3% ($SD = 22.0\%$) of the time for gender minority students, $t(402) = 2.25$, $p < 0.05$. However, there was no statistically significant difference in terms of the time spent studying collaboratively or solo between genders. Compared with domestic students ($M = 36.8\%$, $SD = 27.6\%$), international students ($M = 25.5\%$, $SD = 27.3\%$) reported spending on average a significantly smaller percentage of time working collaboratively, $t(402) = 2.08$, $p < 0.05$. In addition, international students ($M = 50.7\%$, $SD = 29.1\%$) spent a significantly greater percentage of their time than domestic students ($M = 39.3\%$, $SD = 27.1\%$) working by themselves, $t(402) = 2.15$, $p < 0.05$. No significant differences were found in group means across the dimensions of race/ethnicity or first-generation status.

Comparing Self to Others

Students who reported ever studying or doing work in the library during college were asked whether they thought they spent more time, about the same amount of time, or less time in the library compared with other students in the College of Engineering. I ran chi-squared tests of independence to determine whether these self-other comparisons differed by demographic group. The test was significant at the $p < 0.05$ level for one demographic category only: first-generation status, $\chi^2(2) = 8.23$, $p < 0.05$. Specifically, it appears that a disproportionate percentage of first-generation students believe they spend more time in the library than other students; 25.5% ($N = 13$) of first-generation students placed themselves in this bin, compared with only 11.1% ($N = 39$) of continuing-generation students.

Although the group mean of time spent studying or doing work in the library did not differ between first-generation and continuing-generation students, the shape of the distributions differed somewhat with the distribution for continuing-generation students being more skewed left. Specifically, among the 353 continuing-generation students who responded to the question about the number of hours they spent in the library in a typical week, a plurality (113 students, 32.0%) selected “Less than 5 hours,” followed by the next most common answers of “5-10 hours” (103 students, 29.2%) and “11-25 hours” (67 students, 19.0%). For the 51 first-generation students who responded to this item, the most common answer was “5-10 hours” (15 students, 29.4%), then “11-25 hours” (13 students, 25.5%), and then “Less than 5 hours” (12 students, 23.5%). Among the 13 first-generation students who reported that they thought they spent more time in the library, 3 said they spent 5-10 hours in the library, 7 said they spent 11-25 hours in the library, 2 said they spent 26-40 hours in the library, and 1 said they spent more than 40 hours studying or doing work in the library in a typical week.

Major and Library Use

In order to determine whether library use differed significantly by academic major, I conducted a series of independence tests (displayed in Table 6), excluding students who did not indicate a major ($N = 7$) or who reported having a major other than the 17 majors offered by the College of Engineering ($N = 2$). The null hypothesis of an independence test between a categorical variable (e.g., academic major) and an outcome is that the categorical variable and outcome are independent; that is, there is no statistical relationship between the categorical variable and the outcome. If the p-value of the test indicates significance, this means that the variables are *not* independent of one another (e.g., students from some majors are more likely to use the library than others).

Three of the six library use dimensions were either extremely uncommon (i.e., having a job at the library or taking a course in which the primary instructor was a librarian) or extremely

common (i.e., studying or doing work in the library). For these dimensions, some observed and expected cell counts were very small (between 0 and 1) so I used Fisher's exact test to obtain directly the exact probability of the observed data (see McDonald, 2009). For the other three dimensions of library use (i.e., getting help from the library website, searching for an article, and visiting the library website), I conducted a chi-squared (χ^2) test of independence. For the chi-squared tests, I pooled majors with 12 or fewer students (i.e., Civil Engineering, Climate and Meteorology, Data Science, Engineering Physics, Naval Architecture and Marine Engineering, Nuclear Engineering and Radiological Sciences, and Space Science and Engineering) into an "other majors" category in order to ensure that all expected cell counts were 5 or greater.

Table 6. Fisher's exact and chi-squared tests of independence between library use and academic major (N = 405).

	Studied in the library	**Got help from library**	**Searched for an article**	**Visited the website**	**Had job at the library**	**Course with a librarian**
	98% overall	*34% overall*	*67% overall*	*63% overall*	*1.7% overall*	*1.7% overall*
Exact	0.082	--	--	--	0.192	0.807
$p(\chi^2)$	--	0.985	0.055	0.034*	--	--

Note: * denotes $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$. Shading corresponds to significance levels, with darker shading representing higher levels of significance.

A significant difference was found only for one dimension of library use: visiting the library website, $\chi^2(10, N = 405) = 19.51$, $p < 0.05$. The largest contributors to the chi-squared test statistic for visiting the library website were Electrical Engineering majors (29% reported visiting the library website, $\chi^2 = 8.5$) and Chemical Engineering majors (80.0%, $\chi^2 = 3.5$).

Academic Self-Efficacy

Descriptive Results

A summary of item responses for the 15 academic self-efficacy items are shown in Table 7. Overall, students demonstrated high levels of academic self-efficacy. Note that these items had a theoretical minimum score of 1 (corresponding to an answer of "Not at all true of me") and a theoretical maximum of 5 (corresponding to "Completely true of me"). For the two items denoted with an asterisk in the table, a higher level of agreement with the original item corresponded to *lower* self-efficacy. I then reverse-coded these items so that a higher numerical score would correspond to higher self-efficacy, consistent with the other survey items.

Exploratory Factor Analysis (EFA)

In order to reduce the number of variables for subsequent analysis, I conducted exploratory factor analysis (EFA) with the maximum likelihood (ML) method of extraction and promax

rotation to uncover the underlying factor structure of the academic self-efficacy inventory. Consistent with best practices, items with loadings less than 0.40 or significant cross-loading between multiple factors were removed (Pett, Lackey, & Sullivan, 2003).

Table 7. Mean item responses and standard deviations for academic self-efficacy items

Item	***M* (*SD*)**
I believe it is possible for me to get good grades in college.	4.21 (0.87)
I think I am a good student compared with others in the College of Engineering.	3.45 (1.04)
I work hard to get a good grade even when I don't like a class.	4.10 (0.95)
I am determined to do what it takes to succeed in college.	4.41 (0.75)
I prefer to take classes that are challenging so I can learn new things.	3.62 (1.01)
My study skills are excellent compared with other students in the College of Engineering.	2.93 (1.09)
* I wait to study until the night before the exam.	3.98 (0.99)
I always meet the deadlines for my assignments.	4.48 (0.75)
I am confident that I will be able to learn the basic concepts covered in my classes.	4.29 (0.76)
I'm confident I can understand the most complex material in my courses.	3.49 (1.00)
I feel confident in my ability to ask questions in class.	3.21 (1.20)
* I avoid speaking up in class.	3.07 (1.17)
When I do poorly on an exam or assignment, I try to learn from my mistakes.	4.04 (0.88)
I hold myself to a high academic standard.	4.27 (0.89)
I make an effort to attend all of my classes.	4.27 (0.93)

Note: * indicates that item is reverse coded.

Examination of eigenvalues and scree plots indicated that a total of three factors, shown in Table 8, should be retained. The first, which I've deemed "Academic Confidence," includes seven items that reflect self-confidence and optimism with respect to learning and academic achievement. The scale reliability coefficient (Cronbach's α) for the Academic Confidence subscale was 0.86. The four items in the second retained factor, "Academic Diligence," are related to working hard or putting effort into school work as well as following rules or expectations. Cronbach's α for this scale was 0.62. The final retained factor, "Class

Communication," contains two items which both relate to communicating in class. Cronbach's α for the Class Communication factor was 0.72.

I removed one item ("I am determined to do what it takes to succeed in college") because it had significant cross-loading between the Academic Confidence and Academic Diligence factors, and another "When I do poorly on an exam or assignment, I try to learn from my mistakes") because it did not load onto any factors.

Table 8. Promax rotated pattern matrix of exploratory factor analysis for academic self-efficacy items with reliability coefficients (*N* = 413)

Factor labels and individual items	**α**	**1**	**2**	**3**	**Unique-ness**
Factor 1: Academic Confidence (ASE-AC)	0.86				
I'm confident I can understand the most complex material in my courses.		**0.789**	-0.118	0.112	0.371
I think I am a good student compared with others in the College of Engineering.		**0.782**	0.147	-0.054	0.307
I believe it is possible for me to get good grades in college.		**0.767**	-0.079	0.102	0.395
I prefer to take classes that are challenging so I can learn new things.		**0.704**	-0.113	0.051	0.529
My study skills are excellent compared with other students in the College of Engineering.		**0.664**	0.236	-0.220	0.452
I am confident that I will be able to learn the basic concepts covered in my classes.		**0.655**	0.003	0.200	0.446
I hold myself to a high academic standard.		**0.572**	0.399	-0.125	0.393
Factor 2: Academic Diligence (ASE-AD)	0.62				
I work hard to get a good grade even when I don't like a class.		0.201	**0.682**	-0.053	0.410
I always meet the deadlines for my assignments.		0.096	**0.676**	-0.107	0.512
* I wait to study until the night before the exam.		-0.218	**0.663**	0.119	0.590
I make an effort to attend all of my classes.		-0.157	**0.633**	0.190	0.580
Factor 3: Class Communication (ASE-CC)	0.72				
* I avoid speaking up in class.		-0.101	0.079	**0.890**	0.224
I feel confident in my ability to ask questions in class.		0.291	-0.082	**0.747**	0.257

Note: * indicates that item is reverse coded.

While the value of the internal reliability coefficient α for the Academic Diligence dimension was lower than the cutoff of 0.70 cited widely in social science research, Cortina (1993) notes that α is "very much a function of the number of items in a scale" (p. 102) and suggests that conventional cutoffs of acceptability for α should be applied with caution for scales with very few or very many items, as the value of α becomes falsely inflated for scales with many items even when true inter-item correlation is quite low. In addition, Sijtsma (2009) notes that Cronbach's α is not a true estimate but a *lower bound* to the reliability that can result in a "gross underestimate" (p. 107) of a scale's actual internal consistency. For these reasons, I decided to proceed with dimensional reduction despite the low value of α for one of the three retained factors.

I combined the academic self-efficacy items into factor-based scores by computing the mean of items in each of the three indicated subscales from EFA: Academic Confidence (ASE-AC, 7 items), Academic Diligence (ASE-AD, 4 items), and Class Communication (ASE-CC, 2 items). The three subscales were weakly-to-moderately positively correlated with one another, with the correlation between the ASE-AC and ASE-AD subscales equal to +0.440 ($p < 0.001$); between the ASE-AC and ASE-CC subscales, +0.410 ($p < 0.001$); and between the ASE-AD and ASE-CC subscales, +0.268 ($p < 0.001$).

Demographics and Academic Self-Efficacy

Using the computed factor-based scores for the three subscales (ASE-AC, ASE-AD, and ASE-CC) I performed a series of independent samples t-tests in order to detect differences in group mean across demographic characteristics (i.e., gender, race/ethnicity, national origin, parental education), displayed in Table 9. I found significant two-sided differences between male and gender minority students in terms of the ASE-AC and ASE-CC subscales, with gender minority students having significantly lower self-efficacy across these dimensions compared with male students (both $p < 0.001$). No other significant differences were detected with respect to demographic characteristics.

In order to understand and quantify the impact of these demographic factors on academic self-efficacy in another way, I constructed a series of three multiple linear regression models with the self-efficacy subscales as continuous outcomes and the four demographic indicators as predictors. Two of the three models had significant model p-values, indicating that the models had some overall predictive power. However, the overall p-value for the ASE-AD model was greater than 0.05, so I did not interpret the coefficients for this model.

Regression coefficients for the ASE-AC and ASE-CC models are displayed in Table 10. The demographic variables included in the models explained 7% of the variance in ASE-AC and 5%

of the variance in ASE-CC, as evidenced by the coefficient of determination R^2 for each model. In both models, the only significant coefficient other than the constant term was gender minority status, which had a negative effect on academic self-efficacy across both dimensions as expected. These findings indicate that gender has a significant relationship to ASE-AC and ASE-CC when holding URM status, international status, and first-generation status constant, but that the magnitude of the effect is relatively small.

Table 9. Sample means and two-tailed p-values for two-sample t-tests between academic self-efficacy subscales and dichotomized demographics variables

	Gender minority			URM			International			First-generation		
	0	**1**	***p***	**0**	**1**	***p***	**0**	**1**	***p***	**0**	**1**	***p***
ASE-AC	3.92 (0.67)	3.56 (0.70)	0.000 ***	3.77 (0.72)	3.62 (0.60)	0.191	3.74 (0.70)	3.91 (0.80)	0.192	3.76 (0.70)	3.67 (0.77)	0.368
ASE-AD	4.15 (0.63)	4.27 (0.61)	0.058	4.21 (0.63)	4.17 (0.54)	0.696	4.22 (0.61)	4.01 (0.76)	0.067	4.22 (0.63)	4.11 (0.60)	0.219
ASE-CC	3.37 (1.01)	2.89 (1.03)	0.000 ***	3.14 (1.05)	3.18 (0.99)	0.792	3.14 (1.05)	3.19 (1.03)	0.778	3.14 (1.03)	3.16 (1.15)	0.877

Note: * denotes $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$. Shading corresponds to significance levels, with darker shading representing higher levels of significance.

Table 10. Linear regression coefficients and standard errors for models predicting academic self-efficacy in terms of demographics

	Academic Confidence	**Class Communication**
	$R^2 = 0.070, p < 0.001$	$R^2 = 0.054, p < 0.001$
Gender minority	-0.35 (0.07)***	-0.49 (0.10)***
URM	-0.11 (0.11)	+0.07 (0.17)
International	+0.10 (0.13)	-0.04 (0.19)
First-generation	-0.07 (0.11)	+0.00 (0.16)
Constant	+3.58 (0.05)***	+2.88 (0.08)***

Note: * denotes $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$. Shading corresponds to significance levels, with darker shading representing higher levels of significance.

Library Use and Academic Self-Efficacy

In order to look for relationships between different types of library use and academic self-efficacy, I conducted independent samples t-tests comparing mean academic self-efficacy

scores across each of the three sub-dimensions using dichotomized indicators of library use as grouping variables.

Basic Library Use Dimensions

I first looked for differences in group means for users and non-users of the six main categories of library engagement I investigated: doing work or studying in the library, getting help from someone who works at the library, searching online for scholarly research articles, visiting the University of Michigan Library website, having a job at the University of Michigan Library, and taking a course in which the primary instructor was a librarian. A significant two-sided difference was found in mean ASE-AC score between those who held a job at the library (M = 2.69, SD = 0.47) and those who had not (M = 3.77, SD = 0.70), $t(412) = 4.06$, $p < 0.001$. The same group also had a lower mean score for the ASE-AD dimension but the difference was only marginally statistically significant, $t(412) = 1.95$, $p = 0.0514$. No other statistically significant differences were found across these indicators.

Regular Users vs. Non-Users

I decided to look in more depth at the indicators within the basic library use dimensions. First, I created a new indicator variable signifying whether or not a student was a regular user of library space to study or do work. Students were assigned 0 if they had reported never studying or doing work in the library during college or if they selected the option "I do not go to the library in a typical week," and 1 if they reported studying or doing work in the library at least "Less than 5 hours" in a typical week. In total, 343 students (82.9%) were classified as regular users of library space to do work or study and the remaining 71 students (17.2%) were classified as non-users. However, no significant differences in mean academic self-efficacy scores for any of the three dimensions were found across the two groups.

Searching for Scholarly Articles

Next, I looked for differences in mean academic self-efficacy across the different reasons listed for searching for scholarly articles: for a class or assignment, for a club or extracurricular activity, for academic research, for a job or internship, and just for fun. Because the original variables had missing data for those who didn't report searching for a scholarly article at all during college, I recoded these variables so that all students were assigned a dummy value of 0 unless they had indicated that they had searched for an article for each reason; those students were assigned a 1.

Using the recoded variables, I found that searching for a scholarly article for a club or extracurricular activity was associated with both higher mean scores for both ASE-AC ($t(412) = 2.42$, $p < 0.05$) and ASE-CC ($t(412) = 2.40$, $p < 0.05$). Similarly, searching for a scholarly article for extracurricular academic research (e.g., in a lab) was associated with higher mean scores for

ASE-AC ($t(412) = 1.98$, $p < 0.05$) and ASE-CC ($t(412) = 2.51$, $p < 0.05$). Searching for a scholarly article for class, for a job or internship, or just for fun were not associated with a difference in mean academic self-efficacy across any of the three dimensions, and no differences were found across the ASE-AD dimension.

Visiting the Library Website

I repeated a similar analysis to detect differences among those who had visited the library website during college along the lines of what they had done when they visited the website (e.g., used the search bar, followed links to databases). Only one statistically significant difference emerged: students who had followed links to databases on the library website had slightly lower mean ASE-AC scores ($M = 3.80$, $SD = 0.71$) compared with students who had never followed links to databases ($M = 3.65$, $SD = 0.69$), $t(412) = 2.00$, $p < 0.05$.

Getting Help

Finally, I repeated the recoding and testing procedure to look for differences in academic self-efficacy with respect to the different modes of getting help from someone who works at the library: in person, online, and over the phone. (Getting help by text message was omitted because only one respondent reported getting help from someone who works at the library in this way.) No significant differences in group means were found across the three dimensions of academic self-efficacy.

Demographics, Library Use, and Academic Self-Efficacy

In order to understand how demographic characteristics, library use, and academic self-efficacy all fit together to answer RQ5 (*Does the use of library resources predict academic self-efficacy above and beyond demographic characteristics alone?*) I constructed a series of multiple linear regression models with each of the three academic self-efficacy dimensions as outcomes. I selected as predictors variables that I believed, for either theoretical or empirical reasons, might relate to academic self-efficacy. These included five demographic measures (number of semesters completed in the College of Engineering, gender, race/ethnicity, national origin, and parental education) and twelve dimensions of library use. Because only students who reported ever using the library during college ($N = 404$) answered the question about how much of their library time they spend working collaboratively, non-collaboratively in groups, and independently, and because I believed this dimension might be related to at least one dimension of academic self-efficacy, I decided to build the models using only the data from the 97.6% of students ($N = 404$) who reported studying or doing work in the library at least once during college.

Regression coefficients for the three models are displayed in Table 11. Of note, the model of the Academic Diligence (ASE-AD) dimension failed to attain overall significance ($p >> 0.05$)

meaning that the model has no predictive value and the coefficients are not interpretable. Gender and at least one library use dimension were significant predictors in the other two models. Library use was not necessarily associated with *positive* effects on academic self-efficacy, however. In fact, more hours spent studying or doing work in the library were associated with a lower mean ASE-CC score ($p < 0.01$), as was spending a higher percentage of time spent working alone at the library ($p < 0.05$). In addition, having a job working at the library was associated with a large decrease in ASE-AC ($p < 0.001$). In contrast, searching for a research article for an extracurricular club or activity was associated with a higher ASE-AC score ($p < 0.01$) and getting help from the library was associated with higher ASE-CC ($p < 0.05$).

Table 11. Multiple linear regression coefficients and standard errors for models predicting academic self-efficacy dimensions in terms of demographics and library use ($N = 404$)

	Academic Confidence	**Academic Diligence**	**Class Communication**
	$R^2 = 0.147$, $p < 0.001$***	$R^2 = 0.040$, $p = 0.526$	$R^2 = 0.119$, $p < 0.001$***
Demographics			
Number of semesters	-0.005 (0.018)	*-0.000 (0.017)*	-0.047 (0.027)
Gender minority	-0.347 (0.070)***	*+0.129 (0.065)**	-0.515 (0.105)***
URM	-0.115 (0.115)	*+0.014 (0.107)*	+0.043 (0.174)
International	+0.050 (0.136)	*-0.172 (0.126)*	-0.135 (0.205)
First-generation	-0.035 (0.106)	*-0.090 (0.099)*	+0.020 (0.160)
Library use			
# of hours in library	+0.000 (0.003)	*-0.000 (0.003)*	-0.012 (0.005)**
% of time collaborating	+0.000 (0.002)	*+0.001 (0.002)*	-0.006 (0.003)
% of time solo	+0.002 (0.002)	*+0.001 (0.002)*	-0.007 (0.003)*
Got help from library	+0.034 (0.074)	*-0.041 (0.069)*	+0.222 (0.112)*
Visited library website	-0.001 (0.079)	*-0.053 (0.074)*	-0.054 (0.119)
Had job in library	-1.091 (0.261)***	*-0.376 (0.243)*	-0.533 (0.393)
Course with librarian	-0.276 (0.233)	*-0.100 (0.217)*	+0.240 (0.352)
Article: for class	-0.120 (0.081)	*-0.031 (0.076)*	+0.080 (0.123)
Article: for club	+0.285 (0.103)**	*+0.170 (0.096)*	+0.300 (0.155)
Article: for research	+0.112 (0.091)	*+0.047 (0.085)*	+0.131 (0.137)
Article: for job	+0.177 (0.122)	*-0.014 (0.114)*	+0.193 (0.184)
Article: for fun	-0.086 (0.100)	*-0.051 (0.093)*	-0.023 (0.150)
Constant term	+3.870 (0.168)***	*+4.152 (0.156)****	+4.004 (0.252)***

Note: * denotes $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$. Shading corresponds to significance levels, with darker shading representing higher levels of significance.

Results by Gender

Because male and gender minority students were found to differ with respect to academic self-efficacy and because the gender coefficient was highly significant in the models displayed in Table 11, I decided to create separate models for the dichotomized gender categories so that I could examine coefficients for each group.

Table 12. Multiple linear regression coefficients and standard errors for models predicting academic self-efficacy dimensions for male (gender majority) students (*N* = 210)

	Academic Confidence	**Academic Diligence**	**Class Communication**
	$R^2 = 0.178$, $p = 0.001$**	$R^2 = 0.082$, $p = 0.263$	$R^2 = 0.079$, $p = 0.423$
Demographics			
Number of semesters	+0.017 (0.024)	*+0.032 (0.023)*	*-0.004 (0.038)*
URM	-0.127 (0.160)	*+0.018 (0.157)*	*+0.110 (0.257)*
International	+0.029 (0.160)	*+0.105 (0.157)*	*-0.027 (0.256)*
First-generation	+0.015 (0.138)	*-0.057 (0.136)*	*+0.019 (0.222)*
Library use			
# of hours in library	-0.000 (0.005)	*-0.003 (0.004)*	*-0.018 (0.007)**
% of time collaborating	-0.002 (0.004)	*-0.001 (0.003)*	*-0.009 (0.004)**
% of time solo	+0.002 (0.003)	*-0.001 (0.003)*	*-0.006 (0.004)*
Got help from library	+0.055 (0.104)	*-0.007 (0.102)*	*+0.124 (0.166)*
Visited library website	+0.018 (0.109)	*+0.050 (0.108)*	*+0.022 (0.176)*
Had job in library	-0.872 (0.301)**	*-0.207 (0.296)*	*-0.601 (0.482)*
Course with librarian	-0.384 (0.304)	*-0.130 (0.299)*	*+0.115 (0.487)*
Article: for class	-0.237 (0.116)*	*-0.349 (0.114)***	*+0.073 (0.186)*
Article: for club	+0.565 (0.141)***	*+0.344 (0.138)**	*+0.313 (0.226)*
Article: for research	-0.041 (0.117)	*-0.070 (0.115)*	*+0.016 (0.188)*
Article: for job	+0.193 (0.171)	*-0.011 (0.168)*	*+0.233 (0.274)*
Article: for fun	-0.174 (0.127)	*-0.051 (0.125)*	*-0.048 (0.203)*
Constant term	+3.974 (0.232)***	*4.301 (0.228)****	*3.992 (0.372)****

Note: * denotes $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$. Shading corresponds to significance levels, with darker shading representing higher levels of significance.

Table 13. Multiple linear regression coefficients and standard errors for models predicting academic self-efficacy dimensions for gender minority students (*N* = 194)

	Academic Confidence	Academic Diligence	Class Communication
	$R^2 = 0.102$, $p = 0.227$	$R^2 = 0.142$, $p = 0.030$*	$R^2 = 0.132$, $p = 0.052$
Demographics			
Number of semesters	*-0.022 (0.027)*	-0.031 (0.023)	*-0.101 (0.039)**
URM	*-0.016 (0.171)*	+0.053 (0.145)	*-0.032 (0.247)*
International	*+0.144 (0.256)*	-0.668 (0.216)**	*-0.479 (0.368)*
First-generation	*-0.151 (0.169)*	-0.210 (0.142)	*-0.011 (0.243)*
Library use			
# of hours in library	*+0.001 (0.005)*	+0.003 (0.005)	*-0.003 (0.008)*
% of time collaborating	*+0.001 (0.003)*	+0.003 (0.002)	*-0.001 (0.004)*
% of time solo	*+0.001 (0.003)*	+0.003 (0.002)	*-0.009 (0.027)**
Got help from library	*+0.036 (0.111)*	-0.064 (0.094)	*+0.354 (0.160)**
Visited library website	*-0.047 (0.118)*	-0.156 (0.100)	*-0.156 (0.170)*
Had job in library	*-0.162 (0.577)***	-0.183 (0.487)	*-0.352 (0.831)*
Course with librarian	*-0.160 (0.384)*	-0.203 (0.324)	*+0.298 (0.553)*
Article: for class	*-0.015 (0.118)*	+0.224 (0.134)*	*+0.080 (0.170)*
Article: for club	*+0.034 (0.158)*	-0.014 (0.134)	*+0.242 (0.228)*
Article: for research	*+0.362 (0.144)**	+0.240 (0.122)	*+0.325 (0.208)*
Article: for job	*+0.009 (0.182)*	-0.122 (0.154)	*+0.051 (0.262)*
Article: for fun	*+0.186 (0.180)*	+0.107 (0.152)	*-0.019 (0.260)*
Constant term	*+3.510 (0.236)****	+4.206 (0.200)***	*+3.488 (0.340)****

Note: * denotes $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$. Shading corresponds to significance levels, with darker shading representing higher levels of significance.

For male students, only the Academic Confidence (ASE-AC) model was significant overall as indicated by the model F-statistic and p-value. Three coefficients (and the constant term) were significant in this model, as shown in Table 12. Specifically, having a job working in the library and searching for a scholarly article for class were associated with lower self-efficacy along the ASE-AC dimension, while searching for an article for a club or extracurricular activity had a positive relationship to ASE-AC score for male students.

In contrast, only the Academic Diligence (ASE-AD) model was significant at the $p < 0.05$ level for students of other genders, although the Class Communication (ASE-CC) model was marginally significant overall with $p = 0.052$. Regression coefficients for these models are displayed in Table 13. In the ASE-AD model for gender minority students, being an international

student was significantly negatively related to ASE-AD score, while searching for a scholarly article for class had a positive relationship to ASE-AD.

Discussion

The discussion of results in this section is organized by research question, followed by overall implications for practice.

RQ1: How do undergraduate students in the College of Engineering use the University of Michigan Library?

The results of this study paint a portrait of academic library use in the College of Engineering that is unprecedented in its level of detail. Perhaps the most encouraging finding is the fact that a large percentage (83.6%, N = 342) of engineering students regularly use the library to do work or study, with nearly a third of those students spending more than 10 hours doing work or studying in the library in a typical week. In focus groups and cognitive interviews, students told me about the heavy, relentless workload in most engineering majors, and many said that they considered studying in the library to be essential for academic success, despite stereotypes held by students and librarians alike that engineering students do not use the library. Although my data do not allow me to draw comparisons between majors, these findings appear to align with Bridges (2008) and Collins and Stone (2014), who found that students majoring in engineering use the physical library no less often than students in other disciplines, along with Soria (2013) who reported that students aspiring to careers in engineering placed greater importance on libraries and research compared with others.

In contrast to others who have studied college student library use, I made distinctions between time spent working in the library collaboratively with others, non-collaboratively with others, and independently. These distinctions are particularly important in the context of engineering because of the prevalence of group projects in engineering coursework as well as co-curricular design teams. My survey data showed that there was a large amount of variance between students in terms of the percentage of time at the library they spent working collaboratively with others, with others but independently, and by themselves. These differences among individuals were borne out in interviews; in fact, discussions of whether students used the library primarily for group work or for solitary study sparked raucous (yet friendly) debate in several of the focus groups I conducted. Future work in this area could investigate how students from different majors (within and outside of engineering) spend their time in the library, which may inform design of academic library spaces and physical resources such as group study rooms and individual study carrels.

Just over half of respondents to the survey thought that they spent less time studying or doing work in the library compared with other students in the College of Engineering, while only a fifth thought they spent more time. This counterintuitive finding has several possible explanations. One is that the heaviest library users did not complete the survey. (Perhaps they were too busy studying to do so.) Another is that students are not accurately perceiving or remembering how much time other people are spending in the library. If a student visits the library and notices that many others were there before they arrived and that many remain after they leave, the student may mistakenly infer that most other people are spending more time in the library. A third explanation is the deep-seated humility I found to be characteristic of undergraduate engineers at the University of Michigan. During the focus groups and cognitive interviews, I was struck by students' modesty (often expressed as self-effacing humor) as well as the value placed on hard work. Whether this humility was performative, genuine, or some combination of the two, such an attitude may lead students to undersell their own level of dedication to academics. Whatever the explanation, the fact that most considered their library use to be less than average suggests that students may feel inadequate or inferior compared with hard-working, high-achieving peers when it comes to study habits and library use. This may be related to "library anxiety," the feeling that one's library use skills are inadequate, a construct originally described by Constance Mellon (1986). To reduce feelings of library anxiety or inadequacy, librarians and library staff could do more to educate engineering students about the fact that using the library irregularly or for only a few hours per week on average is actually quite typical.

Mellon (1986) noted that anxious students may avoid asking questions at the library because they are afraid of revealing their inadequacy to others. Perhaps this helps to explain why only about a third of students reported getting help from someone who works at the library through any mode (in person, online, by phone, or via text) at least once during college. While engineering students certainly have information needs, they may not fully understand the breadth of resources and services the library has to offer or what kinds of assistance librarians are able to provide, and therefore feel reluctant to ask for information or help. In focus groups and cognitive interviews, few engineering students reported ever interacting with librarians or other library staff during college, and those who had done so mostly recalled asking wayfinding questions about the locations of library resources rather than asking for substantive research assistance. It is also important to note that this survey question was also somewhat problematic during survey pretesting in terms of comprehension and it underwent several rounds of revisions. Students had an inconsistent understanding of both "help" and "someone who works at the library," but most agreed that "help" did not include assistance locating the restroom and that "someone who works at the library" includes librarians, paraprofessional library staff, and student workers, but not people who were studying ("working") in the library. Nonetheless, the data suggest that

substantive engagement with librarians or library staff is infrequent among engineering students, perhaps because they do not understand what is possible at the library.

Survey results also showed that two-thirds of students had ever searched for a scholarly article in college and that a similar percentage had visited the library website at least once during college. During focus groups and cognitive interviews, most students who had searched for a scholarly article or visited the library website reported that they had done so during their first-year Engineering 100 class, but that they haven't made much use of electronic library resources since freshman year. Further analysis of the survey data revealed differences by major in whether or not students had visited the library website, with a disproportionately small number of Electrical Engineering majors (5 out of 17, or 29.4%) and a disproportionately large number of Chemical Engineering majors (24 out of 30, or 80.0%) reporting that they had done so. This may be explained by the fact that some sections of Engineering 100 include an information literacy component (e.g., instructional session with a librarian or a requirement of finding/using scholarly articles in assignments) while others do not. Examination of Engineering 100 course syllabi could clarify the origin and nature of sub-disciplinary differences in use of the library website and electronic library resources. Librarians providing instruction to Engineering 100 students might also consider emphasizing the fact that reviewing the scholarly literature for information about a topic is an important part of the engineering design process, even when locating scholarly articles is not explicitly required by professors.

RQ2: How do engineering student demographic characteristics (e.g., gender, race) relate to the use of library resources and services in college?

Overall, my data and analyses support the hypothesis that students with different demographic characteristics use the university library differently, in alignment with Kuh and Gonyea (2003), Whitmire (2001, 2003), and others. This study, however, provides additional insight into the experiences of engineering students, whose demographics and patterns of academic library use are known to differ from students majoring in humanities, social science, and natural science disciplines.

Two interesting differences in library use emerged with respect to gender. First, I found that a significantly smaller percentage of male students reported visiting the library website at least once during college compared with gender minority students. This difference is likely explained at least in part by major. For example, while the study sample was 52.7% male, male students comprised 70.6% of those who reported studying Electrical Engineering, a major with disproportionately low use of the library website, as discussed above. In contrast, just 43.3% of the Chemical Engineering majors were male, and students in this major were more likely to report visiting the library website at least once during college. Collection of additional data and further analyses may help clarify the nature of the relationship between major, gender, and use of

electronic library resources. Second, I found that male students spent significantly less of their time studying or doing work at the library non-collaboratively with others compared with gender minority students. Much as Kuh and Gonyea (2003) speculated that students of color in predominantly white colleges and universities might find the academic library to be a "safe haven" that supports collaboration with other students from similar racial and ethnic backgrounds, I hypothesize that gender minority students, who comprise only 26% of the undergraduate student population in the College of Engineering overall, may find solace in studying together in the library. That is to say, gender minority students may be inclined to band together to feel more comfortable in male-dominated spaces such as the Art, Architecture & Engineering Library even when they do not intend to work collaboratively. In addition, I have shown elsewhere that male students in the College of Engineering engaged in significantly less general socializing behavior compared with their female peers in general (Brennan-Wydra et al., 2019), a trend which may extend to use of the library. This finding supports Oliveira's (2017) observation that the library serves not only an academic function for students, but a social one as well.

Several differences in library use emerged with respect to race/ethnicity. Specifically, I found that URM students were significantly more likely to have gotten help from someone at the library at least once during college and that among regular library users, URM students spent more time studying or doing work in the library compared with non-minority students. These findings are in agreement with Whitmire (2003) who found that students of color used the library to read or study and asked librarians for help more than their white peers as well as Kuh and Gonyea (2003) who observed that Hispanic, Latino, and Black students visited the library more frequently than their White and Asian counterparts. My analyses also revealed that URM students were significantly more likely to have taken a course in which the primary instructor was a librarian. It is possible that URM students are more likely to take classes outside of engineering in general or that URM students place greater importance on developing their research skills compared with white and Asian students. In addition, experiences that develop research skills and confidence such as taking a course with a librarian may be a protective factor for URM students in engineering (Adedokun et al., 2013; Chang et al., 2014; Oseguera et al., 2006) leading to overrepresentation of students who took such a course in the survey sample because those students were more likely to persist in engineering majors.

In agreement with Stone and Collins (2013), I found that international students differed from their domestic counterparts across several dimensions of library use. Specifically, international students were less likely to have studied or done work in the library, less likely to have searched for a scholarly article, and less likely to have visited the library website during college. In addition, international students spent less time than domestic students working collaboratively in the library and a larger percentage of their time working by themselves. These results do not

necessarily imply that international students spend less of their time engaged in collaborative group work compared with domestic students because it is possible that international students simply prefer to use spaces other than the library for collaboration. In addition, differences in use of online library resources (i.e., scholarly articles and the library website) may be partially explained by academic major. However, these troubling disparities in use of online library resources appear to support the hypothesis put forth by Jiao and Onwuegbuzie (1998) that international students in American universities may experience more library anxiety than their domestic peers, particularly with respect to library technology. Collection of additional data around the library experiences of international students in the College of Engineering and the University of Michigan more broadly could help to explain these differences and inform the design of library instructional sessions geared toward international students.

Finally, I found that first-generation students were more likely to have a job working in the library compared with other students. This is probably explained by the fact that first-generation students are more likely to have *any* job during college because they are more likely to come from low-income backgrounds (Brennan-Wydra et al., 2019), and that many student library jobs at the University of Michigan are designated Work-Study positions. While Bell (2014) posits that students benefit in terms of academic performance "when librarians become part of a student's support network," having a job working in the library does not seem to produce a support network for students in the same way. In addition, a larger proportion of first-generation students indicated that they believed they spent more time studying or doing work in the library compared with continuing-generation students: 25.5% of first-generation students vs. 11.1% of continuing-generation students placed themselves in this bin. Indeed, while first-generation students comprise only an eighth of the survey sample, a quarter of the students who believed they spent more time than others studying in the library were first-generation students. However, first-generation students as a group did not differ significantly from their peers in terms of the mean amount of time spent studying or doing work in the library. This seemingly contradictory result may be explained by the differing skew of the distributions, as discussed previously, or due to differences in understanding academic norms and expectations. Collier and Morgan (2008) noted that first-generation students may have more difficulty mastering the "college student" role compared with continuing-generation students who enter the college environment with more cultural capital. In turn, these differences in role mastery can lead to differing expectations around workload, priorities, and time management (Collier & Morgan, 2008). It is possible that students in the College of Engineering who are the first in their families to go to college may have distorted perceptions of what is a typical amount of time to spend in the library or how their own academic effort (i.e., time spent studying) compares with that of their peers. Engineering librarians (and academic librarians in general) might consider holding supplementary library orientation workshop sessions for first-generation college students.

RQ3: How do engineering student demographic characteristics relate to academic self-efficacy?

While demographic characteristics do appear to play a role in self-efficacy in engineering, the magnitude of the effect is relatively small, eclipsed by individual differences not fully captured by the study instrument. Regression models showed that demographic characteristics were predictive of Academic Confidence (ASE-AC) and Class Communication (ASE-CC) overall, but not predictive of Academic Diligence (ASE-AD). The percentage of variance in the self-efficacy outcomes explained by demographic predictors; however, was small: 7.0% for ASE-AC and 5.4% for ASE-CC. When library use variables were added to the models, the effects of demographic predictors on the outcomes remained relatively consistent.

Gender, but not other demographic characteristics, were found to relate to academic self-efficacy for this population. Regression coefficients and t-tests revealed that male students had significantly higher mean ASE-AC and ASE-CC scores compared with gender minority students, both at the $p < 0.001$ level. These findings are consistent with Huang's (2003) meta-review of gender differences in academic self-efficacy: male students were found have higher general academic self-efficacy than female students as well as higher discipline-specific self-efficacy in mathematics and computing. In addition, although the difference was only marginally statistically significant ($p = 0.058$), I found that male students had *lower* mean ASE-AD scores compared with gender minority students. The ASE-AD scale, which included items such as "I work hard to get a good grade even when I don't like a class" and "I make an effort to attend all of my classes," may serve as a proxy for perceived effort. Considered that way, this finding is in alignment with prior studies that have found that women in engineering report applying more effort in their studies (Goodman Research Group, 2002; Vogt, Hocevar, & Hagedorn, 2007).

For gender minority students, national origin may also influence self-efficacy, but the nature of this relationship is not clear. In the models of self-efficacy for gender minority students with both demographic characteristics and library use variables as predictors, only the ASE-AD model achieved overall significance at the $p < 0.05$ level, with one significant demographic predictor: international student status. Specifically, international gender minority students ($N = 9$) had significantly lower mean ASE-AD scores than domestic gender minority students did. Further investigation revealed that the differences between international and domestic gender minority students were particularly marked for two ASE-AD items: "I wait to study until the night before the exam" (reverse-coded) and "I make an effort to attend all of my classes." These differences may be the result of differing academic norms from students' home cultures or cultural differences in academic self-efficacy, which have been demonstrated in the literature. For instance, Lee (2009) found that international students from countries with more collective cultures such as Korea and Japan had low math self-efficacy despite high achievement on math tests. However, the relationship of this effect to gender is not entirely clear. After comparing

self-efficacy scores of students from individualistic and collective cultures, Huang (2013) did not detect any significant differences in gender differences across cultures, but noted that the statistical power of this test was low because the number of studies from collective cultures was small. Collection of additional qualitative data from gender minority students representing different countries of origin could elucidate these differences.

The results of my study coupled with previous research (Concannon & Barrow, 2009; Huang, 2013) suggest that while some gender differences in academic self-efficacy persist across studies, the relationship between gender and self-efficacy may be highly sensitive to the particular measures used and to the specific educational context in which self-efficacy was measured. Additional exploratory research may help clarify the nature of gender-based differences in engineering students' belief in their ability to succeed as well as the effects these differences may have on outcomes such as academic performance and engineering identity. Particular emphasis should be placed on understanding the interactions between gender and national origin.

It is interesting to note that while there was a significant relationship between being a first-generation student and having a job in the library and that having a job in the library was associated with lower mean ASE-AC score, first-generation status was not found to be significantly related to any of the self-efficacy outcomes overall. My regression models did not include any interaction terms, so it is difficult to say whether first-generation students who work in the library fare better or worse in terms of self-efficacy compared with students who share only one of those traits. These models also omit interactions between first-generation status, having a job in the library, and race/ethnicity. MacPhee, Farro, and Canetto (2013) found that "double-disadvantaged" students who are both low SES (low income and/or first-generation) *and* ethnic/racial minorities had lower academic self-efficacy compared with their single minority counterparts, but also that students with double minority status obtained the greatest benefit from participation in a program designed to support minority students in STEM.

RQ4: How does the use of library resources and services relate to academic self-efficacy?

I found evidence to support the hypothesis that library use is associated with academic self-efficacy, but the specific relationships that emerged were somewhat surprising. Perhaps the most salient finding was that having a job working in the library had a large and highly significant negative relationship to mean ASE-AC score as evidenced by t-tests and regression coefficients. Could it really be that working in the library somehow decreases engineering students' academic confidence? Probably not. Rather, it is more likely that my question about having a job working in the library served as a proxy for socioeconomic status (SES): working class or low-income students are more likely to have a job (in the library or elsewhere) during college. When interpreted this way, my data suggest that low-income students may experience significant disparities in academic confidence compared with their more affluent peers. This

finding corroborates Santiago and Einarson (1998) who reported that college students who were concerned about their ability to finance their education had academic lower self-efficacy than students who did not express funding concerns, as well as Griffiths (2006) who found that students from low-SES backgrounds had lower academic and career self-efficacy compared with higher SES students.

Although searching for a scholarly article during college was not related to academic self-efficacy overall, I did find statistically significant relationships between several of the *reasons* for searching for a scholarly article and some self-efficacy dimensions. Specifically, searching for an article for an extracurricular club and searching for an article for academic research outside of coursework were both associated with significantly higher mean ASE-AC and ASE-CC scores. Rather than having anything specific to do with library resources, this result may suggest that some aspects of academic self-efficacy are positively associated with co-curricular participation. It is not known, however, if this relationship is causal, and if so, what the direction of causality may be. Can we conclude that co-curricular participation in clubs and research bolsters self-efficacy? Or do more efficacious students tend to participate at a higher rate than others? Studies have shown that co-curricular participation in engineering education is associated with a number of beneficial outcomes, including ethical development (Finelli et al., 2012), leadership skills (Burt et al., 2011), and GPA (Gonzales & Millunchick, 2016) although the designs of these studies do not allow causal inferences to be drawn. My findings suggest that extracurricular clubs that require engagement with the scholarly literature may have a particularly strong relationship to engineering student self-efficacy.

Several library use variables were significantly related to the Class Communication (ASE-CC) subscale, which contained two items: “I avoid speaking up in class” (reverse-coded) and “I feel confident in my ability to ask questions in class.” The regression model containing both demographic characteristics and library use variables as predictors revealed that getting help from someone who works at the library is associated with higher mean ASE-CC score. It is not surprising that students who feel more comfortable communicating with professors in class are also more comfortable asking questions of librarians and library staff. In addition, I found that both the number of hours spent studying or doing work in the library and the percentage of time spent working independently in the library were associated with lower mean ASE-CC score. Although the magnitudes of these regression coefficients appear relatively small, the model implies that a student who spends 80% of the time in the library working alone will have an ASE-CC score that is 0.42 points lower than an otherwise identical student who only spends 20% of the time working alone. Evidently, engaging in solitary library-based study does not increase students’ confidence in their abilities to speak and ask questions in class. Considered another way, students who feel less confident in their communication abilities may be inclined to isolate themselves in the library rather than engaging in group study or attending office hours.

Collection of additional data could clarify the motivations of students who spend a large number of hours engaged in library study by themselves.

I also uncovered some interesting gender differences when I built separate regression models predicting academic self-efficacy for male and gender minority students. For male students, having a library job and searching for a scholarly article for class had significant negative relationships to ASE-AC while searching for an article for an extracurricular club was associated with an increase in mean ASE-AC score. While the relationships between having a library job and searching for an article for a club are the same as those in the model for students of all genders, the negative association between mean ASE-AC score and searching for a scholarly article for class is significant for male students only. In addition, searching for an article for class was positively related to mean ASE-AD score for gender minority students only. These gender-based differences may be a reflection of different course-taking patterns between male and gender minority students in the College of Engineering. Collection of additional data could help to explain this finding.

All in all, the dimensions of library use I measured in this study seem to have served at least in part as a proxy for other student characteristics, such as socioeconomic status and co-curricular participation. These characteristics in turn relate to academic self-efficacy, but the direct effects of library use on academic self-efficacy are not clear.

RQ5: Does the use of library resources predict academic self-efficacy above and beyond demographic characteristics alone?

Statistically speaking, the use of library resources does predict academic self-efficacy above and beyond demographic characteristics alone. Multiple linear regression models containing both demographic characteristics and library use variables as predictors explained a larger percent of the variance in two dimensions of academic self-efficacy than models containing demographics alone, and at least one library use variable was a significant predictor in each model. For the third dimension, the model was only significant overall for gender minority students, and one dimension of library use (as well as international student status) emerged as a significant predictor of mean ASE-AD score in this model. This result, however, is somewhat unsatisfying for two main reasons. First, I found that the relationships between library use and self-efficacy were not necessarily positive ones. For example, I found that spending more hours studying in the library was associated with *lower* confidence around speaking in class. This suggests that more engagement with the library may not translate result in gains in self-efficacy. Second, the significant predictors that emerged seem to reflect unmeasured confounding variables, such as socioeconomic status and co-curricular engagement, rather than any authentic effects of engaging with library resources and services on self-efficacy. Future work in this area might

employ a experimental research design that could isolate the effects of a library-based intervention on outcomes of interest.

Implications for Practice

Although this study provided only limited evidence in support of the hypothesis that engaging with the library results in gains in academic self-efficacy, the results of this study have several implications for practice when taken together.

First, disparities in library use between international and domestic students suggest the need for additional library instruction and support for international students in engineering. Compared with domestic students, international students are less likely to search for a research article and less likely to visit the library website during college. In addition, they are less likely to study or do work in the library, and they spend less time in the library working collaboratively and more time alone. In a highly collaborative, research-intensive discipline such as engineering, these disparities put international students at an academic and professional disadvantage. Engineering librarians might consider how to make library resources, services, and spaces more accessible to international students. This could include providing academic support tailored to non-native English speakers, including more foreign language materials in library collections, and hosting events for international students in the library.

Second, engineering librarians should seek out opportunities to integrate not only with engineering coursework but also the informal engineering curriculum, which includes co-curricular activities such as design teams, professional societies, and undergraduate research opportunities. Conducting background research by searching industry and scholarly literature is an essential step in the engineering design process, yet many undergraduate engineering students never receive training in conducting bibliographic research during college through their coursework, and those that do receive instruction during Engineering 100 may not understand how to apply what they learned to other coursework or projects. It stands to reason that engineering design teams might benefit from scheduling consultation sessions with engineering librarians, who can provide tailored instruction addressing specific information needs. Engagement with librarians and the library through co-curricular activities may strengthen students' academic support network (Bell, 2014) and help develop students' research skills and self-efficacy, which could in turn promote post-graduate aspirations for careers in engineering (Adedokun et al., 2013; Chang et al., 2014).

Third, the University of Michigan Library should provide increased personal and academic support for its student workers. Engineering students who had a job working at the library (N = 7) had significantly lower academic self-efficacy along the dimension of Academic Confidence (ASE-AC) compared with students who did not have a library job, with large effect size. This

disparity was likely not the result of library employment itself, but instead suggests that low-income students—who are more likely to have any job during college, including jobs in the library—may have lower self-efficacy than their more affluent peers after controlling for other factors (Griffiths, 2006; Santiago & Einarson, 1998). As a major on-campus employer of low-income students, the University of Michigan Library is also uniquely positioned to support this population. Librarians should provide academic and mentoring support to student workers, promote the formation of study groups to encourage peer learning and peer mentorship, and help student workers draw connections between their work in the library and their own studies. Focus groups with student library workers could identify additional areas where support could be enacted.

Summary and Conclusions

The purpose of this study was to determine (a) how engineering students use the library during college, and (b) how engineering students' library use relates to their academic self-efficacy after controlling for demographic factors. Through a survey of 414 undergraduate students enrolled in the College of Engineering, I obtained a detailed profile of engineering student library use at the University of Michigan. In alignment with previous research, I found that engineering students use the library heavily as a place to study but that levels of engagement with other library resources and services have some room for improvement. Several facets of library use were related to demographic characteristics. For example, significant disparities emerged between domestic and international students: international students were less likely to have searched for a scholarly article, visited the library website, or studied in the library compared to domestic students, and international students spent more of their time studying in the library by themselves and less time working collaboratively compared with their domestic counterparts. Differences in library use were also detected along lines of gender, race/ethnicity, and first-generation status.

Various dimensions of library use were found to have statistically significant relationships to academic self-efficacy above and beyond the effect of demographic predictor variables. Specifically, I found that having a job working in the library was associated with lower mean academic self-efficacy along the dimension of Academic Confidence (ASE-AC) while searching for a scholarly article for an extracurricular club or activity was associated with higher mean ASE-AC score. Spending more hours studying in the library and spending a greater percentage of library study time working by oneself were each associated with lower mean Class Communication self-efficacy (ASE-CC) while getting help from someone who works at the library at least once during college was associated with higher mean ASE-CC score. In addition, searching for a scholarly article for class was positively related to Academic Diligence (ASE-AD) for gender minority students. However, many of these associations were more likely

the result of unmeasured confounding variables such as socioeconomic status and co-curricular participation rather than authentic relationships between library engagement and self-efficacy.

Overall, this study provided limited evidence in support of the hypothesis that engagement with the academic library builds engineering students' academic self efficacy. However, library engagement may yet be shown to relate to other key outcomes in engineering education (e.g., engineering identity, research self-efficacy, post-graduation aspirations) using the novel instrument developed in the context of the present work to measure engineering students' library experiences. Based on my findings, I have also made practical recommendations for ways that the library can support three distinct groups of engineering students: international students, students who participate in co-curricular activities, and student library workers.

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Appendix A. Focus Group Protocol

1. Introductions

    1. Welcome everyone, introduce myself and note-taker, first names on name tags

    2. Brief overview of project: “I'm going to talk to you about how you use and understand the Library here at the University of Michigan. I will use what you tell me to create a survey questionnaire that will be administered to students within the College of Engineering so that I can better understand the relationships between library use and your experiences in college.”

    3. Hand out consent form, ask participants to read and sign, collect forms

    4. Incentives and incentive receipt form

    5. Explain logistics: time, bathroom, water

    6. Establish ground rules for conversation: everything is completely voluntary, you can pass on any question, nothing you say will be attached to you, one person talks at a time, no right or wrong answers, what's said here stays here

2. Questions (semi-structured interview; change order and probe as necessary)

    1. When I say “University of Michigan Library,” what do you think of?

    2. Can you name some places, resources, or services that you consider to be a part of the University of Michigan Library? … Are there any other places, resources, or services (either physical or online) that you consider to be a part of the University of Michigan Library?

    3. How have you personally used the University of Michigan Library during your time in college?

    4. How do you think other people in the College of Engineering use the University of Michigan Library?

    5. Why do you go to the library?

    6. How have you interacted with librarians at the University of Michigan during your time in college?

7. Have you ever visited the University of Michigan Library website, lib.umich.edu? If so, how have you used the website? What parts of the website have you used the most?

These next few questions are about online resources, including academic journals and databases, and doing research online. Remember, there are no right or wrong answers to any of these questions.

8. Have you ever looked for scholarly articles, also known as academic or peer-reviewed articles? If so, when or why?

9. If you have looked for scholarly articles before: When you needed to find an article, how did you do it? What websites did you use?

10. Do you consider scholarly journals and articles to be a part of the University of Michigan Library? Why or why not?

11. Can you name any examples of academic databases? Have you used any of these databases before? If so, when and how have you used them?

12. Do you consider academic databases to be a part of the University of Michigan Library? Why or why not?

13. Is there anything else you'd like to share about your experiences with the University of Michigan Library before we wrap up?

3. Wrapping Up

1. Thank everyone for participating

2. Provide my contact information for follow-up

Appendix B. Survey Questionnaire

Thank you for your interest in our study! The purpose of this study is to investigate the relationships between engineering students' use of the library and academic self-efficacy.

This survey will take approximately 5-10 minutes to complete. You will be asked questions about your background, how you have used the library during your time in college, and your attitudes towards school and studying. Students who complete the survey will be entered for a chance to win one of ten $15 Amazon gift cards.

Participating in this study is completely voluntary and involves no more than minimal risks or discomforts. Even if you decide to participate now, you may change your mind and stop at any time. You may choose not to answer any question for any reason. Your answers will be taken as confidential and your name will not be linked to your responses.

If you have any questions, please feel free to contact lead investigator Emma Brennan-Wydra (ebwydra@umich.edu) or faculty advisor Dr. Elizabeth Yakel (yakel@umich.edu).

Q1. Do you consent to participate in this study?

- Yes
- No

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Q2. Are you a full-time undergraduate student at the University of Michigan?

- Yes
- No

Q3. Are you enrolled in the College of Engineering?

- Yes
- No

Q4. In what semester were you **first enrolled** in the College of Engineering?

- Fall 2015 or earlier
- Winter 2016
- Spring/Summer 2016
- Fall 2016
- Winter 2017
- Spring/Summer 2017

- Fall 2017
- Winter 2018
- Spring/Summer 2018
- Fall 2018
- Winter 2019
- I have never been enrolled in the College of Engineering

Q5. What is your major (or intended major, if you have not yet declared)?

- Aerospace Engineering
- Biomedical Engineering
- Chemical Engineering
- Civil Engineering
- Climate and Meteorology
- Computer Engineering
- Computer Science
- Data Science
- Electrical Engineering
- Engineering Physics
- Environmental Engineering
- Industrial and Operations Engineering
- Materials Science and Engineering
- Mechanical Engineering
- Naval Architecture and Marine Engineering
- Nuclear Engineering and Radiological Sciences
- Space Science and Engineering
- Some other major not listed here

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Q6. During college, have you ever done work or studied in the library, either by yourself or with others? Please consider all University of Michigan libraries, including those on North Campus and Central Campus.

- Yes
- No

If "Yes":

Q7. Do you think you spend more, less, or about the same amount of time doing work or studying in the library compared with other students in the College of Engineering?

- I spend more time in the library
- I spend about the same amount of time in the library
- I spend less time in the library

Q8. What percentage of your time doing work or studying in the library do you spend in each of the following contexts? (Percentages must add up to 100.)

- With others, working together (e.g., as part of a project team or study group)
- With others, but working independently
- By yourself

Q9. In a typical week, how many hours do you spend doing work or studying in the library, either by yourself or with others?

- I do not go to the library in a typical week
- Less than 5 hours
- 5 - 10 hours
- 11 - 25 hours
- 26 - 40 hours
- More than 40 hours

Q10. During college, have you ever gotten help from someone who works at the library?

- Yes
- No

If "Yes":

Q11. In which of the following ways have you ever gotten help from someone who works at the library during college?

- In person (e.g., information desk, workshop or library session, appointment)
  - Yes
  - No
- Online (e.g., email, online chat feature)
  - Yes
  - No
- Over the phone
  - Yes
  - No
- By text message
  - Yes
  - No

Q12. During college, have you ever searched online for a scholarly research article?

- Yes
- No

If "Yes":

Q13. For which of the following reasons have you searched online for a scholarly research article during college?

- For a class or assignment
  - Yes
  - No
- For an extracurricular club or activity (e.g., a design team)
  - Yes
  - No
- For academic research outside of your coursework (e.g., in a lab)
  - Yes
  - No
- For a job, internship, or co-op
  - Yes
  - No
- Just for fun
  - Yes
  - No

Q14. During college, have you ever visited the University of Michigan Library website (www.lib.umich.edu)?

- Yes
- No

If "Yes":

Q15. Which of the following have you done when you've visited the University of Michigan Library website?

- Used the search bar to find books, journals, articles, or other library materials
  - Yes
  - No
- Used a Research Guide to find resources for a particular subject or class
  - Yes

    - No
- Followed links to databases (e.g., PubMed, PsycINFO, Engineering Village, Web of Science, Scopus)
    - Yes
    - No
- Used the Ask a Librarian feature
    - Yes
    - No
- Looked for information about the library (e.g., hours, location, library floor plans)
    - Yes
    - No
- Reserved a study room in the library
    - Yes
    - No

Q16. During college, have you ever had a job working at the University of Michigan Library?

- Yes
- No

Q17. During college, have you ever taken a course in which the primary instructor was a librarian (e.g., ALA 105)?

- Yes
- No

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Please read the following statements and respond by indicating how true each statement is of you.

Q18. I believe it is possible for me to get good grades in college.

- Not at all true of me
- Slightly true of me
- Somewhat true of me
- Mostly true of me
- Completely true of me

Q19. I think I am a good student compared with others in the College of Engineering.

- Not at all true of me
- Slightly true of me

- Somewhat true of me
- Mostly true of me
- Completely true of me

Q20. I work hard to get a good grade even when I don't like a class.

- Not at all true of me
- Slightly true of me
- Somewhat true of me
- Mostly true of me
- Completely true of me

Q21. I am determined to do what it takes to succeed in college.

- Not at all true of me
- Slightly true of me
- Somewhat true of me
- Mostly true of me
- Completely true of me

Q22. I prefer to take classes that are challenging so I can learn new things.

- Not at all true of me
- Slightly true of me
- Somewhat true of me
- Mostly true of me
- Completely true of me

Q23. My study skills are excellent compared with other students in the College of Engineering.

- Not at all true of me
- Slightly true of me
- Somewhat true of me
- Mostly true of me
- Completely true of me

Q24. I wait to study until the night before the exam.

- Not at all true of me
- Slightly true of me
- Somewhat true of me
- Mostly true of me
- Completely true of me

Q25. I always meet the deadlines for my assignments.

- Not at all true of me
- Slightly true of me
- Somewhat true of me
- Mostly true of me
- Completely true of me

Q26. I am confident that I will be able to learn the basic concepts covered in my classes.

- Not at all true of me
- Slightly true of me
- Somewhat true of me
- Mostly true of me
- Completely true of me

Q27. I feel confident in my ability to ask questions in class.

- Not at all true of me
- Slightly true of me
- Somewhat true of me
- Mostly true of me
- Completely true of me

Q28. I avoid speaking up in class.

- Not at all true of me
- Slightly true of me
- Somewhat true of me
- Mostly true of me
- Completely true of me

Q29. When I do poorly on an exam or assignment, I try to learn from my mistakes.

- Not at all true of me
- Slightly true of me
- Somewhat true of me
- Mostly true of me
- Completely true of me

Q30. I hold myself to a high academic standard.

- Not at all true of me
- Slightly true of me
- Somewhat true of me

- Mostly true of me
- Completely true of me

Q31. I make an effort to attend all of my classes.

- Not at all true of me
- Slightly true of me
- Somewhat true of me
- Mostly true of me
- Completely true of me

Q32. I'm confident I can understand the most complex material in my courses.

- Not at all true of me
- Slightly true of me
- Somewhat true of me
- Mostly true of me
- Completely true of me

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Q33. Are you a domestic student or an international student?

- I am a domestic student
- I am an international student

If "I am a domestic student":

Q34. Are you an in-state student or out-of-state student?

- I am an in-state student
- I am an out-of-state student

Q35. Do you consider yourself to be a first-generation college student?

- Yes
- No

Q36. What is your gender?

- Female
- Male
- Non-binary or third gender
- Some other gender: _____
- Prefer not to say

Q37. What race or races do you consider yourself to be? You may select more than one.

- American Indian or Alaskan Native
- Asian
- Black or African American
- Hispanic or Latino
- Native Hawaiian or Pacific Islander
- White or Caucasian
- Some other race: _____
- Prefer not to say

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Q38. If you would like to be entered to win one of ten $15 Amazon gift cards, please enter your email address below.