

The Influence of Gender on the Support and Confidence of Students in Undergraduate STEM Majors

Minnatallah Nassir Elsinay^{ab}, Danielle E. Lin Hunter^c, Porché Spence^d, & Zakiya Leggett^{de}

^aDepartment of Biological Sciences, North Carolina State University, Raleigh, NC

^bCarle Illinois College of Medicine, Urbana, IL

^cNorth Carolina Environmental Justice Network

^dDepartment of Natural Resources and Environmental Design, North Carolina Agricultural and Technical State, Greensboro, NC

^eDepartment of Forestry and Environmental Resources, North Carolina State University, Raleigh, NC

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Student: minna_eltinay@hotmail.com

Mentors: plspsence@ncat.edu, dani@ncejn.org, zholmes@ncsu.edu,

ABSTRACT

Gender can have an impact on the intended career pathways in the science, technology, engineering, and mathematics (STEM) fields. This has important implications for research on gender issues in STEM education in larger contexts. In particular, this is essential to gain a better understanding of gender representation, academic confidence, STEM confidence, and career progression in higher education. Using a quantitative questionnaire-based research design approach, this study analyzes the experiences of undergraduate students currently pursuing and enrolled in STEM disciplines at a four-year land-grant university in North Carolina. With family members, friends, peers, classmates, and professors playing a role in supporting undergraduate STEM students, this data signifies a trend of men/self-identified males (males) demonstrating more confidence than women/self-identified females (females).

KEYWORDS

STEM Confidence; STEM Identity; Undergraduate Support; Gender Representation; Gender Identification; Higher Education; Scientific Confidence; Underrepresented Students; Undergraduates

INTRODUCTION

Science, technology, engineering, and mathematics (STEM) institutions have historically excluded people on the basis of gender and race.¹ As a result many STEM fields still suffer from a lack of gender and racial and ethnic diversity, especially as people persist through higher level graduate degrees.² Ecology, evolution, and conservation fields specifically have a drastic overrepresentation of people who identify as white relative to people of color,³ though there is some evidence that gender diversity is improving.^{2,4} Despite this representation, women in these fields still experience implicit bias, discrimination, and societal pressure to have and raise children relative to their colleagues who are men.⁵ Efforts to better understand the factors that support and hinder women in these fields are important. The development of innovative policy and change is also crucial as this historical exclusion reduces the sense of comfort and belonging that students must have as they pursue higher education.¹

Scientific Confidence

Scientific confidence refers to an individual's perception that they can be successful in science. This includes their ability to systematically understand and apply knowledge in the natural, social, and life sciences.⁶ It stems from science identity, which refers to the extent to which an individual identifies as a member of a science field⁷ and perceives that other people view them as such.⁸ People's experiences, upbringing, and socialization inform how they develop this confidence.⁹ Because gender is intimately tied to socialization,¹⁰ gender may impact an individual's scientific confidence.

This socialization can come from both school and familial support systems. For example, instructors can affect how students perceive a scientific field and their abilities within it. One study of high school students and teachers demonstrated the role that instructors play in imparting biases to their students which resulted in students attributing feminine characteristics to the humanities while attributing masculine characteristics to the sciences.¹⁰ For this study, instructors and students were surveyed, and these surveys accounted for gender role biases and gender-based teaching methods. Furthermore, various studies have demonstrated both instructors and students in the classroom perceive that male students perform better than their female

counterparts.^{10,11} Interestingly, despite these perceptions, some studies indicate that female students outperform male students in various science disciplines.¹¹

Other studies have looked at how socialization in the home affects students’ scientific confidence. Longitudinal studies suggest that when parents value gender roles, this can increase the likelihood that children will pursue careers dominated by members of their gender.¹² Furthermore, parents can impose perceptions of science on their children. For example, parents are more likely to perceive that science is less interesting and more difficult for their daughters relative to their sons, and as such, use more technical language when discussing science with their sons.¹³ There is also evidence that parents who value science are more likely to push their sons, rather than their daughters, to scientific careers.¹⁴ This upbringing affects the norms that children develop. This is important because studies have shown that males who adhere to traditional norms of masculinity are more likely to pursue scientific majors in college,¹⁵ while females who identify as more feminine are less likely to pursue scientific majors.¹⁶ Given that scientific confidence is related to how suitable an individual perceives that they fit into science and how others perceive that they belong in the field, socialization in the home may affect scientific confidence.

This study explores the influence of gender on the support and confidence of undergraduate science majors. While other factors like race or ethnicity, socioeconomic status, and an individual’s personality may affect their scientific confidence,¹⁷⁻¹⁹ our study focused on the impacts of gender. While these other variables are often held constant across children in various households or may have less of an impact on how they are raised, as discussed above, children often receive different upbringing and support based on their gender. Thus, we wanted to better understand how a student’s gender affected their perceived systems of support in selecting a science career as well as their scientific confidence.

METHODS AND PROCEDURES

This study utilized a quantitative approach to investigate the experiences of undergraduate students enrolled in an introductory, in-person environmental science course at a four-year land grant university. Data were collected through a Qualtrics™ survey containing a series of demographic questions about gender, race, academic major, and career interest. We measured personal support levels from various individuals (family members, friends, peers, classmates, and professors), and personal STEM confidence using Likert scale questions. STEM confidence was measured using the Perceived Identity Compatibility Between Gender and Major/Career²⁰ and Self-efficacy for Learning and Doing Science²¹ constructs. We evaluated the dataset utilizing independent sample t-tests to determine if there were differences in level of support and STEM confidence by gender.

Altogether, *n* = 237 students were recruited to participate in the study. Over 95% of participants were between the ages of 18 and 24. Additionally, there was approximately an equal percentage of male (53.2%) and female (45.2%) participants in this study (**Table 1**). There were 37.6% of the students classified as freshmen, 36.7% as sophomores, 16.0% as juniors, and only 9.7% as seniors. A large proportion of students self-identified as White or Caucasian (73.0%), while the remainder self-identified as students of color, other or declined to provide information on their race/ethnicity (**Table 1**).

Participant Demographics	Percentage (%)
<i>Gender</i>	
Female	45.2
Male	53.2
<i>Age</i>	
18 - 24 years old	95.8
25 - 34 years old	2.9
35 - 44 years old	1.3
<i>Classification</i>	
Freshman	37.6
Sophomore	36.7
Junior	16

Senior	9.7
<i>Race/Ethnicity</i>	
American Indian/Alaskan	1.2
Asian	11.1
Black/African American	6.8
Hispanic/Latino	5.6
Native Hawaiian/Pacific Islander	0.8
White/Caucasian	73.0
Other	1.2
Decline to Answer	0.4

Table 1. Demographics of the Participants (n = 237).

RESULTS

The results of the study indicate that a larger percentage of male undergraduates agreed with statements that imply their STEM confidence (Figure 1). Self-reported data indicated that there is a trend of male undergraduates demonstrating more confidence than their female counterparts. About 62% of males and 32% of females reported that they think their personal identity/gender and major are very compatible. A larger percentage of males (76%) do not think their personal identity/gender will affect how well they will do in their major. A larger percentage of males (76%) do not think that their personal identity/gender will affect how others view them in their major. The data reveal that more males (43%) than females (18%) think they are good at understanding science topics.

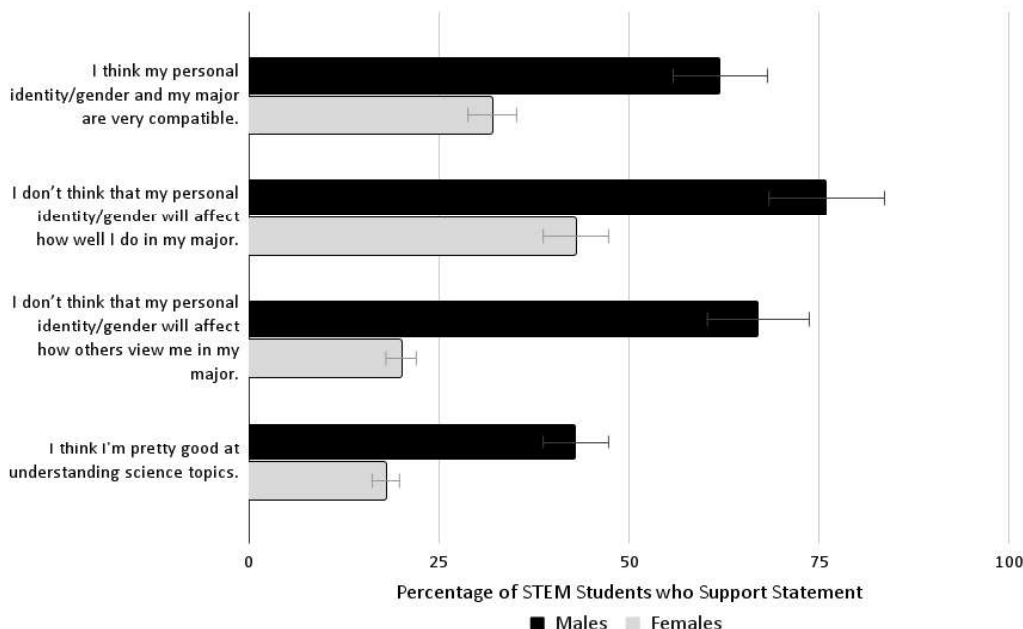


Figure 1. Questionnaire Results of the Confidence of STEM Majors of Opposite Genders (n = 237). The lines to the right of the bars are error bars, representing the potential variability of the data from its reported value.

Gender Representation in Higher Education

Female students reported less support from their classmates, peers, parents, and siblings (Figure 2). The results also found that male undergraduates were more likely to indicate support from individuals they frequently interact with. While professors and

friends generally supported male and female students equally, classmates, peers, fathers, mothers, and other relatives were likely to support males 10% more than their female counterparts (Figure 2). Additionally, the results indicated that siblings supported their brothers 20% more than their sisters who pursue STEM fields.

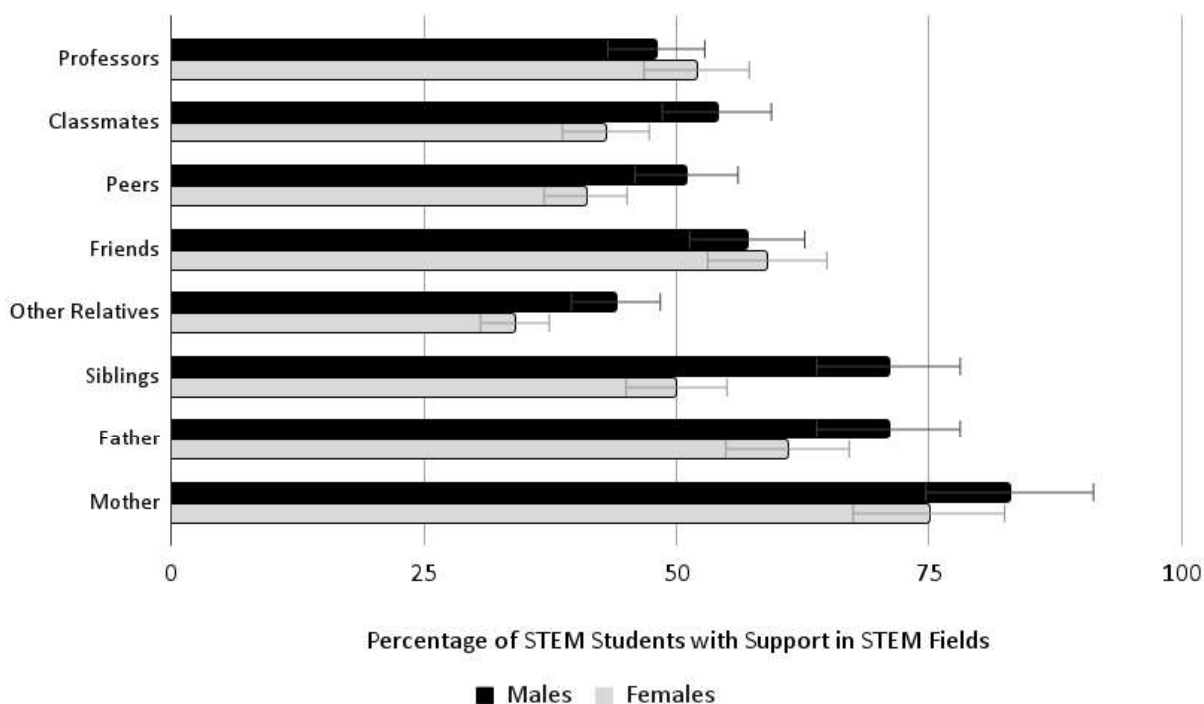


Figure 2. Results of Undergraduate Support Levels for STEM Majors of Opposite Genders (n = 237).

Overall, students felt that their gender did not influence their STEM confidence, although males reported higher confidence on average (Table 2). While female students were more likely to perceive that gender would lead to challenges in their major ($p < 0.01$) and impact their career choice ($p < 0.01$), both male and female students generally disagreed that gender directly affected their experiences or career decisions. This was further supported by perceptions of how others would view them in their major and their perceptions of how well they would do in their major. While male students were less likely to perceive that their gender affected how others view them in their majors ($p < 0.01$) and how well they would perform in their major ($p < 0.01$), both tended to agree that there was not an effect. There was a trend for male students being more likely to perceive that their major and gender were compatible ($p = 0.08$) and that they were good at understanding science ($p = 0.09$), though both male and female students agreed about both statements. Finally, there was no difference between how male and female students perceived that their gender affected their choice in professional fields ($p = 0.11$), though both groups did tend to agree that gender affected their field (Table 2).

Confidence Statements	Gender	N	Mean	Std. Deviation	Std. Error Mean	Sig. (2-tailed)
I don't think that my personal identity/gender will affect how others view me in my major.	Man/Male	125	5.86	1.71	0.15	<0.01
	Woman/Female	106	4.81	2.03	0.19	
I don't think that my personal identity/gender will affect how well I do in my major.	Man/Male	125	6.22	1.42	0.13	<0.01
	Woman/Female	106	5.64	1.77	0.17	

I think my personal identity/gender and my major are very compatible.	Man/Male	125	5.86	1.49	0.13	0.08
	Woman/Female	106	5.52	1.46	0.14	
I think I may experience difficulties in my major because of my personal identity/gender.	Man/Male	125	1.72	1.12	0.10	<0.01
	Woman/Female	106	2.77	1.82	0.18	
I think my personal identity/gender will be an important factor in the type of career I decide to pursue.	Man/Male	125	2.56	1.79	0.16	<0.01
	Woman/Female	106	3.26	1.78	0.17	
I don't think I would pursue certain fields because of my personal identity/gender.	Man/Male	125	2.39	1.78	0.16	0.11
	Woman/Female	106	2.78	1.93	0.19	
I think I'm pretty good at understanding science topics.	Man/Male	125	5.49	1.27	0.11	0.09
	Woman/Female	106	5.22	1.10	0.11	

Table 2. Independent T-test Results of the STEM Confidence Levels Between Male and Female STEM Undergraduates (n = 237). Mean equals average response where 1=strongly disagree and 7=strongly agree.

There were no significant differences between how male and female STEM undergraduates perceived support in their choices about their majors from those around them. Specifically, there was no difference in perceived support from mothers ($p = 0.49$), fathers ($p = 0.15$), siblings ($p = 0.25$), other close relatives ($p = 0.99$), friends ($p = 0.39$), peers ($p = 0.97$), classmates ($p = 0.70$), and professors ($p = 0.60$). While not statistically significant, there was a trend that female students may perceive less support from fathers in their choice of major than male students do, even though there was no difference at all for mothers (**Table 3**).

How supportive the following individuals are about the choice of major:	Gender	N	Mean	Std. Deviation	Std. Error Mean	Sig. (2-tailed)
Mother	Male	126	6.53	1.22	0.11	0.49
	Female	106	6.42	1.32	0.13	
Father	Male	126	6.39	1.33	0.19	0.15
	Female	102	6.11	1.57	0.16	
Siblings	Male	125	6.18	1.47	0.13	0.25

	Female	102	5.95	1.59	0.16	
	Male	104	6.06	1.42	0.14	
Other Close Relatives						0.99
	Female	86	6.06	1.32	0.14	
	Male	126	6.1	1.25	0.11	
Friends						0.39
	Female	106	6.25	1.27	0.12	
	Male	126	5.89	1.33	0.12	
Peers						0.97
	Female	106	5.9	1.38	0.13	
	Male	126	5.85	1.42	0.13	
Classmates						0.70
	Female	106	5.77	1.55	0.15	
	Male	126	5.99	1.27	0.11	
Professors						0.60
	Female	106	5.9	1.52	0.15	

Table 3. Independent T-test results comparing the Levels of the Support from various Individuals for Levels for Male and Female STEM Undergraduates (n = 237). Mean equals average response where 1=strongly disagree and 7=strongly agree.

DISCUSSION

While gender representation in certain fields is improving in certain STEM fields like ecology, evolution, and conservation biology,^{2,4} issues with discrimination and bias still persist.⁵ Our results support that conditions may be improving, but that there are still persistent issues today. While male and female students perceived that they were supported by various groups of people and that their gender did not affect their scientific confidence, male students still reported higher levels of scientific confidence than female students.

Scientific confidence is important because it relates to an individual's perception that they can be successful in science. This includes their ability to systematically understand and apply knowledge in the natural, social, and life sciences.⁶ This study is supported by several others that suggest that gender affects students' confidence in STEM fields,^{19,20,23} though other studies have suggested that other factors may also contribute to scientific confidence.¹⁸⁻²⁰ Gender differences in scientific confidence are important because they can have far-reaching implications for the future. Differences in confidence can result in different levels of test anxiety with resulting significant differences in exam scores.²⁴ However, more recent research is suggesting that confidence in STEM fields and cultural perceptions of the appropriateness of certain fields for people who identify with certain genders is related to the pay gap between males and females in STEM fields.²⁵ Additionally, it is important to consider how scientific confidence may parallel findings outside of STEM. Studies in business and leadership have also shown that women experience lower confidence than men, which can hinder their progression into leadership roles. These similarities suggest that confidence barriers for women may be a societal issue rather than a STEM-specific one.

While our study suggested that there were no differences in the support students received for selecting a science major, previous studies have suggested that parental support can be an impacting factor.²⁶ Fathers were the only group from whom students perceived near significant differences in support, with male students perceiving greater support. Students conversely perceived that they had equal levels of support from mothers regardless of gender. Our findings may also support previous research on the relevance of parental support, while contributing to research on student-professor interactions by investigating perceived support. While several studies have investigated the link between same-gender instructors and student success^{27,28} scientific confidence,²⁹ few have looked at perceived support.

Another study of undergraduate students revealed that female students experienced lower scientific confidence if there were no female instructors, but male and female students experienced scientific confidence equally when there was gender diversity among instructors.¹¹ Thus, students' scientific confidence may be affected by their peers and instructors, yet there is some evidence this confidence may not have a measured effect on how they perform.

This study was limited in scope as it was bound to a sample of undergraduate students at a single university in North Carolina. Furthermore, we did not investigate the differences in perceived support by the gender of the person providing support. Given our findings on the differences between perceived support from mothers and fathers, investigating how support differs from other groups by gender may have been informative. Future research should investigate the degree to which gender effects support from peers, professors, and non-parental family members. We were also unable to include students who identify as gender diverse in our study due to a limited sample, though research suggests that support from professors is especially important for these students to succeed in academia.³⁰

Despite these limitations, this research has implications to combat the generalization that STEM fields are male-dominated. Developing a sense of scientific confidence is essential when it comes to a female student's academic achievement and success in a science career.^{24,25} We specifically suggest that interventions are needed earlier on in students' lives to counter this socialization, as our results suggest that it may begin in the home with parents. Furthermore, efforts to train teachers to address these biases in students and themselves may be meaningful.

CONCLUSIONS

This study examined the associations between support levels and confidence among students by gender. Overall, male students had higher levels of scientific confidence, but both genders perceived that they were exhibited scientific confidence and were supported by their networks. Our work contributes to research on gender in STEM fields by looking at the intersection between support systems and scientific confidence. While this study suggests that there are no significant differences in STEM support levels for male and female students, more research is needed to examine the influence of other identities on scientific confidence. In particular, the examination of intersectional identities would allow for a better understanding of how scientific confidence and support levels interact with other identities. Beyond STEM fields, confidence gaps between genders have also been reported in other areas, such as business and leadership, suggesting that the issues women face in STEM may be part of a broader trend in society. Ultimately, this study is important for institutions seeking to promote diversity, equity, and inclusion within STEM fields.

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ABOUT THE AUTHORS

Minnatallah Nassir Elsir Eltinay, B.S., completed this manuscript after graduating from North Carolina State University in Raleigh, North Carolina, with a B.S. in Biological Sciences with a concentration in Human Biology and a minor in Nutrition.

Danielle E. Lin Hunter, Ph.D. is a postdoctoral scholar in the Department of Forestry and Environmental Resources at North Carolina State University in Raleigh, North Carolina.

Porché Spence, Ph.D., is an assistant professor in the Department of Natural Resources and Environmental Design at North Carolina Agricultural and Technical State University in Greensboro, North Carolina.

Zakiya Leggett, Ph.D., is an associate professor in the Department of Forestry and Environmental Resources at North Carolina State University in Raleigh, North Carolina.

PRESS SUMMARY

This study examines the influence of gender on the support and confidence of STEM undergraduate students. The findings suggest a trend of males demonstrating more confidence and support in comparison to females.