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Bridging the Gender Gap: Examining Academic and Social Factors Influencing the Persistence of Women in Mathematics and Statistics

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Abstract

Women remain underrepresented in mathematics and statistics despite efforts to increase gender diversity in STEM. This study shares initial results from a larger study that examines the academic and social factors influencing the persistence of undergraduate women in mathematics-intensive programs, with a particular focus on academic development and social support factors. Using a mixed-methods research design, survey responses from 24 undergraduate women and qualitative focus group discussions were analyzed to assess key retention factors. Findings from the survey responses indicate that participants in this study rated academic development factors such as coursework relevance and performance (91%) as well as the quality of instruction (70%) as more influential on persistence than social support structures, including peer interactions (38%) and faculty-student interaction (41%). The study highlights a critical research gap in understanding the long-term persistence of women beyond Calculus I. Recommendations include expanding faculty mentorship programs, integrating experiential learning opportunities, and implementing departmental policies to foster inclusive STEM environments. Future research should explore longitudinal studies, workforce transitions, and innovative pedagogical strategies to enhance retention. Addressing these challenges is crucial for creating gender-equitable STEM education and increasing the representation and persistence of women in mathematics and statistics-related careers.

Keywords:
Mathematics, Statistics, Women in STEM, Academic support, Social belonging, Gender diversity.

1. INTRODUCTION

Women remain significantly underrepresented in mathematics-intensive fields within Science, Technology, Engineering, and Mathematics (STEM) education, despite ongoing interventions aimed at increasing their participation (Rivers, 2017). Research suggests

that women are approximately 1.5 times more likely than men to leave STEM programs, especially after taking foundational calculus courses, which are often perceived as a barrier to success in these fields (Ellis et al., 2016). However, while numerous studies have investigated the reasons for attrition among women in STEM, fewer have focused on understanding why some persist, particularly in mathematics and statistics programs (Joseph, 2023). The persistence of women in these programs is a crucial area of study, as their continued presence in STEM fields is integral to addressing gender disparities in the workforce and fostering a more diverse scientific community (Ortiz-Martínez et al., 2023). Existing literature highlights multiple factors influencing women's persistence in STEM, including academic preparation, institutional support, self-efficacy, and social belonging (Espinosa, 2011; Park et al., 2001). Women who persist often cite the relevance of their coursework, faculty encouragement, and access to mentorship opportunities as key contributors to their retention in STEM programs (Baah & Otten, 2025). However, social support networks, including peer interactions and student organizations, have been found to play a less significant role in persistence when compared to academic factors (Baah & Otten, 2025. Furthermore, stereotype threat and implicit biases continue to undermine women's confidence in their mathematical abilities, further influencing retention rates in STEM education (Greenwald et al., 2001).

While previous research has predominantly focused on early-stage attrition in STEM education, there remains a gap in understanding the specific factors contributing to women's long-term persistence in mathematics and statistics programs, particularly after Calculus I. Most studies concentrate on students transitioning from high school to college, leaving a gap in knowledge regarding the experiences of undergraduate women who continue beyond their first and second years of study. Additionally, existing research often focuses on general STEM disciplines without adequately addressing the unique challenges women face in math-intensive fields, such as mathematics and statistics (Joseph, 2023). Given these limitations, this study aims to explore the academic and social experiences that influence women's persistence in undergraduate mathematics and statistics programs.

Objectives

- To examine the impact of academic development opportunities, including coursework relevance and faculty engagement, on the persistence of undergraduate women in mathematics and statistics programs.
- To assess the role of social support structures, such as peer networks and student organizations, in influencing women’s retention in math-intensive fields.
- To identify institutional strategies that can enhance the retention of women in mathematics-intensive STEM programs beyond their second year of study.

2. LITERATURE REVIEW

Efforts to encourage the retention of women in mathematics-intensive STEM fields have been widely studied, yet gender disparities remain a significant challenge. Studies indicate that while women demonstrate equal or even superior academic capabilities compared to their male counterparts, they continue to be underrepresented in STEM

disciplines, particularly in mathematics and statistics (Bloodhart et al., 2020; Joseph, 2023). Several factors contribute to this trend, including academic preparedness, self-efficacy, social support, institutional structures, and gender-based stereotypes (Concannon & Barrow, 2010; Park et al., 2001). Research has consistently shown that women's experiences in STEM are shaped by sociocultural expectations, biases, and environmental challenges that influence their retention (Joseph, 2023). The lack of a supportive academic climate, particularly in male-dominated mathematics fields, can discourage women from continuing in these programs (Ortiz-Martínez et al., 2023). Institutional policies that fail to provide targeted mentorship, career guidance, and academic development programs further exacerbate the issue of female attrition from STEM disciplines (Hilts et al., 2018). One of the most critical aspects influencing women's persistence in mathematics and statistics is the role of self-efficacy. Research by Beasley and Fischer (2012) demonstrates that women in STEM often experience stereotype threat, which negatively impacts their confidence in their mathematical abilities. This aligns with findings by Findley-Van Nostrand and Pollenz (2017), who emphasize that interventions aimed at boosting women's science identity and sense of belonging can significantly enhance their retention in STEM fields. Additionally, Joseph (2023) identifies psychological, environmental, and pedagogical factors as key determinants in women's STEM persistence, reinforcing the need for institutions to create inclusive and supportive learning environments. These studies collectively highlight the importance of improving an academic culture that enhances women's self-confidence and resilience in STEM disciplines.

Beyond self-efficacy, academic preparedness and institutional support play a crucial role in determining whether women persist in mathematics-intensive programs. Undergraduate research involvement, internships, and practicum experiences positively impact women's retention in STEM, as these opportunities provide hands-on learning and industry exposure (Ortiz-Martínez et al., 2023). Similarly, Casad et al. (2019) found that women in STEM who engage in structured academic support programs are more likely to persist through the challenges of their coursework. However, as Rainey et al. (2019) point out, many institutions fail to provide women with tailored academic interventions, leaving them to navigate STEM disciplines with limited structural support. This gap in institutional efforts underscores the need for universities to implement targeted strategies that strengthen faculty-student interactions and provide specialized academic guidance for women in math-intensive fields. The influence of social support on women's persistence in STEM has also been a subject of extensive research. While social networks and peer interactions are often cited as essential components of student success, studies suggest that their impact on undergraduate women in mathematics and statistics is moderate compared to academic development factors (Baah & Otten, 2025). Walton et al. (2015) noted that while interventions fostering a sense of belonging can be beneficial, they must be integrated with academic mentorship to yield meaningful retention outcomes. Additionally, mentorship by female STEM professionals has been identified as a key driver of persistence, as women who receive guidance from role models in their field exhibit higher levels of confidence and motivation (Stout et al., 2011). However, despite the known benefits of mentorship, many institutions lack formalized mentorship programs for women in mathematics and statistics, limiting their access to essential academic and career guidance (Joseph, 2023).

The broader institutional culture in STEM also plays a crucial role in shaping women's experiences. Beasley and Fischer (2012) argue that stereotype threat, gender biases, and discriminatory academic climates contribute to the disproportionate attrition of women in STEM fields. This is further reinforced by findings from Smith et al. (2013), who emphasize that women often face a "chilly climate" in mathematics departments, where they encounter implicit and explicit biases that challenge their sense of belonging. Research by Barthelemy, McCormick, and Henderson (2016) further illustrates how gender discrimination in STEM environments, including microaggressions and exclusionary practices, creates additional barriers for women seeking to persist in mathematics-intensive disciplines. These studies highlight the need for institutional policies that actively address gender biases and create inclusive academic environments that encourage women's participation and success in STEM.

While research on women's attrition from STEM fields is extensive, there remains a gap in understanding the factors that contribute to long-term persistence, particularly in mathematics and statistics. Existing literature largely focuses on early-stage barriers such as calculus as a gatekeeper course (Ellis et al., 2016) and the role of stereotype threat in discouraging women from pursuing STEM (Greenwald et al., 2001). However, fewer studies explore the specific experiences of women who continue beyond their first and second years in math-intensive programs despite the challenges they face. Joseph (2023) emphasizes that a more comprehensive approach is needed—one that integrates academic, social, psychological, and environmental factors to develop a holistic framework for women's persistence in STEM. Additionally, Ortiz-Martínez and colleagues (2023) suggest that institutional and national policies must shift toward proactive interventions that support women throughout their undergraduate STEM journey rather than solely focusing on recruitment efforts. Addressing these research gaps will provide deeper insights into the structural and academic factors that enable women to persist in mathematics and statistics programs, ultimately contributing to a more equitable and diverse STEM workforce.

Enrolment and Retention Trends in Mathematics and Statistics

The enrolment and retention of women in mathematics and statistics programs remain a critical issue in STEM education, with persistent gender disparities despite numerous interventions. Research indicates that while women comprise a substantial portion of undergraduate enrollments, their representation in mathematics-intensive disciplines remains disproportionately low (Joseph, 2023). Despite efforts to encourage female participation, the retention of women in these fields continues to lag behind that of their male counterparts, with studies showing that women are more likely to leave STEM programs, particularly after introductory mathematics courses (Park et al., 2001). Ortiz-Martínez et al. (2023) highlight that while there has been an increase in the number of women entering STEM fields over the past two decades, their persistence rates remain significantly lower than men's, indicating that enrollment does not necessarily translate into retention. This trend suggests that systemic barriers continue to hinder women's progression in mathematics and statistics, necessitating further investigation into the factors influencing their persistence. The decline in women's retention in mathematics-intensive disciplines has been linked to several key factors, including self-efficacy, academic climate, institutional support, and gendered social norms (Joseph, 2023). Research by Findley-Van Nostrand and Pollenz (2017) demonstrates that women in

STEM often struggle with self-doubt and lack of confidence in their mathematical abilities, which can negatively impact their persistence. This aligns with Beasley and Fischer's (2012) findings that stereotype threat contributes to the attrition of women in STEM, as societal biases reinforce the notion that mathematics and statistics are male-dominated fields. Additionally, Joseph (2023) argues that the lack of female role models in mathematics further exacerbates the issue, as mentorship and representation are crucial factors in retaining women in STEM disciplines. Women who do not see themselves reflected in their professors or industry professionals may feel isolated and less motivated to persist in their chosen fields.

A significant contributor to the gender gap in mathematics and statistics enrolment and retention is the impact of institutional culture and pedagogy. Research by Ortiz-Martínez et al. (2023) highlights that traditional teaching methods in mathematics often fail to engage female students, as they tend to emphasize competition over collaboration. Studies suggest that women thrive in academic environments that emphasize cooperative learning and practical applications of mathematics rather than abstract, lecture-based instruction (Casad, Petzel, & Ingalls, 2019). This is further supported by Rainey et al. (2019), who found that instructional style and professor engagement play a critical role in shaping women's experiences in STEM. When professors actively encourage participation and provide supportive learning environments, women are more likely to persist in mathematics programs. However, many institutions continue to rely on traditional lecture-based instruction, which may alienate female students who prefer more interactive and application-based approaches (Joseph, 2023). Beyond instructional style, institutional policies and support structures also play a crucial role in influencing women's enrolment and retention in mathematics and statistics. Universities that implement targeted retention programs, such as mentorship initiatives and academic advising, experience higher rates of female persistence in STEM fields (Walton et al., 2015). Similarly, Stout et al. (2011) found that exposure to female STEM professionals significantly increases women's confidence and likelihood of continuing in their programs. However, despite the known benefits of such programs, many institutions lack formalized support systems for women in mathematics, leaving them to navigate their academic journeys with minimal guidance (Joseph, 2023). As a result, many female students who initially enroll in mathematics-intensive disciplines eventually transfer to non-STEM fields due to a lack of institutional support and mentorship (Beasley & Fischer, 2012).

Another critical factor affecting women's retention in mathematics and statistics is the role of social belonging and peer networks. While social factors, such as peer interactions and faculty-students interactions, also contribute to persistence, they are often secondary to academic influences because the social support factors are mostly not available to them (Baah & Otten, 2025). Research by Hilts, Part, and Bernacki (2018) indicates that women who feel isolated or lack peer support are more likely to leave STEM programs, highlighting the need for stronger social integration initiatives. However, as noted by Joseph (2023), many mathematics programs fail to foster inclusive and supportive academic communities, contributing to the underrepresentation of women in these fields. This aligns with findings by Barthelemy, McCormick, and Henderson (2016), who emphasize that gender discrimination and exclusionary practices remain prevalent in STEM environments, further discouraging women from persisting in mathematics and statistics programs. The issue of retention is further complicated by broader societal

expectations and career perceptions. Smith and colleagues (2013) suggest that societal biases about gender roles influence women's career choices, often steering them away from mathematics-intensive fields. According to Cromley et al. (2013), women in STEM frequently experience external pressures to pursue careers perceived as more "feminine or socially oriented, leading to higher attrition rates in mathematics and statistics programs. Joseph (2023) further argues that the lack of visibility of women in math-intensive careers reinforces these biases, making it difficult for female students to envision long-term success in these fields. These findings underscore the importance of addressing societal stereotypes and promoting positive representations of women in mathematics to encourage greater retention.

While enrolment trends show a gradual increase in women entering STEM programs, retention rates remain a major challenge, particularly in mathematics and statistics. The factors influencing women's persistence are multifaceted, including self-efficacy, academic climate, pedagogy, institutional support, social belonging, and societal perceptions. Ortiz-Martínez et al. (2023) emphasize the need for targeted interventions that address these barriers, including mentorship programs, inclusive teaching strategies, and institutional policies that promote gender diversity in mathematics education. Joseph (2023) further highlights that universities must shift their focus from simply increasing enrollment numbers to ensuring that women receive the necessary support to complete their degrees. Addressing these challenges is crucial for closing the gender gap in mathematics and statistics, ultimately leading to greater gender equity in STEM careers.

Academic and Social Factors Influencing Mathematics and Statistics Undergraduates

The persistence of undergraduate women in mathematics and statistics is influenced by a combination of academic and social factors, with academic experiences often being more decisive than social support structures in determining retention rates. Numerous studies have highlighted the importance of course relevance, faculty engagement, institutional support, and self-efficacy in shaping women's academic trajectories in mathematics-intensive disciplines (Joseph, 2023). Research by Ortiz-Martínez et al. (2023) suggests that institutional policies, teaching methodologies, and mentorship programs significantly impact women's persistence in STEM, reinforcing the need for targeted academic interventions. One of the most significant academic factors influencing retention in mathematics and statistics is the quality of instruction and curriculum design. Studies show that the way mathematics is taught has a profound effect on students' experiences, particularly for women, who may feel alienated by competitive and abstract learning environments (Casad, Petzel, & Ingalls, 2019). Research by Rainey et al. (2019) further emphasizes that faculty-student interactions play a crucial role in fostering persistence, with women who receive encouragement from professors being more likely to remain in their programs. However, many mathematics departments continue to rely on traditional lecture-based instruction, which can be disengaging and isolating for female students (Joseph, 2023). Instead, active learning approaches that emphasize collaboration and real-world applications of mathematics have been found to improve retention among women in STEM (Findley-Van Nostrand & Pollenz, 2017).

Another key academic factor is the availability of research opportunities, internships, and experiential learning programs. Ortiz-Martínez et al.(2023) highlight that participation in undergraduate research significantly increases persistence in mathematics-intensive

fields by allowing students to apply theoretical knowledge in practical settings. Similarly, Stout, Dasgupta, Hunsinger, and McManus (2011) found that exposure to real-world applications of mathematics enhances women's confidence in their abilities and reinforces their commitment to STEM careers. However, Joseph (2023) argues that many universities fail to provide adequate research and internship opportunities for women in mathematics, limiting their exposure to career-relevant experiences. This lack of institutional support can contribute to attrition, as students who do not see clear career pathways in their field may opt to transfer to other disciplines. Self-efficacy and academic confidence also play a significant role in influencing persistence in mathematics and statistics. Beasley and Fischer (2012) found that women in STEM often struggle with self-doubt, a challenge that is compounded by stereotype threat and societal biases about mathematical ability. Smith and colleagues (2013) support this, noting that women in math-intensive programs frequently experience implicit biases that undermine their confidence, leading to higher dropout rates. Joseph (2023) further emphasizes that institutions must actively work to counter these effects by implementing confidence-building initiatives, such as mentorship programs and academic workshops, to help women develop resilience in STEM fields.

While academic factors are central to persistence in mathematics and statistics, social factors also contribute to retention by influencing students' sense of belonging and engagement in their programs. Peer support and social integration can play a crucial role in helping women navigate the challenges of STEM education (Walton et al.,2015). However, studies indicate that women in mathematics and statistics often report lower levels of social belonging compared to their peers in other disciplines (Hilts et al., 2018). This lack of social connection can lead to feelings of isolation, which in turn contributes to attrition. As Rainey et al. (2019) note, women in STEM benefit from participation in student organizations, study groups, and campus initiatives that promote community building, yet many mathematics programs lack structured social support systems to facilitate these interactions.

Mentorship and role modeling are additional social factors that significantly impact women's persistence in mathematics and statistics. Research by Cromley et al. (2013) found that women who have access to female role models in STEM exhibit higher levels of motivation and confidence in their abilities. Similarly, Barthelemy, McCormick, and Henderson (2016) emphasize that mentorship programs can provide women with guidance, career advice, and emotional support, all of which are crucial for retention in STEM fields. However, as Joseph (2023) notes, the lack of female faculty in mathematics departments often limits students' access to mentorship, reinforcing gender disparities in the field. To address this, institutions must actively recruit and support female faculty members while also developing structured mentorship initiatives that connect undergraduate women with successful professionals in mathematics.

Despite the known benefits of social support structures, research suggests that undergraduate women perceive their academic factors as the strongest influence on their persistence in mathematics and statistics. According to Baah and Otten (2025), social factors such as peer interaction and positive unstructured faculty-student interactions outside of the classroom, although they play a role in student retention, are often secondary to academic factors such as coursework relevance, quality of instruction, and internship opportunities. This aligns with findings by Ortiz-Martínez et al. (2023), who

emphasize that institutional policies must prioritize academic interventions to ensure that women in mathematics receive the necessary resources to succeed. Overall, the persistence of undergraduate women in mathematics and statistics is shaped by a combination of academic and social factors. While academic experiences, including faculty engagement, instructional quality, and research opportunities, play a dominant role in retention, social factors such as peer networks, mentorship, and sense of belonging also contribute to students' success. Addressing these challenges requires a multifaceted approach that integrates both academic and social interventions, ensuring that women in mathematics-intensive fields receive the support they need to thrive. Research by Joseph (2023) underscores the importance of institutional commitment in fostering inclusive learning environments, while studies by Ortiz-Martínez et al. (2023) and Walton et al. (2015) highlight the need for targeted retention initiatives that address both academic and social barriers. By implementing these strategies, universities can help close the gender gap in mathematics and statistics, ultimately contributing to a more diverse and equitable STEM workforce.

Identifying Research Deficiencies in Women's Persistence in Mathematics and Statistics

Despite extensive research on gender disparities in STEM, significant gaps remain in understanding the factors influencing women's persistence in mathematics and statistics. While many studies have focused on the early attrition of women in STEM, particularly in the transition from high school to college, fewer have explored the experiences of those who persist beyond their third and fourth years in mathematics-intensive disciplines (Joseph, 2023). This lack of research limits the development of targeted interventions that address the unique challenges faced by advanced undergraduate women in these fields. Ortiz-Martínez et al. (2023) emphasize that while enrollment trends for women in STEM have shown modest improvements, retention remains a persistent challenge, with many students leaving before completing their degrees. This suggests that current institutional efforts may be insufficient in addressing the long-term barriers to persistence. Another key research gap lies in the understanding of intersectional factors that influence persistence among women in mathematics and statistics. Most existing studies tend to generalize women's experiences in STEM without adequately considering how race, socioeconomic status, and cultural background intersect with gender to shape academic trajectories (Barthelemy, McCormick, & Henderson, 2016). Research by Beasley and Fischer (2012) suggests that underrepresented minority women face compounded challenges in STEM due to systemic biases and lack of support structures, yet there is limited empirical research examining how these factors specifically impact women in mathematics-intensive fields. Joseph (2023) highlights the need for more nuanced studies that investigate how institutional policies and social dynamics affect diverse populations within STEM education.

While the role of self-efficacy and stereotype threat in STEM persistence has been widely studied, there is still limited research on the long-term effects of these psychological barriers on women in mathematics and statistics (Findley-Van Nostrand & Pollenz, 2017). Studies have established that women often experience self-doubt and a lack of confidence in their mathematical abilities due to societal stereotypes (Smith et al., 2013). However, fewer studies have examined how these perceptions evolve over time and whether targeted interventions effectively mitigate their impact. Casad, Petzel, and Ingalls

(2019) indicate that women who persist in STEM develop coping mechanisms to counteract stereotype threat, but the mechanisms by which they navigate these challenges remain underexplored. Further research is needed to identify the specific psychological and institutional support systems that enable long-term resilience in mathematics-intensive disciplines. Additionally, there is a gap in research on the effectiveness of academic and social support programs designed to retain women in mathematics and statistics. While some studies have highlighted the benefits of mentorship and experiential learning opportunities (Ortiz-Martínez et al., 2023; Stout et al., 2011), there is limited empirical evidence assessing the long-term impact of these initiatives. Walton et al. (2015) suggest that while interventions aimed at increasing a sense of belonging can improve short-term retention, their effectiveness in sustaining persistence throughout undergraduate studies and into professional careers is not well-documented. Moreover, many existing programs are designed as broad STEM initiatives without addressing the specific needs of women in mathematics-intensive fields (Joseph, 2023). A more targeted approach is needed to evaluate which interventions are most effective in fostering persistence among women pursuing mathematics and statistics degrees.

Another underexplored area is the role of institutional climate and departmental culture in shaping women's experiences in mathematics and statistics. Cromley et al. (2013) suggest that the "chilly climate" of mathematics departments—characterized by implicit biases, lack of female representation among faculty, and competitive academic environments—can negatively impact women's persistence. However, there is limited research examining how specific institutional policies and teaching practices contribute to either reinforcing or dismantling these barriers. Barthelemy, McCormick, and Henderson (2016) emphasize that addressing gender disparities in STEM requires a deeper understanding of how institutional structures either support or hinder women's academic progress. More research is needed to identify best practices for creating inclusive learning environments that foster long-term retention in mathematics-intensive disciplines.

Finally, while much research has been devoted to understanding the barriers to women's persistence in STEM education, there is a gap in studying their transition from undergraduate mathematics programs into the workforce. Ortiz-Martínez et al. (2023) highlight that many women who persist in STEM education still face challenges in securing and maintaining careers in mathematics-related fields due to biases in hiring practices and workplace culture. Research by Beasley and Fischer (2012) suggests that the underrepresentation of women in mathematics extends beyond academia and into professional industries, yet few studies have explored how undergraduate experiences influence career trajectories. Investigating the link between undergraduate support systems and long-term success is crucial for developing strategies that not only improve retention in academia but also facilitate smoother transitions into the STEM workforce (O'Connell & McKinnon, 2021). While significant progress has been made in understanding the factors influencing women's persistence in mathematics and statistics, several research gaps remain. There is a need for more in-depth studies on advanced undergraduate persistence, intersectional experiences, long-term psychological barriers, effectiveness of retention programs, institutional climate, and career transitions. Addressing these gaps will provide a more comprehensive understanding of the

challenges women face in mathematics-intensive disciplines and inform more effective strategies for fostering long-term retention and success in STEM.

3. METHODOLOGY

This study reports on the initial findings from a larger study that employs a mixed-methods research design to examine the factors influencing the persistence of undergraduate women in mathematics and statistics. The combination of quantitative and qualitative data collection allows for a comprehensive understanding of the academic and social experiences that shape retention in these fields. The quantitative component consists of survey responses from female students enrolled in collegiate mathematics and statistics programs, while the qualitative component involves focus group discussions that provide deeper insights into students' academic and social support experiences. This approach aligns with prior research that emphasizes the need to analyze both survey responses and interviews to understand the factors that influence STEM persistence (Joseph, 2023). In this study, persistence is defined as students' continuous enrollment through the third year, placing them on a presumed path to STEM degree attainment from the university (Baah & Otten, 2025). The study specifically investigates the impact of academic development factors (such as course relevance, faculty engagement, and internship opportunities) and social support structures (including peer and faculty interactions and major-related organizations) on women's persistence in mathematics and statistics programs. Academic development refers to the formal and experiential learning opportunities provided officially within the program. Likewise, social support describes the support and mentorship students receive beyond the official capacity of the program/department (Baah & Otten, 2025).

Research Design: The larger research study utilizes an explanatory sequential design, where quantitative data are collected first through surveys, followed by qualitative data obtained from focus groups. This design enables the identification of key persistence factors from the survey responses, which are then explored in greater detail through qualitative discussions (Cromley et al., 2013). A five-point Likert scale survey was used to measure students' perceptions of academic and social factors impacting their persistence, with items focusing on the quality of instruction, access to research and internship opportunities, availability of peer support, and academic advising (Baah & Otten, 2025). The current study reports on initial findings from the students' survey. The qualitative component involved semi-structured focus group interviews to capture students' perspectives on institutional barriers and enablers of persistence. Prior research suggests that such an approach enhances the validity of findings by allowing participants to elaborate on their survey responses (Barthelemy, McCormick, & Henderson, 2016).

Participants: The study surveyed 24 self-identified undergraduate women enrolled in mathematics or statistics programs at Pink University (a pseudonym) in the Midwest United States. The focus group participants were selected through purposive sampling, ensuring that all respondents were actively pursuing their degrees beyond the second year, thereby capturing persistence-related experiences. This focus on third- and fourth-year students addresses a key gap in STEM retention research, as most studies focus on early attrition. As Ortiz-Martínez and colleagues (2023) argue, analyzing persistence

factors among upper-level students provides critical insights into the institutional and personal strategies that promote STEM retention. The participants represented diverse backgrounds, with variations in the year in program when they decided to pursue major in their STEM program, among others. Figures 1 and 2 shows the diverse backgrounds of participants.

Figure 1: Participants' major and year in program

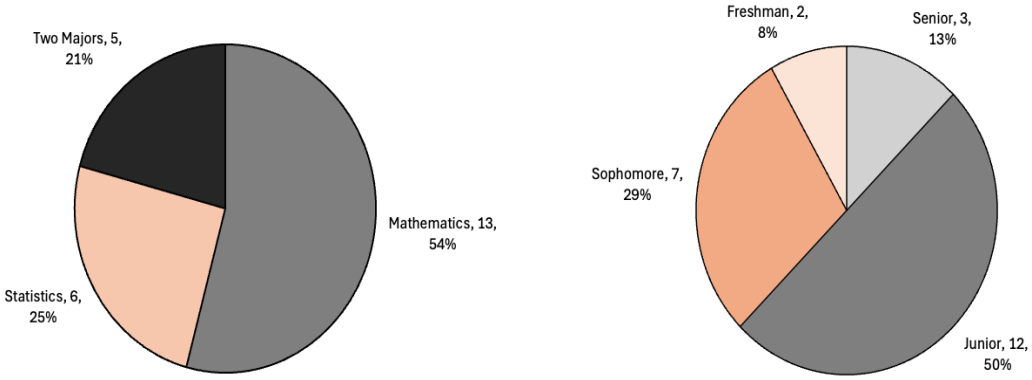
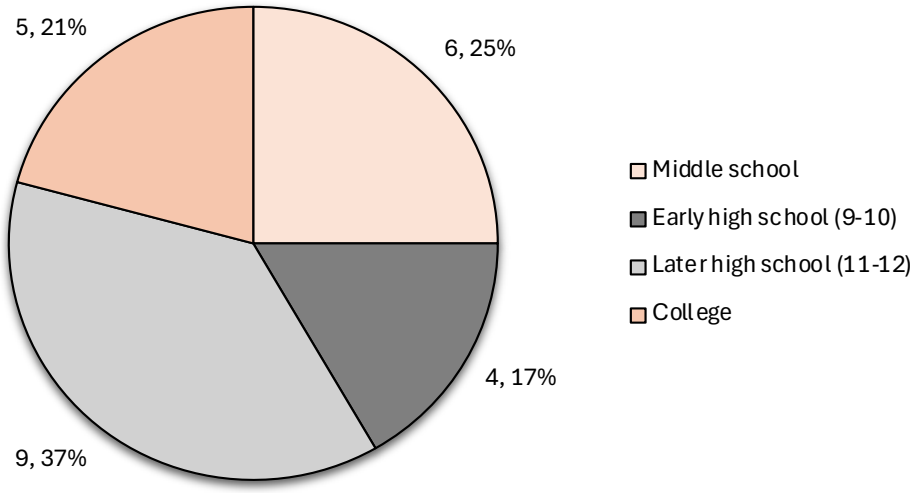


Figure 2: When participants decided to pursue a major in mathematics or Statistics



Survey: The survey consisted of 31 items and 5 open-ended questions (Baah & Otten, 2025). For example, three multiple-choice questions measured persistent intentions that included doubts about continuing in a math or statistics major (binary variable) and commitment levels (measured on a 5-point Likert scale) toward obtaining a degree in the major. Following the persistence intention questions, 26 multiple-choice questions measured the perceived level of influence of academic and social support factors on persistence. The perceived influences of experiences on persistence questions used a

5-point Likert scale ranging from 1 = not influential to 5 = extremely influential. One of the questions was: “How do you rate the influence of the quality of instruction on your persistence in your math or statistics program?” The academic development items included questions about course relevance, quality of instruction, performance (GPA), and access to career development programs such as internships. The social support questions assessed the impact of peer interactions (e.g., study groups and friends in department), faculty-students interaction beyond the classroom, and participation in major-related clubs on persistence.

4. RESULTS AND DISCUSSION

Below, Figures 3, 4, and 5 illustrate the initial findings from the survey data on academic development and social support factors.

Figure 3: Influence of Academic Development Factors on Persistence: This chart presents the percentage of students who identified various academic factors as influential on their persistence in mathematics and statistics.

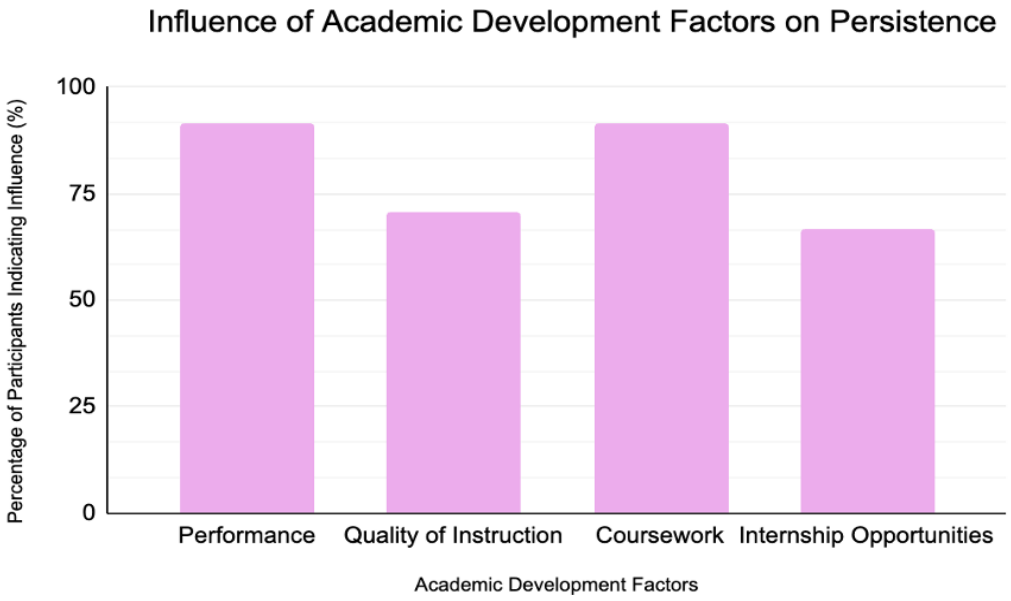


Figure 4: Influence of Social Support Factors on Persistence: This chart presents the percentage of students who identified various social support factors as influential on their persistence in mathematics and statistics.

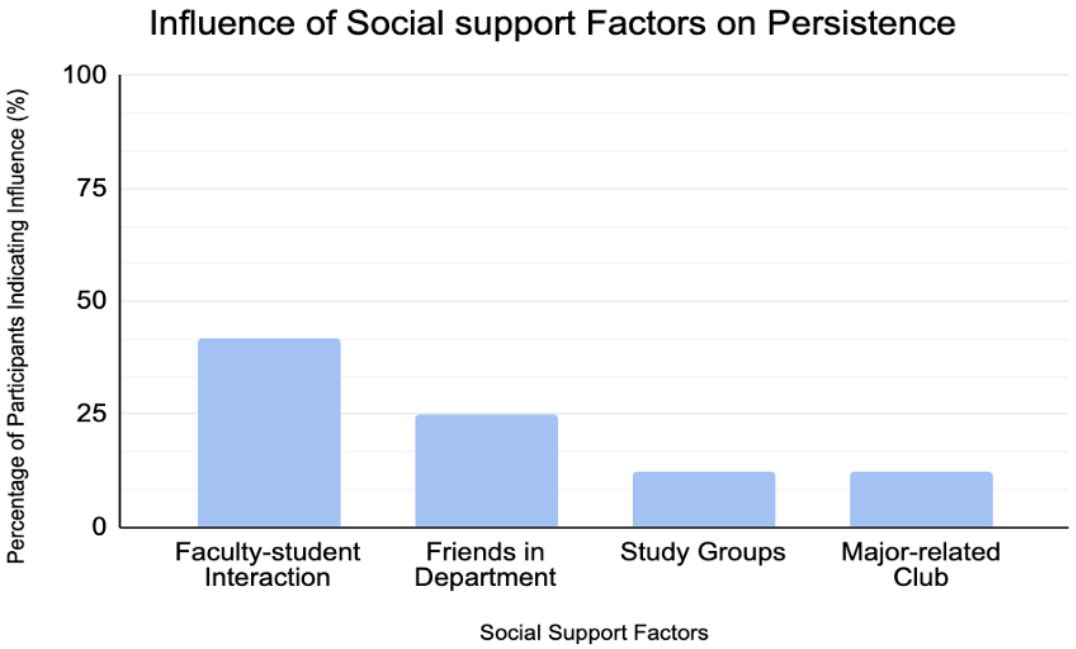
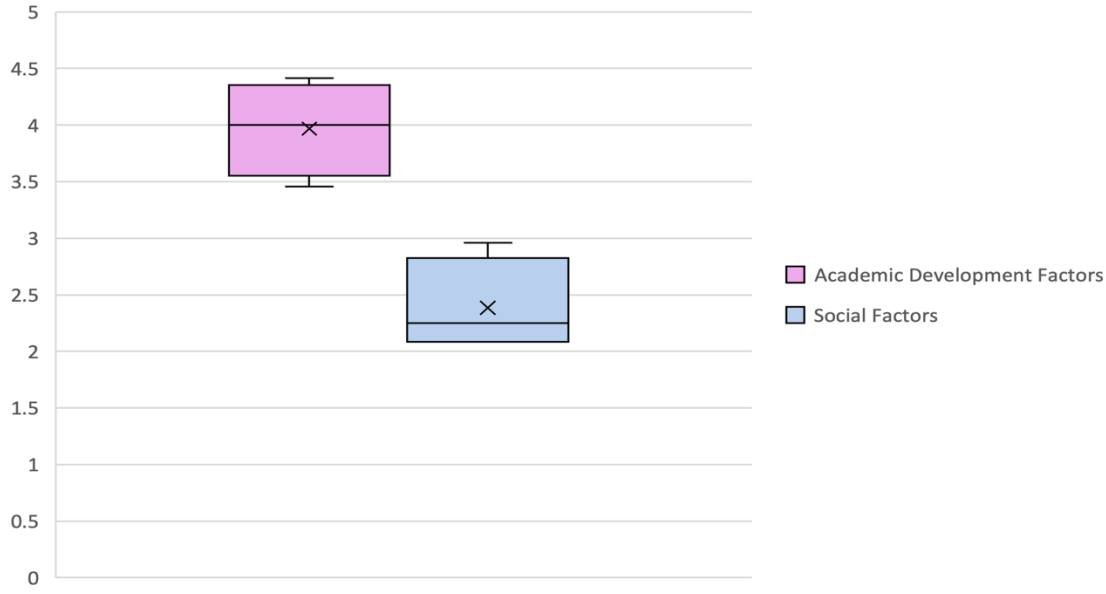


Figure 5: Comparative Influence of Academic and Social Support Factors on Persistence: This chart compares the overall influence of academic development and social support factors on the persistence of undergraduate women in mathematics and statistics.



The results from the survey indicate that academic development factors play a significantly stronger role in the persistence of undergraduate women in mathematics and

statistics than social support factors. Figure 3 demonstrates that the relevance of coursework (91.6%) quality of instruction (70.8%), internship opportunities (66.7%) and performance (91.6%) are key determinants of student retention, reinforcing prior research that highlights the role of instructional quality and curriculum design in STEM persistence. Figure 4 illustrates that while social support factors, such as faculty-student interaction (41.7%), peers in the department (25%), study groups (12.5), and major-related clubs (12.5) contribute to student persistence, they are generally less influential than academic factors for most undergraduate women. Figure 5 further emphasizes this contrast, showing that academic development factors were rated to be highly influential than social support factors. The research methodology adopted in this study ensures a comprehensive analysis of both academic and social factors influencing the persistence of undergraduate women in mathematics and statistics. By integrating quantitative survey data with qualitative focus group discussions, the larger study provides a detailed understanding of the college experiences that shape math-intensive STEM retention for women and other under-represented groups. About 91% of the respondents rated course relevance and their academic performance as highly influential in their persistence, while about 70% indicated that the quality of instruction and internship opportunities significantly contributed to their retention. In contrast, 75% of participants reported that social support structures had only a low to moderate influence on their persistence. The findings underscore the need for universities to prioritize academic interventions, such as career development opportunities, the relevance of coursework to students' careers, and quality of classroom instruction, among others, while also improving social support structures like peer interactions, and student organizations in the various departments. Addressing these factors can help improve the retention of women and other underrepresented groups in mathematics-intensive fields and contribute to greater gender equity in STEM education and careers (O'Connell & McKinnon, 2021).

5. CONCLUSION

The persistence of undergraduate women in mathematics and statistics remains a critical challenge, despite ongoing efforts to promote gender diversity in STEM. This study highlights the significant role of academic development factors, such as the structure and relevance of coursework, supportive teaching strategies, internship and research opportunities in shaping students' decisions to continue in these fields. In contrast, undergraduate women perceive social support structures, including peer networks, major-related clubs, and unstructured faculty-students interaction that occurs outside the classroom, play a secondary but still relevant role in influencing their persistence. The findings reinforce existing literature that emphasizes the need for institutional interventions to create more inclusive and supportive learning environments for women in mathematics and statistics (Ortiz-Martínez et al.,2023; Joseph, 2023). The comparative analysis of academic and social factors (Figure 5) suggests that while peer support and unstructured faculty-students interaction contribute to students' persistence, institutional policies that enhance academic engagement have a more pronounced impact on undergraduate women persistence. Women who perceive their coursework as relevant to their career goals, receive high-quality instruction, performs well in their coursework and participate in experiential learning opportunities are more likely to persist in their programs (Baah & Otten, 2025). These findings are consistent with prior research

indicating that retention in STEM is strongly correlated with students' confidence in their abilities and the academic support they receive from faculty and institutions (Beasley & Fischer, 2012; Findley-Van Nostrand & Pollenz, 2017).

RECOMMENDATIONS

Strengthening Faculty-Student Engagement and Academic Support: Faculty-student engagement has been identified as a crucial factor in promoting persistence in math-intensive STEM fields, and structured academic advising programs can further enhance student retention (Casad et al., 2019; Rainey et al., 2019). Institutions should prioritize faculty development programs to train educators on inclusive teaching strategies, active learning methodologies, and mentorship practices such as sharing relevant resources and inviting students to work on research projects with faculty. Likewise, Institutions should develop structured mentorship programs that connect undergraduate women with female faculty members, STEM professionals, and alumni networks (Dennehy & Dasgupta, 2017). Representation matters and having visible role models in mathematics-intensive fields can significantly impact students' confidence and motivation.

Expanding Research and Internship Opportunities: Providing structured undergraduate research experiences and industry internships can significantly enhance women's engagement in mathematics and statistics programs. Universities should establish formal partnerships with STEM industries and research institutions to ensure that undergraduate women enrolled in STEM fields such as mathematics and statistics gain practical exposure to career-relevant experiences (Ortiz-Martínez et al.,2023). Such initiatives would help bridge the gap between academic learning and professional application, increasing students' confidence and career readiness.

Promoting Inclusive Institutional Policies and Support Networks: University departments should implement equity-driven policies that promote a more inclusive and supportive academic climate for women in mathematics and statistics. This includes addressing issues related to gender bias, stereotype threat, and departmental culture (Barthelemy, McCormick, & Henderson, 2016). Additionally, while social support factors were found to have a moderate influence on persistence, establishing women-focused student organizations and networking opportunities can further enhance retention by fostering a sense of belonging (Hilts, Part, & Bernacki, 2018).

Conducting Further Research on Long-Term Persistence and Career Transitions: Future research should explore longitudinal studies tracking women's experiences from undergraduate education into their professional careers. Understanding how institutional support influences long-term career success is essential for developing sustainable interventions in math-intensive STEM education (O'Connell & McKinnon, 2021). Additionally, intersectional research that examines the unique challenges faced by women of color and those from marginalized socioeconomic backgrounds is necessary to create targeted support structures.

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