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Opportunities for libraries to address research anxiety in undergraduate students in STEM fields

Many students pursuing STEM fields in the United States leave these subjects early on in their undergraduate studies, and this is especially true for under-represented groups of students. STEM retention is a multifaceted problem, and one emerging factor is research anxiety. Research anxiety produces negative feelings associated with scientific research, and these feelings can lead students to change their subjects of study, creating a smaller and less diverse pool of STEM graduates. Unpreparedness is a strong indicator of whether a student will experience research anxiety, so, theoretically, research anxiety may be combated by preparing students to partake in research early in their academic careers by strengthening their information literacy and library-related skills. Librarians are uniquely positioned to help alleviate this problem by providing programs centered on preparing students to partake in research-intensive assignments. However, in order to do so, research anxiety needs to be widely recognized, and librarian-led intervention needs to be specifically targeted towards this significant issue.

Keywords

research anxiety; STEM retention; information literacy instruction

Introduction

Historically, higher education institutions in the United States have faced issues regarding academic success for students of science, technology, engineering and mathematics (STEM) subjects, specifically in terms of undergraduate student retention. Since 2013, the USA's National Center for Education Statistics has stated that producing a sufficient number of STEM graduates is a national priority. However, many students leave STEM subjects in the early years of their undergraduate studies, especially under-represented groups of students, including low-income students.[1] Feeling underprepared, under-represented or overwhelmed by new responsibilities and expectations can quickly take a toll on students' mentality. Specifically, many students who decide to pursue STEM degrees are often expected to be equipped with skills and competencies, specifically research skills, in which they did not gain considerable experience during their primary education. Gaining these research capabilities can seem daunting, especially at a higher education level where students are still learning how to meet higher expectations for their work.

EMILY HENDERSON

Librarian
Columbus State
Community College
(Previously MSIS
student
University of
Tennessee
Knoxville)

Research in STEM is a multifaceted endeavor. STEM subjects and career paths are likely to involve technical laboratory and field work where data is collected and analyzed. However, library-based research, which involves searching for, reading and synthesizing past scholarly literature is vital and foundational work that STEM students need to understand before they can be equipped to pursue scientific research. Library-based research skills are fundamental building blocks for STEM-based research, and if students are not competent in them, expectations to produce or explore their own novel research questions further along in their STEM careers can seem even more formidable. Developing strong research skills is essential to pursuing a STEM career field, but when combined

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with all of the other novel competencies that students need to quickly acquire to thrive in a higher education environment, it can become demotivating to the point where students consider changing courses, or even dropping out altogether.[2] It is vital that these issues be combated so that diverse populations of STEM graduates can be produced, as diverse teams tend to outperform more homogenous groups.[3] Overall, diversity in STEM allows for fresh and innovative viewpoints to be applied to real-world STEM-related challenges in order to develop equitable, optimal and inclusive solutions.

Seeking help for these academic deficiencies can also be challenging for students who face academic-related anxieties. Thus, extensive work and research have been done in library and information science fields to combat library anxiety. Library anxiety is described as 'an uncomfortable feeling or emotional disposition, experienced in a library setting, which has cognitive, affective, physiological, and behavioral ramifications".[4] Library anxiety is a well-researched concept and a well-recognized problem; however, this concept may be a contributing factor to a newer, less recognized and less researched problem: research anxiety.[5] Research anxiety may stem from library anxiety, as students may be afraid to seek out help from librarians to aid in acquiring research strategies and skills. However, even though the concepts may be related, efforts to solely alleviate library anxiety are not adequate in regard to alleviating research anxiety. Separate, specifically targeted measures need to be taken towards combating research anxiety so that students can get recognition and relief for the distinct problems that they are facing in their STEM education. Combating research anxiety is something that needs to be done early in a student's career to promote success in STEM fields, and library staff may be uniquely qualified to provide the instruction, resources and tools to help alleviate this problem.

> 'Library-based research skills are fundamental building blocks for STEM-based research'

The relationship of research anxiety and STEM undergraduate student success

Research anxiety is a major factor that could affect a student's choice to continue in a STEM field. Research anxiety is defined as 'feelings of fear and uncertainty associated with authentic scientific research and production'.[6] These feelings can produce a variety of negative emotions in students completing academic research and could possibly lead to such levels of fear or anxiety that trigger a response to change to a different subject area or drop out of undergraduate studies altogether. Previous research has found that feeling 'underprepared' was a very strong predictor of feelings of research anxiety, and that research anxiety was significantly and negatively related to student intent to pursue a research-related career.[7] Cooper et al.'s study is one of the first to study anxiety in a context of conducting research and indicates that this may be a problem that needs to be studied further to be better understood.[8] While there are many factors that can contribute to a student's choice to change courses, including university readiness, feeling of belonging and level of maturity, according to Barefoot, research anxiety is one specific piece of the puzzle that librarians can target using their research skill sets to promote retention in STEM fields.[9] While librarians cannot necessarily help with STEM-specific research design or implementation, librarians can help students build skills in developing research questions, scoping and background searches on relevant and helpful literature, which would provide students with a solid foundation from which to build confidence and self-efficacy in research.

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Higher education has faced issues in regard to promoting and achieving academic success for all students, but especially in underserved student populations.[10] A key aspect of student success includes retention of women, students of an ethnic or racial minority group, and students of a lower economic status in STEM programs and courses. Due to many varying factors, such as gender stereotypes and lack of resources, these groups of students face additional issues or obstacles beyond the regular, rigorous academic coursework of every STEM student, which may cause them to rethink their choice of academic studies.

While all students can experience research anxiety, underserved populations may be more vulnerable to it. Specifically, Cooper et al. have found that women were more likely to experience research anxiety.[11] Students may also feel like they do not fit in or belong in the current environment and climate of STEM fields. This is due in part to the societal norms at play, but there is research that suggests that this can be combated if students have the chance to develop strong relationships with mentors or advisors, or are able to work with academics who are receptive to working with students with differing needs, backgrounds or learning styles.[12] Ultimately, underserved populations are more likely to believe that experiencing research anxiety, when combined with other anxieties, personality traits and educational background, can indicate that they are not qualified to or capable of pursuing an education in STEM subjects.[13] Academia needs these voices in STEM to ensure that research is addressing a broad range of societal needs and so that diverse voices and ideas can be applied to contemporary problem-solving. Therefore, it is vital that students can gain preparedness in the field, rather than succumb to their assumptions that they cannot participate in these important areas of study.

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Ideas for how information literacy can be foundational in efforts to alleviate research anxiety

Librarians are well placed to help students improve their self-confidence and alleviate some anxieties through library programs and resources, including information literacy instruction, research coaching and individualized consultations with students. There have been many research cases of how these programs and resources have improved student success in STEM courses, and in higher education overall. One example is embedded information literacy instruction into STEM courses and curricula. This embedded instruction allowed students to engage with information literacy concepts and competencies directly through a course instead of having to seek help on their own, outside of the classroom.[14] While this is not an immediate fix to a lack of information literacy, embedded instruction introduces students to the importance of information literacy concepts and their necessity in STEM coursework and research assignments. Additionally, this example would provide resources for students who had little background in information literacy, to the point where they may not know enough to seek out help themselves.

> 'embedded instruction allowed students to engage with information literacy concepts and competencies directly through a course'

Another similar strategy is to provide stand-alone information literacy courses. These courses are a chance for students to become acquainted with information literacy and research strategies, as well as having the potential to improve student perception of library-based research.[15] Again, however, these courses do not provide a quick-fix to the problem, but rather the ability to help alleviate it when combined with other efforts. This route, too, requires students to take the initiative to sign up and regularly attend the course, which may be a big step for students struggling with research anxiety. Additionally, stand-alone courses may not directly connect to a student's course of study or actual research intentions, and this may not prove effective in terms of using information literacy to specifically combat research anxiety in STEM students.

In addition to information literacy instruction, programs like research coaching can also help to increase student success in academia. Research appointments can build information literacy skills and a sense of trust in the library in students who partake.[16] These programs prove extremely valuable because students develop a sense of community with a librarian, with whom they have the opportunity to build a relationship and who they can turn to in times of academic stress or uncertainty. Personal librarians can also be a way to engage with students' questions about research on a deeper level. By having an assigned librarian, students can be aware that they have someone to introduce them to library resources and research concepts that are appropriate for their STEM coursework, which was found to be correlated with confidence in information literacy.[17] However, it is important to acknowledge

that personal librarian programs can be difficult to scale to larger colleges and universities, so this option should only be implemented on a contextual basis. Fundamentally, all of these programs have proven potential to assist students with achieving academic success. Now, it can be argued that the next step is to design and implement programs like these with the specific goal of assisting students in STEM subjects, directly targeting those who may need additional resources to help combat research anxiety, build confidence and boost their research competencies to match the skill levels necessary to thrive in STEM.

Research anxiety is a fairly new concept with much further research needed on how and when it affects students, who it affects, who it affects to the greatest extent, and how it can best be ameliorated so that students do not feel unnecessary additional pressure when determining if they want to study a STEM discipline. Academic librarians are champions of information who specialize in assisting students with research endeavors, so they seem to be in an ideal position to help students who experience research anxiety. Librarians produce and assist with many programs that aim to teach information literacy and promote strong research practices, and these programs have a strong chance to help alleviate research anxiety. However, the alleviation of research anxiety should not be a second-hand benefit from participation in these programs. Research anxiety should be widely recognized as a real and important issue with specialized, targeted programs, resources and initiatives. This way, students experiencing this problem can feel seen and validated, as well as able to seek out specialized help for their research anxiety from professionals who are trained and educated to help. It is vital for more research to be done surrounding research anxiety and, specifically, on how librarians fit into the solution.

Conclusion and personal reflections

I want students with fresh ideas, perspectives and voices to be able to find their footing and thrive in academia, not be dismayed by high barriers of entry before they even get a chance to try. Through the early intervention of research principles and library-centered skills, librarians can help give students the confidence to contribute their perspectives to STEM conversations in the form of scholarly research. By acknowledging the issue of research anxiety, librarians can help students feel as if their voices matter, even if they are not as prepared to share them in a scholarly setting as their other classmates at the beginning of their academic careers.

'Research anxiety should be widely recognized as a real and important issue with specialized, targeted programs, resources and initiatives'

I made the decision to enter graduate school for information science based on my first-hand experience in working with undergraduate STEM students. As a teaching assistant for an introductory environmental science course, I worked with many individuals who felt lost, confused, or incapable of completing one of their first university-level scientific literature research papers. Throughout the semester, I worked with them to help develop research techniques and strategies, and ultimately provide them with any support they needed as they tackled this challenge. I got to witness how students not only grew their research skills, but also their confidence in their academic abilities and their choices to continue on in their fields of study. I got to see so many students leave the course passionate about their research project and, thinking back to how unsure some of them seemed at the beginning of the semester, I realized how much power alleviating research-based anxiety held in terms of students' personal and academic success. Looking back, I can identify the feeling of being underprepared as a root cause for many of these students' research anxiety. This aspect is what, I believe, librarians have the ability to lock in on, in order to prepare students for what's ahead of them, whether it be research, or even emerging competencies, like understanding AI, open data or data visualization, that higher education may expect from their STEM students in the near future.

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As a recent graduate of a master's program on an academic library-centered track, I have been taught and prepared to work with students to promote their academic success. To do this, I have learned how to partake in reference work, collection development and program planning and assessment. I have become familiar with many ways that librarians can aid students in higher education to help them achieve success in their courses and fields. However, I feel as if I still have a lot to learn about cultivating personal relationships with students where I can truly identify their personal, individualized needs and how my skills can help them reach their full potential. I want the students I work with to feel like they have the power to knock down the barriers in front of them. I feel that a large part of achieving this lies in acknowledging that students do not only need instruction on how to participate in or do research, but they also need the power to use what they learn to overcome anxieties to the point where they are confident enough to want to pursue a research field or project. Ultimately, I think that every student's journey to alleviating their own anxiety will be deeply personal and individualized. But we as librarians need to be aware that anxieties, including research anxiety, are likely to play a significant role in students' academic success, and therefore provide students with tools and resources that specifically target their anxieties and that they can use in ways to best empower them. We need to create, implement and assess programs with the goal of alleviating anxieties, not solely increasing knowledge, so that students pursuing STEM degrees can face any new problem in front of them and, instead of contemplating switching courses, have the confidence in themselves to keep trying and moving towards their goals.

> 'I want the students I work with to feel like they have the power to knock down the barriers in front of them'

Abbreviations and Acronyms
A list of the abbreviations and acronyms used in this and other *Insight*s articles can be accessed here – click on the URL below and then select the 'full list of industry A&As' link: **http://www.uksg.org/publications#aa**.

Competing interests
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References

1. Xianglei Chen, *STEM Attrition: College Students' Paths into and out of STEM Fields, Statistical Analysis Report, NCES 2014-001* (National Center for Education Statistics, November 2013), **https://nces.ed.gov/pubsearch/pubsinfo.asp?pubid=2014001rev** (accessed 24 July 2023).

2. Rachel de los Reyes, "College Students' Decision Making and Experiences in Changing Their STEM Major and Their Career Choice," *Walden Dissertations and Doctoral Studies* (2021): 10900, **https://scholarworks.waldenu.edu/dissertations/10900** (accessed 24 July 2023).

3. Lu Hong and Scott E. Page, "Groups of Diverse Problem Solvers Can Outperform Groups of High-Ability Problem Solvers," *Proceedings of the National Academy of Sciences* 101, no. 46 (November 16, 2004): 16385–89, DOI: **https://doi.org/10.1073/pnas.0403723101** (accessed 24 July 2023).

4. Qun G. Jiao, Anthony J. Onwuegbuzie, and Art A. Lichtenstein, "Library Anxiety: Characteristics of 'at-Risk' College Students," *Library & Information Science Research* 18, no. 2 (March 1, 1996): 151–63, DOI: **https://doi.org/10.1016/S0740-8188(96)90017-1** (accessed 24 July 2023).

5. Hasan Ashrafi-Rizi et al., "Study on Research Anxiety Among Faculty Members of Isfahan University of Medical Sciences," *Materia Socio-Medica* 26, no. 6 (2014): 356, **https://www.ejmanager.com/mnstemps/16/16-1418566366.pdf?t=1690887861** (accessed 2 August 2023); DOI: **https://doi.org/10.5455/msm.2014.26.356-359**
Katelyn M. Cooper, Sarah L. Eddy, and Sara E. Brownell, "Research Anxiety Predicts Undergraduates' Intentions to Pursue Scientific Research Careers," *CBE – Life Sciences Education* 22, no. 1 (March 2023): ar11, DOI: **https://doi.org/10.1187/cbe.22-02-0022** (accessed 24 July 2023); Katelyn M. Cooper et al., "Factors That Predict Life Sciences Student Persistence in Undergraduate Research Experiences," *PLoS ONE* 14, no. 8 (2019): e0220186, DOI: **https://doi.org/10.1371/journal.pone.0220186** (accessed 24 July 2023).

6. Ashrafi-Rizi et al., "Study on Research Anxiety Among Faculty Members of Isfahan University of Medical Sciences."

7. Cooper, Eddy, and Brownell. "Research Anxiety Predicts Undergraduates' Intentions to Pursue Scientific Research Careers."

8. Cooper, Eddy, and Brownell. "Research Anxiety Predicts Undergraduates' Intentions to Pursue Scientific Research Careers."

9. Betsy O. Barefoot, "Higher Education's Revolving Door: Confronting the Problem of Student Drop Out in US Colleges and Universities," *Open Learning* 19, no. 1 (2004): 9–18, **https://doi-org.utk.idm.oclc.org/10.1080/0268051042000177818** (accessed 26 July 2023). DOI: **https://doi.org/10.1080/0268051042000177818**

10. Chen, *STEM Attrition: College Students' Paths into and out of STEM Fields. Statistical Analysis Report, NCES 2014-001*.

11. Cooper, Eddy, and Brownell, "Research Anxiety Predicts Undergraduates' Intentions to Pursue Scientific Research Careers."

12. Katelyn M. Cooper et al., "Factors That Predict Life Sciences Student Persistence in Undergraduate Research Experiences,"; Stacy N. Brinkman and Arianne A. Hartsell-Gundy, "Building Trust to Relieve Graduate Student Research Anxiety," *Public Services Quarterly* 8, no. 1 (2012): 26–39, DOI: **https://doi.org/10.1080/15228959.2011.591680** (accessed 26 July 2023).

13. Alec Sithole et al., "Student Attraction, Persistence and Retention in STEM Programs: Successes and Continuing Challenges," *Higher Education Studies* 7, no. 1 (2017): 46–59, DOI: **https://doi.org/10.5539/hes.v7n1p46** (accessed 26 July 2023).

14. Aline Soules et al., "Embedding Multiple Literacies into STEM Curricula," *College Teaching* 62, no. 4 (October 2014): 121–28, DOI: **https://doi.org/10.1080/87567555.2014.935699** (accessed 26 July 2023).

15. Wilma L. Jones and Tara Mastrorilli, "Assessing the Impact of an Information Literacy Course on Students' Academic Achievement: A Mixed-Methods Study," *Evidence Based Library and Information Practice* 17, no. 2 (April 2022): 61–87, DOI: **https://doi.org/10.18438/eblip30090** (accessed 26 July 2023).

16. Meika E. Matook, "The Impactful Research Appointment: Combating Research Anxiety and Library Stereotypes," *Reference Librarian* 61, no. 3–4 (July 2020): 185–98, DOI: **https://doi.org/10.1080/02763877.2020.1837710** (accessed 26 July 2023).

17. Catherine Meals, "Evaluating the Impact of Personal Librarians on Academic and Affective Outcomes," *College & Research Libraries* 83, no. 1 (January 2022): 25–44, DOI: **https://doi.org/10.5860/crl.83.1.25** (accessed 26 July 2023).

Corresponding author:
Emily Henderson
Librarian
Columbus State Community College
(Previously MSIS student
University of Tennessee
Knoxville), US
E-mail: emhenderson10@gmail.com
ORCID ID: https://orcid.org/0009-0003-5073-6585