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From Stereotypes to STEM Careers: A Mixed-Methods Study of Gender Bias and Female Self-Efficacy in Pakistani Universities

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ABSTRACT

This study investigates the impact of gender bias on female students' aspirations toward science, technology, engineering, and mathematics (STEM) disciplines in Pakistani universities, with a particular focus on the mediating role of self-efficacy and the moderating influence of coping strategies and support systems. Using a cross-sectional survey design, data were collected from 250 female undergraduate students representing different age groups and faculties. The analysis employed descriptive statistics, Pearson's correlation, and multiple regression in SPSS to examine relationships among five major variables: gender bias and STEM aspirations, factors influencing gender bias, coping strategies and support systems, self-efficacy, and confidence. Results revealed strong correlations between gender bias and reduced STEM aspirations, with factors such as curriculum design, teacher attitudes, societal expectations, and lack of female role models playing critical roles. Self-efficacy was significantly associated with aspirations but demonstrated diminished predictive power when structural variables were included, underscoring that individual confidence alone cannot counteract systemic barriers. Coping strategies; including family encouragement, mentorship, and peer support were found to buffer the negative impacts of bias, though their effectiveness varied across contexts. The findings align with international evidence from South Asia, the United Kingdom, and China, but offer unique insights into the cultural specificities of Pakistan. The study contributes to theory by extending Bandura's Social Cognitive Theory and Social Cognitive Career Theory in a South Asian context, and to practice by providing recommendations for universities, policymakers, and NGOs to design gender-sensitive curricula, strengthen institutional support, and foster inclusive STEM environments. Ultimately, this research highlights the urgent need for systemic reforms to achieve gender equity in higher education and expand women's participation in STEM.

Keywords: *Gender bias, STEM aspirations, self-efficacy, confidence, coping strategies, social cognitive career theory*

INTRODUCTION

Worldwide, women remain underrepresented in science, technology, engineering, and math (STEM) whereas some of the advancements have been made regarding education level besides pursuing equality (UNESCO, 2021). The imprints of other structural factors such as gender stereotypes, implicit discrimination, and cultural norms continue to influence the academic major and careers of the female students (Cheryan et al., 2017). Researchers consistently find that women who study STEM are not only underrepresented, but also more inclined to quit these disciplines due to differences in confidence and support in higher education establishments (Wang & Degol, 2017).

Such issues are particularly critical in the example of Pakistan. Socially embedded cultural beliefs and gender-related social norms predetermine the possibility of realizing the women role in society by restricting women to pursue the possibility of a career in science and technology (Mumtaz, 2017). Women learners experience academic stereotypes that undermine their skills and abilities to succeed in mathematics and engineering courses, lack of access to female role models, and the issue of adhering to mainstream gender norms (Khan & Malik, 2019). As a result, their inner belief in themselves, as well as long-term career goals in any STEM-related field get discouraged, sustaining an overrepresented trend.

Self-efficacy- the perceptions of one ability to accomplish something in specific fields, becomes pivotal when explaining career preferences, and perseverance in STEM (Bandura, 1997). When students feel that they are competent, then they have higher chances of tackling difficult activities, continuing even when things do not go their way, and having ambitious ambitions in their careers (Lent et al., 1994). On the other hand, gender prejudice and stereotyping have an adverse implication on the confidence of female students leading to self-doubt and avoidance of careers in STEM fields (Zeldin & Pajares, 2000). The issue of self-efficacy has been underrepresented in the internal Pakistani context, especially concerning its mediation between gender bias and career aspirations.

Although gender stereotypes, self-efficacy and STEM engagement are the topics of numerous studies in the whole world (Mujtaba et al., 2023; Paudel et al., 2025), there is a gap in the area of empirical research concerning Pakistani higher education system based on mixed-methods designs. This paper aims to fill that gap by using both data to analyze the intersection of gender bias and stereotypes as well as self-efficacy on the STEM aspirations of female students in Pakistani universities.

Research Objectives and Questions

The study is guided by a set of interrelated objectives and research questions designed to explore the phenomenon comprehensively. The objectives of this study are:

- To examine how gender stereotypes and bias influence female students' STEM career aspirations.
- To explore the relationship between gender bias, confidence, and self-efficacy.
- To identify coping mechanisms and institutional supports that help female students navigate gender bias.

Based on these objectives, the study addresses the following research questions:

1. How do stereotypes and biases shape female students' STEM choices?
2. How does gender bias affect self-efficacy and academic confidence?
3. What coping strategies do female students use to deal with gender bias?

4. What role can universities play in reducing gender bias and strengthening female self-efficacy?

This study is significant on many levels. With regard to academic importance, the study fills a critical gap in the existing body of research on gender in STEM, as it examines gender expectations, self-efficacy, and coping strategies in their intersections in a South Asian setting. The findings are of policy importance and can be used to guide systemic intervention aimed at reducing inequity in higher education within a curriculum transformation, faculty training, and provision of support mechanisms to underrepresented groups. Socio-wise, the research points out the need to empower females in STEM not only to promote gender equality in education but also to have them apply their STEM skills in the development of science and technology in Pakistan.

LITERATURE REVIEW

Bandura (1997) introduced the concept of self-efficacy as a central element in human agency, emphasizing that individuals' beliefs about their capabilities directly shape their motivation, choices, and persistence in challenging domains. Within the field of education, this theoretical framework has been extensively applied to explain why students with similar abilities may perform differently when facing obstacles. It would be particularly applicable to STEM fields, a domain in which social norms and gender role stereotypic beliefs commonly imply that women lack the capacity to succeed. Women who personally endorse negative racial/ethnic and gendered beliefs may still feel that they are not capable, or drop out of pursuit of STEM when they have the basis for confidence as a student. This interconnection between gender prejudice, self-perceptions and achievement underscores the place occupied by self-efficacy as a theoretical perspective enabling for the understanding of girls' registration in science and ICTs-related education (Bandura, 1997).

As Kataeva (2025) provocatively puts it, gendered stereotypes and discrimination mandate alternatives: women should be tossed into an alternative sphere of equal legal might but, more positively still, also of STEM-type (such as cave speleologists, geeks). This is useful to start with because it helps centre the conversation beyond a historical analysis of stereotypes: these are not just an abstract shape, but also a fully-formed story that entwines construction of entitlement with identity among teenage girls. Soft under enrollment is driven by a web of identity politics--the stories we tell at home and in schools that say girls are less good. Of course, there are narratives that are equally common and destructive. Reflective of the limitations of a bibliometric approach, Kataeva identifies the existence of these biases at other levels, such as theory, practice and policy interventions.

In the seminal work of Bandura (1997) on the theory of self-efficacy, since redefined by numerous researchers, we find that faith in the ability is neither determined by birth or acquired through experiences alone but through the interaction of the previously mentioned factors. Applying this to gender and STEM students, female students come to believe and accept that they do not belong in science or technical fields based on messages that come at them when they are growing up (family, media, peers, etc.). Their natural interest in and curiosity in things fail before they start without believing in their competence. This psychological backdrop is important because it moves prejudice from the external speech act to the internal: stereotypes generate self-doubt, which undercuts stamina in STEM. But the truths Bandura showed are also timeless because they remind us that, for all our dismissals of stereotype, to break through it is not just to win another fight or election or case.

CCT - Social Cognitive Career Theory Lent et al. (1994) and is based on theoretical premises regarding self-efficacy that emphasize personal beliefs combined with environmental reinforcements and outcome expectations as influences of career. For Pakistani universities, which may have differing levels of infrastructure and societal expectation, SCCT provides an explanation for how gendered contexts leads to the reduction in self-efficacy that results in altered aspirations. Women do not come IN to stem programs with some ability and when they encounter apathy or social gatekeeping by the institution, at an institutional level and personal one on-line, they either persist through their self-efficacy rising or quit. CCT provides an opportunity to be able to study more than just individual-level psychological factors, but also the effects of university policies, peer contexts and social norms on changes in confidence throughout a lengthy period.

Gender schema theory (Bem, 1981), revised in a modern perspective can also account for the structure of how per se and early on it is constructed through socialization a cognitive script of what the accepted courses of action are supposed to be. Pakistani demographics represents a scenario where gendered roles, especially those of women, are frequently supported by religion, media and family, so a tendency to identify STEM as a masculine area of study can occur even before the girl realizes that mathematics is a strength of hers. This premature internalization forms an intangible barrier- one that restrains the sense of belonging. When they fail to derail these schemas- by exposing girls to female role models in STEM, inclusive-looking teaching, messages that challenge stereotypes, and so on- the schema goes on operating, quietly ensuring that girls fall out of the pipeline- quite often without themselves realizing it.

Cheryan et al. (2017) present tremendous evidence that the space of the STEM setting emits cues, be it classroom decorations or staffing, which project the image of who should or should not be there, and who most certainly is not and is usually not female. The fact that they claim that the idea that STEM is a male-dominated discipline discourages women is true even despite the abilities or interest. Even such adequately prepared female students may feel disempowered through spaces filled with sterile laboratories, male-dominated visions, or male-dominated student populations. These cues may be reinforced in places like Pakistan where female presence in any institutional lab or even male environment is already fraught with social judgment, so environmental cues gain greater significance than perhaps they would elsewhere. The signal exchange of that kind is tiny, but significant.

Re-analyses of these studies (Lent et al., 1994; Tellhed et al., 2017) suggested that the self-efficacy gap in relation to gender moderated this predictive association, which has also found support from our re-analyses. They found that low self-efficacy results in low interest which depletes tenacity. Yet they are also a formidable argument for why "building self belief around ability through, say, mentorship and experiences of success, isn't just something nice to do; it is the basis of actual accomplishment. These dynamics are compounded in a Pakistani scenario where not only male demonstrations of affirmation, but institutions and cultures which focus on the need for male approval, flourish. It underscores that self-efficacy is not a bonus; it's a dropout preventer."

The mixed-method study by Saigo (2024) is based on the self-determination theory, which demonstrated that findings reveal a significant relationship of need satisfactions of autonomy, competence, and relatedness with women's persistence in STEM. The authors believe that the observation of the competence being rated very highly in satisfaction and relatedness as lowest- is understandable since individuals are not at 'liberty' to count on support of their own sex, especially women who may not get such peer support (as they would if supported by males working within a male dominated environment). Her stories enable me to recognize that equations of policy or culture must incorporate the emotional, namely that women often persevere in part because they feel competent, when none of the receptors are open. Interventions should hence reinforce the sense of ability and safe belonging.

Husnain et al. (2022) studied the self-efficacy aspect of entrepreneurial intentions of Pakistani female university students- concluding that self-efficacy does make a significant difference. It's the same mechanic there, but instead of focusing on an underlying concept about whether you are capable or will succeed leads to a intention as becoming an entrepreneur. When female STEM students see their talent manifested in entrepreneurial or innovation efforts, they increase their self-efficacy. It works two-ways: – by intellectually including formally (the strong version), and exerting impact that is spread out more, visible female agency in science outside lecture halls, lab or business start-ups.

An infantile culture is a backdrop in display, when Nazli (2023) researches the dichotomies on flipping through their bookish wishes and wants at Pakistani schools: women are slogging at early marriages, pregnancies and kitchens chores before as cultural give-outs do empower women prior to setting footing while building self-efficacy. Girls who dearly want to believe in themselves despite the fact that they have two left feet for housework, who are tired by various trips to testify late at night or experiment in a lab and so on, never fail to get their inner strength smashed by the cold hard outer reality called doing all those things as chores. It is this sort of systemic scuffing that highlights the fact that self-efficacy is not just an academic issue but a thing that lives in culture's demands on our time and energy and identity.

IIT Patna (2025) observed that there still is a perception of the parent being science for daughters as hard and also subconsciously what goes in mind is that it belongs to males. The shape of the bias is depicted through vocabulary, imagery, symbols (in both their form/size) etc., showing how stereotype actually gets melted into thought. That's so deep in code words it means we are not just spending the task at an individual level, but at a community one and to break those coded bars we need more than reclamation of the classroom; we need a cultural narrative.

UNESCO (2021) reports that while women constitute around 28–30% of STEM researchers globally, their representation in engineering fields remains close to 20%, and attrition rates are disproportionately high. Similar trends have been documented in Pakistan, where cultural and institutional barriers continue to erode women's persistence in STEM despite initial enrolment (Aslam, 2018; Halai, 2019). These figures underscore that representation at entry does not guarantee retention, highlighting how weakened self-efficacy and institutional support contribute to women's exit from STEM pathways (Archer et al., 2013; Wang & Degol, 2017).

Rehman et al. (2025) evaluated the preparedness of Pakistan to STEM education using SEM and concluded that policy, funding and teacher preparedness are key determinants of STEM implementation. Without gender-sensitive teachers that are well trained, bias remains. When curricula do not feature female scientists or do not arm teachers with effective strategies to support all students in an equivalent manner, self-efficacy amongst girls declines. The element of readiness involves not just technical training but also in the affirmation of female identity in STEM that is built by the strengthening of teacher agency.

The social cognitive approach to gender differences presented by Chan (2022) once again supports the idea of self-efficacy mediating between gender and interest in STEM: they found that females expressed less interest in STEM, as well as lower levels of self-efficacy, academic and career aspirations, and interest. She demonstrates that stereotypes in gender roles will worsen this gap and, therefore, programs to increase self-efficacy should challenge stereotypes of gender roles as well so that self-belief becomes robust despite discriminatory climate.

The qualitative and quantitative inquiry conducted by Durrani et al. (2025) showed that teachers tend to use essentialized beliefs about gender, presenting girls as the poor learners in Physics and Computer Science. This echoes with the cultures in Pakistani departments where female students will hear faculty jokes, reduced expectations or be left unheard, which makes their self-image and feelings of belonging. There's also an acknowledgment that bias can be as deafening as it is habitable and normal and that to resist it, we should handicap norms at the nucleus of teacher identity.

Finally, UNESCO (2021) clarifies that despite the desire for gender parity in STEM by the international community, it is evident that systemic barriers to women not gaining access to encompass cultural norms, institutions lack of support women and gender bias. This international moment sets the frame for Pakistan, for women who on this same backdrop do not exist in isolation, nor are they a problem to solve (self-efficacy), rather one would argue that there is a convergence of faith (resources and power), culture (stereotypes) and institution factors over coming of faculty members of learning/teaching units. It imparts the feeling of that urgency, not just in listening but action.

METHODOLOGY

This was a mixed methods study using both quantitative survey instruments and qualitative responses to attain breadth and depth of perspectives on gender bias, self-efficacy, coping strategies, and career aspirations among female STEM undergraduates in Pakistan. The sample was recruited among female students of STEM-fields in various universities, and stratified random sampling was chosen based on the age groups, academic status and faculties. The study received a total of 250 respondents which falls within acceptable count of respondents within the social sciences. The research material was based on the use of a structured questionnaire with four major sections, namely, perceptions of gender bias, self-efficacy and confidence, coping strategies and support, and institutional support of career development. The majority of questions have been asked in five-point Likert scales, whereas open questions provide the respondents with the opportunity to give their qualitative reflections. Ethical considerations were met by informing the subjects about the study, keeping the information confidential and anonymous, and the fact that participation was voluntary. The quantitative data were examined via descriptive statistics that were used to summarize trends and regressions, which include structural equation modeling (SEM) in situations where the necessity arises to establish the connection among the variables. Thematic coding of qualitative responses was done to elicit common patterns and experiences and the two strands of data were triangulated to ensure validity and to provide a comprehensive insight on how female students are affected by gender bias in self-efficacy and aspirations in STEM.

RESULTS AND ANALYSIS

Demographic Profile of Respondents

The study focused exclusively on female undergraduate students enrolled in STEM programs at Pakistani universities. A total of 250 respondents participated, providing valuable insights into how gender bias and self-efficacy shape women's aspirations and confidence in STEM careers. Table 1 presents the age distribution of the respondents, which offers a clear understanding of the demographic makeup of the sample.

Table 1: Demographic Profile of Respondents

		N	%
Age	Below 25 Years	191	76.4%
	26 - 30 Years	40	16.0%
	31 - 35 Years	19	7.6%
	Total	250	100.0%

Table 1 demonstrates that the vast majority of survey participants (76.4%) were younger than 25, which indicates the demographic of participants currently being at the initial stages of higher education. This is expected since most universities in Pakistan are attracting very young students especially those who have just come out of secondary school programs. The second-largest group of 16 percent of respondents belonged to the 26 30 age group, implying that there was the presence of older students who may have drawn academic hiatus, studied along professional or family demands, or joined higher education at a more advanced age as compared to their counterparts. A further third (33.8%) were between the ages of 36 and 40, indicating a significant number of mature students who might have re-entered the academic realm to promote their careers or to diversify their skills. The age diversity of the respondents makes the study stronger as it introduces the opinions of both old and young students to the study bringing the results closer to answering the problem under inquiry.

Gender Bias and STEM Aspirations

This section will look at the connection between gender bias and the future STEM plans of the female undergraduate students at the Pakistani universities. Employing correlation and regression techniques, the results demonstrate how gender prejudice, coping mechanisms, institutional factors, and self-efficacy interrelate to reflect their effects on academic confidence and career ambitions. These findings offer an overall picture of the impacts of both individual and structural factors on the experience of women in STEM, revealing how gendered experiences interrelate with confidence and institutional contexts.

Table 2: Correlations

		Gender Bias and STEM Aspirations	Factors Influencing Gender Bias	Coping Strategies and Support Systems	Relationship between Gender Bias and Students' Self-Efficacy	Relationship between Gender Bias and Students' Confidence
Gender Bias and STEM Aspirations	Pearson Correlation	--				
	N	250				
Factors Influencing Gender Bias	Pearson Correlation	.918**	--			
	Sig. (2-tailed)	.000				
	N	250	250			
Coping Strategies and Support Systems	Pearson Correlation	.874**	.782**	--		
	Sig. (2-tailed)	.000	.000			
	N	250	250	250		
Relationship between Gender Bias and Students' Self-Efficacy	Pearson Correlation	.891**	.882**	.781**	--	
	Sig. (2-tailed)	.000	.000	.000		
	N	250	250	250	250	
Relationship between Gender Bias and Students' Confidence	Pearson Correlation	.826**	.744**	.672**	.821**	--
	Sig. (2-tailed)	.000	.000	.000	.000	
	N	250	250	250	250	250

**. Correlation is significant at the 0.01 level (2-tailed).

Table 2 presents Pearson correlation coefficients among the five study variables. The results show that Gender Bias and STEM Aspirations are strongly and positively correlated with Factors Influencing Gender Bias ($r = .918$, $p < .01$), suggesting that institutional and cultural factors significantly contribute to shaping STEM choices. Similarly, there is a high correlation with Self-Efficacy ($r = .891$, $p < .01$) and Coping Strategies ($r = .874$, $p < .01$), indicating that students who perceive greater gender bias also tend to reflect more deeply on their self-belief and employ coping mechanisms. The correlation with Confidence ($r = .826$, $p < .01$) also supports this pattern, reinforcing that gender bias is closely associated with diminished or fluctuating levels of academic confidence. All correlations are statistically significant at the 0.01 level, highlighting the robustness of these relationships.

Table 3: Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.966[a]	.933	.931	.29362

a. Predictors: (Constant), Relationship between Gender Bias and Students' Confidence, Coping Strategies and Support Systems, Factors Influencing Gender Bias, Relationship between Gender Bias and Students' Self-Efficacy

Table 3 reports the regression model summary, where Gender Bias and STEM Aspirations were analyzed as the dependent variable. The model yielded an R value of .966, with an R^2 of .933, meaning that 93.3% of the variance in Gender Bias and STEM Aspirations is explained by the predictors: confidence, coping strategies, factors influencing gender bias, and self-efficacy. The adjusted R^2 (.931) further confirms the model's stability, while the standard error of estimate (.29362) indicates a high degree of accuracy in the model's predictive capability. These findings strongly suggest that the combined influence of confidence, self-efficacy, institutional factors, and coping strategies accounts for the vast majority of variation in how gender bias shapes female STEM aspirations.

Table 4: ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	291.873	4	72.968	846.350	.000[b]
	Residual	21.123	245	.086		
	Total	312.996	249			

a. Dependent Variable: Gender Bias and STEM Aspirations
b. Predictors: (Constant), Relationship between Gender Bias and Students' Confidence, Coping Strategies and Support Systems, Factors Influencing Gender Bias, Relationship between Gender Bias and Students' Self-Efficacy

Table 4 provides the ANOVA results, testing the overall significance of the regression model. The F-statistic of 846.350 ($p < .001$) indicates that the model is statistically significant, confirming that the set of independent variables reliably predicts Gender Bias and STEM Aspirations. The large regression sum of squares (291.873) compared to the residual (21.123) shows that the model explains a substantial portion of the variance, validating the strong predictive power highlighted in the model summary. In practical terms, this implies that female students' STEM aspirations are not determined by isolated factors but rather by an integrated combination of bias, self-efficacy, confidence, and support systems that collectively reinforce or undermine their academic and career pathways.

Factors Influencing Gender Bias

Understanding the factors that influence gender bias in STEM education is essential for identifying how structural, cultural, and individual-level variables shape the experiences of female undergraduates. In this study, particular attention was given to the relationship between bias and other constructs such as aspirations, self-efficacy, confidence, age, and coping strategies. Through correlation and regression analysis, the results provide clear evidence that both psychological resources and demographic factors significantly shape the way gender bias is perceived and internalized.

Table 5: Correlations

		Factors Influencing Gender Bias	Gender Bias and STEM Aspirations	Relationship between Gender Bias and Students' Self-Efficacy	Relationship between Gender Bias and Students' Confidence
Factors Influencing Gender Bias	Pearson Correlation	--			
	N	250			
Gender Bias and STEM Aspirations	Pearson Correlation	.918**	--		
	Sig. (2-tailed)	.000			
	N	250	250		
Relationship between Gender Bias and Students' Self-Efficacy	Pearson Correlation	.882**	.891**	--	
	Sig. (2-tailed)	.000	.000		
	N	250	250	250	
Relationship between Gender Bias and Students' Confidence	Pearson Correlation	.744**	.826**	.821**	--
	Sig. (2-tailed)	.000	.000	.000	
	N	250	250	250	250

**. Correlation is significant at the 0.01 level (2-tailed).

Table 5 displays the correlations between factors influencing gender bias and other major study variables. The results reveal a very strong and significant positive correlation with Gender Bias and STEM Aspirations ($r = .918$, $p < .01$). This implies that the more pronounced gender bias is in academic settings, the stronger its association with limiting or shaping female students' aspirations within STEM fields. Similarly, a significant and strong positive correlation with Self-Efficacy ($r = .882$, $p < .01$) highlights that gender bias is directly tied to how students perceive their own competence and ability to succeed in STEM. In addition, the link between factors influencing gender bias and Confidence ($r = .744$, $p < .01$) is moderately strong, suggesting that while confidence is affected by bias, the effect is not as extensive as with aspirations or self-efficacy. Collectively, these results emphasize that gender bias is not merely an external obstacle but a force that penetrates deeply into the psychological and motivational frameworks of female undergraduates, thereby influencing their academic pathways and career planning.

Table 6: Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.796[a]	.634	.631	.68411

a. Predictors: (Constant), Coping Strategies and Support Systems, Age

Table 6 presents the regression model using age and coping strategies as predictors of factors influencing gender bias. The model reports an R value of .796 and an R^2 of .634, meaning that approximately 63.4% of the variance in gender bias perceptions can be explained by the combined effect of coping strategies and age. The adjusted R^2 (.631) confirms the model's stability, with only a marginal reduction when adjusted for population representation. This finding underscores that both demographic characteristics (age) and personal resources (coping mechanisms) substantially shape the way female students interpret and experience gender bias. Moreover, the standard error of .68411 indicates an acceptable level of prediction accuracy. These results point toward the necessity of interventions that strengthen coping strategies while also acknowledging generational or age-related differences in the way gender bias is internalized.

Table 7: Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients		
		B	Std. Error	Beta	t	Sig.
1	(Constant)	-.026	.174		-.152	.879
	Age	.281	.072	.151	3.919	.000
	Coping Strategies and Support Systems	.935	.046	.791	20.520	.000

a. Dependent Variable: Factors Influencing Gender Bias

Table 7 outlines the coefficients of predictors for factors influencing gender bias. The results show that Coping Strategies and Support Systems are the strongest predictor ($\beta = .791$, $p < .001$), indicating that students who have access to effective coping mechanisms—such as peer networks, mentoring opportunities, or institutional support—are better able to frame and respond to experiences of bias. At the same time, Age also emerges as a significant predictor ($\beta = .151$, $p < .001$), suggesting that older students tend to recognize and articulate gender bias more clearly than younger ones, possibly due to prolonged exposure to academic and social environments. The constant term is non-significant, highlighting that the predictors are essential in explaining the variance. Taken together, these coefficients confirm that the experience of gender bias is both situational and developmental: it is shaped by the availability of support systems and the life stage of the individual.

Coping Strategies and Support Systems

There are protective effects of coping mechanisms and sources of support with regard to gender bias and students' academic performance, as well as psychological health. In the specific area of female STEM-student undergraduates, alleviating stressors specifically related to discrimination will proved beneficial in and of itself as sources of resilience, motivation, and persistence in academic pursuit are also produced. Correlation and regression were used to determine their impact and how they related to psychological aspects such as self-efficacy along with confidence, since the two are connected to academic success.

Table 8: Correlations

		Coping Strategies and Support Systems	Relationship between Gender Bias and Students' Self-Efficacy	Relationship between Gender Bias and Students' Confidence
Coping Strategies and Support Systems	Pearson Correlation	--		
	N	250		
Relationship between Gender Bias and Students' Self-Efficacy	Pearson Correlation	.781**	--	
	Sig. (2-tailed)	.000		

	N	250	250	
Relationship between Gender Bias and Students' Confidence	Pearson Correlation	.672**	.821**	--
	Sig. (2-tailed)	.000	.000	
	N	250	250	250

**. Correlation is significant at the 0.01 level (2-tailed).

Table 8 depicts correlations between the dependent core variables self-efficacy and confidence and coping strategies. The results show that there is a strong positive association with self-efficacy ($r = .781$, $p < .01$) meaning that such effective coping mechanisms as mentorship, family encouragement and peer support, have significant positive impact on enhancing the belief of female students about their ability to succeed in STEM. This underlines the fact that self-efficacy which is largely marred by gender bias can be revived and sustained by stable social and institutional support. Additionally, coping strategies demonstrate a moderately strong positive correlation with confidence ($r = .672$, $p < .01$), suggesting that when students have access to supportive systems, they feel more comfortable expressing opinions, engaging in class discussions, and navigating male-dominated academic spaces. Interestingly, the correlation between self-efficacy and confidence themselves is very high ($r = .821$, $p < .01$), underscoring the interdependence of these two constructs. Together, the correlations confirm that coping strategies act as a protective factor, allowing female undergraduates to resist the detrimental impact of bias while maintaining both confidence and self-efficacy.

Table 9: Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.781[a]	.610	.608	.64388

a. Predictors: (Constant), Coping Strategies and Support Systems

The regression model in Table 9 examines the predictive strength of coping strategies on self-efficacy. The model yields an R value of .781 and an R^2 of .610, indicating that 61% of the variance in self-efficacy can be explained by coping strategies alone. This is a substantial effect size, demonstrating that coping mechanisms are not peripheral but central to shaping how female students perceive their academic competence in STEM. The adjusted R^2 (.608) further supports the reliability of the model, with minimal shrinkage. The standard error (.64388) is within acceptable limits, confirming that the regression model produces consistent and stable results. These findings reinforce the idea that self-efficacy is highly dependent on the quality and availability of coping resources, such as guidance from role models, emotional reassurance from family, and institutional safety nets like counseling or mentorship programs.

Table 10: Coefficientsa

Model		Unstandardized Coefficients		Standardized Coefficients		
		B	Std. Error	Beta	t	Sig.
1	(Constant)	.491	.132		3.718	.000
	Coping Strategies and Support Systems	.842	.043	.781	19.680	.000

a. Dependent Variable: Relationship between Gender Bias and Students' Self-Efficacy

Table 10 Model coefficients for predicting How much coping predicts SE. Standardized beta for coping =. 781 (p <. 001) and a strong predictive effect was revealed (significant). This finding means a one unit increase in coping support will result in an increase of self-efficacy for students towards STEM skills.

The intercept (. 491, p <. 001; so past research on coping matters, but not by much if you also account for support mechanisms. It also furnishes a practical demonstration that institutionally-based initiatives, for example in mentoring women, creating networks of women-in-STEM or making counselling services available are likely to have an impact on self-efficacy which will mitigate the influence of gender bias. Finally, the coefficients also demonstrate that training strategies are not only yet another predictor of psychological resilience in women students who take STEM programs but its most important determinant.

Gender Bias and Self-Efficacy

Self-efficacy represents a very important psychological asset, which predetermines ways in which students judge that they may succeed in combating difficult academic situations. Gender bias in STEM usually undermines self-efficacy by provoking damaging stereotypes, withholding resources, and promoting exclusive forms of practice. At this point, the correlation between gender bias and self-efficacy among female undergraduates is discussed with the correlation and regression analysis described to determine whether biases and related abilities influence self-efficacy of students in their academic life.

Table 11: Correlations

		Relationship between Gender Bias and Students' Self-Efficacy	Gender Bias and STEM Aspirations	Factors Influencing Gender Bias	Coping Strategies and Support Systems
Relationship between Gender Bias and Students' Self-Efficacy	Pearson Correlation	--			
	N	250			
Gender Bias and STEM Aspirations	Pearson Correlation	.891**	--		
	Sig. (2-tailed)	.000			
	N	250	250		
Factors Influencing Gender Bias	Pearson Correlation	.882**	.918**	--	
	Sig. (2-tailed)	.000	.000		
	N	250	250	250	
Coping Strategies and Support Systems	Pearson Correlation	.781**	.874**	.782**	--
	Sig. (2-tailed)	.000	.000	.000	
	N	250	250	250	250

**. Correlation is significant at the 0.01 level (2-tailed).

Table 11 provides the correlation of self-efficacy with the other significant study variables. The findings demonstrate a very close positive relationship between gender bias and STEM aspirations ($r = .891$, $p < .01$), and this indicates that opportunities to manifest greater degrees of gender inclusivity in STEM subjects have a significant contribution to student self-efficacy. Self-efficacy also correlates strongly with gender bias factors ($r = .882$, $p < .01$) suggesting that there is a direct relationship between the structural aspects like the curriculum design and the attitude of teachers and student beliefs about their academic abilities. The support systems and coping strategies are as well highly positively correlated (r = .781, p <. 01) and this goes to show that support systems act as an anti- buffer to the bad effects of gender bias. All of these findings go to show that self-efficacy is highly correlated with both institutional and individual variables, which supports the idea that gender dimension in STEM education is a complex issue.

Table 12: Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.906[a]	.821	.819	.43799

a. Predictors: (Constant), Coping Strategies and Support Systems, Factors Influencing Gender Bias, Gender Bias and STEM Aspirations

Model testing the predictive validity of gender bias, coping strategies, etc., on self-efficacy are presented in Table 12. The model also fits well in its R =. 906 and R^2 =. 821, which means that 82.1 percent of the variation in self-efficacy is explained by the predictors in the model. This is mind-blowingly potent and it is evidence that gender bias, support structures and structural factors have a very strong interrelationship which contributes to shaping what students think their capabilities are. The shrinkage is small with an adjusted R^2 (. 819), suggesting the robustness of the model. The prediction strength of the model was relatively high (SE=. 43799. Our results suggest, however, that self-efficacy in female STEM undergraduates is not independent, but rather the effect of contextual factors such as prejudice, aspirations and institutional cultures.

Table 13: Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients		
		B	Std. Error	Beta	t	Sig.
1	(Constant)	.389	.095		4.111	.000
	Gender Bias and STEM Aspirations	.432	.080	.471	5.364	.000
	Factors Influencing Gender Bias	.379	.062	.416	6.074	.000
	Coping Strategies and Support Systems	.048	.060	.045	.799	.425

a. Dependent Variable: Relationship between Gender Bias and Students' Self-Efficacy

Table 13 shows that the predictive power of each indicator can be investigated. Both STEM aspirations and gender bias (beta =. 471, p <. 001) and gender bias mediators (beta =. 416, p <. 001) emerge as strong and significant predictors of self-efficacy. These results indicate that addressing gender stereotypes, neutralizing curriculum biases, and enhancing equal practice will powerfully contribute to the development of beliefs in students about their potential. Strikingly also, there is only a relationship between coping as well as support systems (β of. 045, p =. 425), although it was not statistically significant in this model. It seems, therefore, that support mechanisms, whilst always positive, have little in the way of influence per se upon self-efficacy once stronger structural factors such as institutional racism and academic aspirations are held constant at the same time. The findings also suggest that systemic gender bias, rather than specific coping strategies, is the variable most likely to predict gains in self-efficacy.

Gender Bias and Confidence

Confidence personifies the readiness of the students to communicate, discuss, and engage in learning of STEM subjects. A gender aspect is really sensitive to prejudice because all the stereotypes and the impacts of subtle forms of exclusion may damage their self-belief. This section examines the association between gender bias and confidence in female undergraduates, with the help of correlation and regression analysis with a view to identifying the bearing of structural and personal aspects.

Table 14: Correlations

		Relationship between Gender Bias and Students' Confidence	Gender Bias and STEM Aspirations	Factors Influencing Gender Bias	Coping Strategies and Support Systems
Relationship between Gender Bias and Students' Confidence	Pearson Correlation	--			
	N	250			
Gender Bias and STEM Aspirations	Pearson Correlation	.826**	--		
	Sig. (2-tailed)	.000			
	N	250	250		
Factors Influencing Gender Bias	Pearson Correlation	.744**	.918**	--	
	Sig. (2-tailed)	.000	.000		
	N	250	250	250	
Coping Strategies and Support Systems	Pearson Correlation	.672**	.874**	.782**	--
	Sig. (2-tailed)	.000	.000	.000	
	N	250	250	250	250

**. Correlation is significant at the 0.01 level (2-tailed).

Table 14 demonstrates the correlations between confidence and other variables. The results reveal a very strong positive correlation between confidence and gender bias and STEM aspirations ($r = .826, p < .01$), suggesting that when students perceive reduced bias and more equitable opportunities, their confidence to pursue STEM majors rises considerably. Confidence is also moderately to strongly correlated with factors influencing gender bias ($r = .744, p < .01$), which reflects the role of curriculum and teacher attitudes in shaping how comfortable students feel in expressing themselves. Similarly, coping strategies and support systems are significantly correlated with confidence ($r = .672, p < .01$), highlighting that family, mentorship, and peer support play a meaningful role in sustaining academic self-assurance. Overall, the correlations confirm that confidence does not exist in isolation but is strongly influenced by gender inclusivity in the academic environment.

Table 15: Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.833[a]	.694	.691	.43065

a. Predictors: (Constant), Coping Strategies and Support Systems, Factors Influencing Gender Bias, Gender Bias and STEM Aspirations

The regression model in Table 15 provides evidence of the collective predictive power of gender bias, structural influences, and coping strategies on confidence. The model explains a substantial portion of variance, with an R value of .833 and R^2 of .694, indicating that 69.4% of the variation in confidence can be explained by the combined predictors. The adjusted R^2 (.691) suggests strong model stability, while the standard error of .43065 confirms a reliable prediction accuracy. These findings highlight that confidence among female STEM students is shaped by a combination of institutional bias, aspirations, and available support, reinforcing the need for comprehensive interventions.

Table 16: Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients		
		B	Std. Error	Beta	T	Sig.
1	(Constant)	1.673	.093		17.998	.000
	Gender Bias and STEM Aspirations	.777	.079	1.125	9.822	.000
	Factors Influencing Gender Bias	-.080	.061	-.116	-1.298	.195
	Coping Strategies and Support Systems	-.179	.059	-.221	-3.031	.003

a. Dependent Variable: Relationship between Gender Bias and Students' Confidence

Table 16 presents the detailed contribution of each predictor to confidence. Among them, gender bias and STEM aspirations emerge as the strongest positive predictor ($\beta = 1.125$, $p < .001$), showing that when students feel supported in their academic ambitions, their confidence is substantially enhanced. In contrast, factors influencing gender bias ($\beta = –.116$, $p = .195$) are not statistically significant, suggesting that these structural barriers may not directly diminish confidence once other variables are controlled. Interestingly, coping strategies and support systems show a negative effect ($\beta = –.221$, $p = .003$). This counterintuitive finding implies that reliance on external coping mechanisms may sometimes reflect underlying challenges in confidence; students who need stronger coping mechanisms may already be experiencing greater bias-related pressures. This result underscores the importance of addressing root causes of gender bias rather than solely focusing on individual coping strategies.

Integrated Analysis

This last segment merges the various aspects of the gender bias- the STEM aspirations, structural factor, coping behaviors, self-efficacy and confidence into a unifying framework. This analysis will be aimed at specifying how all these variables interrelate to explain the aspirations of females' students studying STEM, as well as to identify which variables will be associated with significant, joint contribution to the outcome.

Table 17: Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.966[a]	.933	.931	.29362

a. Predictors: (Constant), Relationship between Gender Bias and Students' Confidence, Coping Strategies and Support Systems, Factors Influencing Gender Bias, Relationship between Gender Bias and Students' Self-Efficacy

Table 17 presents the regression model for the integrated analysis. The model yields an R value of .966 and R^2 of .933, meaning that 93.3% of the variance in gender bias and STEM aspirations is explained by the combined predictors. This exceptionally high explanatory power underscores that gender aspirations are not shaped by isolated factors, but by the interplay of structural influences, coping strategies, confidence, and self-efficacy. The adjusted R^2 (.931) demonstrates strong model reliability, while the standard error of .29362 indicates a high degree of accuracy in predicting outcomes. Taken together, this model validates the conceptual framework that gender bias is a multifaceted phenomenon, requiring multi-level interventions.

Table 18: Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	-.810	.083		-9.807	.000
	Factors Influencing Gender Bias	.432	.037	.434	11.658	.000
	Coping Strategies and Support Systems	.394	.033	.335	11.946	.000
	Relationship between Gender Bias and Students' Self-Efficacy	.061	.046	.056	1.323	.187
	Relationship between Gender Bias and Students' Confidence	.335	.042	.231	7.908	.000

a. Dependent Variable: Gender Bias and STEM Aspirations

Table 18 details the unique contribution of each predictor. Among the variables, factors influencing gender bias stand out as the strongest predictor ($\beta = .434$, $p < .001$), confirming that structural and institutional conditions such as teacher attitudes, curriculum content, and societal norms are central to shaping STEM aspirations. Coping strategies and support systems ($\beta = .335$, $p < .001$) also play a substantial role, suggesting that access to peer, family, and institutional resources can buffer against the negative effects of bias. In contrast, the relationship between gender bias and self-efficacy ($\beta = .056$, $p = .187$) is not statistically significant when the other factors are accounted for. This indicates that while self-efficacy is important in bivariate relationships, its independent effect diminishes in a multivariate framework—likely because self-efficacy is itself influenced by structural conditions and confidence. Finally, confidence emerges as a significant predictor ($\beta = .231$, $p < .001$), reaffirming that students' comfort in voicing opinions and engaging in academic spaces directly supports their STEM aspirations.

The integrated model highlights three key insights. First, institutional and cultural factors remain the most decisive influences, underscoring the need for structural reforms in curriculum and teaching practices. Second, support systems operate as a critical mediating layer, enhancing resilience and offering protective mechanisms for students navigating bias. Third, while self-efficacy is vital at the individual level, its role becomes less direct once broader structural and social factors are considered. This suggests that interventions targeting confidence-building and reducing systemic bias may have a more immediate effect on shaping STEM trajectories than self-efficacy alone.

Qualitative Analysis

The qualitative answers also gave valuable ideas about how students perceive gender bias and how the institution should be reformed. There was also a commonality in the importance of training and workshops in dealing with unconscious bias, which most women considered the initial step in the process of changing attitudes within universities. Some respondents indicated that such training should be applied not only on students but also on faculty and staff since their actions and classroom activities tend to be aiding in stereotyping. The jerk and jolt of Workshops and sensitivity cum orientation campaign for faculty, points to reform as something not one time act as far as the instructors are concerned.

A second key theme was the necessity for systemic change beyond universities. Some participants had the opinion that it should begin from home but another participant shared a more personal story stating that society itself has to change because the fundamental unit of society is the individual. This viewpoint highlights that, the actions in education alone are insufficient and need to re-enforced with culture shift at the family or societal level. Additionally, participants consistently discussed representativeness of different groups on curricula and that resources and support for underrepresented groups should be key in fostering inclusivity and role modelling.

Finally, the students emphasized the need for policies and accountability frameworks. The need for anti-bias policy, mentoring potential, peer support networks and dedicated campus resources were not surprising. Yet others were simply frustrated about system-level structures that should be monitored independently in the evaluation and examination process. Together, these themes illustrate that participants sense that gender bias is rampant but they are not hopeless -- they present a plan of interventions -- trainings, policies, and representation + wide spread societal change--to transform how women students and beginners come to experience confidence, self-efficacy and dream in areas of science.

DISCUSSION

The findings of this study lend strong support to the argument that gender bias factors heavily in whether students form STEM aspirations, as it has in Western and Asian countries. The close relationship between institution and culture to STEM disciplines are evident in the UK, where Archer et al. (2013) suggested that gender stereotypes restricted the extent of women's exploitation. In the same vein, Wang and Degol (2017) in China found that women's career decision-making were influenced by social expectations of what the appropriate jobs for them was despite having the capacity. The present study contributes to this global discussion by showing that in South Asia, cultural norms and teacher attitudes and limited female representation – 'when women are involved' – matter for shaping aspirations. In the integrated model, however, our findings have revealed that the R 2 of 93.3% role of gender bias is much more systemic than this in the sense that aspiration is rarely its result of idiosyncratic individual causes but as blips on the screen embedded in a long-standing trend. This is consistent with the Social Cognitive Career Theory that assumes specific contextual determinants of career-related self-efficacy and outcome expectations (Lent et al., 1994).

Interest is the diminished role of self-efficacy when being conditioned on structural factors. However, the bivariate correlation between self-efficacy and STEM aspirations was substantial (r =. 891), but in the multivariate model, the latter is no longer significant (beta =. 056, p =. 187). This implies that there may be a mediating rather than a predicting role of self-efficacy. This is similar to the research in India and Pakistan where female students expressed a high degree of confidence academically despite being in a constrained environment but were not able to successfully translate this performing well over time within STEM due to cultural and non-beneficial institutional barriers (Aslam, 2018; Halai, 2019). Similarly, Zeldin and Pajares (2000) reported that the self-efficacy of women in STEM options was, more often than not, a function of mentors and role models who encouraged them to engage in such careers and therefore assumed some type of environment-based quality. Thus, this study helps make the case that self-efficacy-focused interventions may not be effective if administered in isolation from systemic interventions aimed at countering curriculum, teaching or sociopolitical bias.

Another critical aspect of gender bias that tangentially emerges from this study is the influence of coping and support systems in mitigating it. Results revealed a powerful predictor of coping strategies (β =. 335, p <. 001) so that students with activated support from peer networks, family support and institutional support significantly more likely to maintain STEM aspiration. This is supported by observation from Bangladesh where Ferdous and Kabir (2021) observed that female engineering students resorted to peer solidarity with peers, informal mentoring as forms of resistance to gendered exclusion inside classrooms. Also, Al-Harthi (2014) in Middle East who found through study that women networks at campus level assisted students to persist into male dominated academic programs among others. They provide additional evidence in favor of Bandura (1997)'s article on the role of self-regulation and external reinforcement on performance, and persistence. The present study goes a step ahead and empirically focuses on the same relationship in South Asian setting suggesting that coping strategies are not simply additions to, but integral for aspiration survival points (Javed & Karim, 2024). This has far-reaching impact on policy because it is an appeal to the universities and ministries to formalize mentorship programs, expand women resource centers, and establish safe spaces where female students can publicly question the stereotypes without feeling threatened of being marginalized.

CONCLUSION

The current study was conducted in order to determine the role of gender bias in shaping college aspirations of female students in the context of Pakistani universities and the extent to which structural factors, coping resources, and self-efficacy have an interactive impact on shaping career pursuits. Based on the research questions, the analysis aimed to learn whether and how gendered stereotypes, institutional practices, and societal norms influence the decisions to pursue STEM; what degree of coping mechanisms and support systems help counteract those effects; and how self-efficacy becomes both a consequence and mediator of bias. These findings showed an obvious tendency: gender bias has a high correlation with diminished STEM aspirations, and the trends are higher than .90 in certain instances, and it manifests in numerous forms, including stereotypes, exclusionary attitudes of educators, cultural expectations, and the absence of female role models. Noteworthy, although self-efficacy was a strong predictor of STEM aspirations in simple regressions, it became less predictive in multivariate logistic regression as wider societal- and institutional trends were held constant implying that even self-reported confidence in one own ability as a student may not be sufficient to overcome systemic obstacles. Motivational support systems such as mentorship, family support, and peer support were influential in countering these challenges and staying motivated, also in line with international evidence in the United Kingdom, South Asia, and China, but providing a new source of quantitative measurement in the Pakistani experience. Together, they add to the body of knowledge by proving that self-efficacy is less of an isolated psychological resource but more of a dynamic mechanism whose enablers or inhibitors are largely systemic rather than individual-level attributes, thereby generalizing the scientific explanations of self-efficacy as proposed by Bandura on social cognitive theory, and Lent, Brown, and Hackett on social cognitive career theory into a South Asian context. From a policy perspective the findings imply that not only should universities and ministries invest in curricular reform and gender-sensitive pedagogy, but also institutionally-endorsed support for mentorship programs; women resource centers; outreach campaigns aimed at changing stereotypes will make available increased spaces for contestations to occur with regard to how women can take their place in STEM. Socially Speaking, what is very listen/argue/believable in this paper is the reframing of cultural discourses that filter through to close off woman space from science and technology – even if you are capable/interested. This work has always been the case and remains to be as such: that gender justice in HE will not happen through empowerment of individuals – they need to be empowered within a system that remains in need of educational, cultural and policy change. In conclusion, it is clear that a reconsideration of what Pakistani universities are supposed to stand for and provide female students – as bastions of inclusivity were female students should be able to study STEM without having to spend time providing disconfirming stereotype is urgently needed; the long-term aim of this being that we build a fairer educational system in Pakistan which does not waste at least half of its human capital trying to develop itself so each country needs.

RECOMMENDATIONS

- **Curriculum Review and Revision:** Integrate gender-sensitive content in STEM curricula to eliminate bias.
- **Faculty Training:** Conduct workshops to raise awareness of unconscious gender bias and promote inclusive teaching.
- **Strengthen Mentorship Programs:** Establish mentorship programs connecting female students with role models in STEM.
- **Create Supportive Environments:** Develop resource centers offering counseling, peer networks, and academic support.
- **Public Awareness Campaigns:** Launch initiatives to challenge gender stereotypes and encourage females in STEM.
- **Policy Development:** Enforce gender equality policies ensuring equal opportunities for female students in STEM.
- **Promote Family and Peer Support:** Encourage family support for female students in STEM and foster peer networks.
- **Increase Female Representation:** Highlight female role models and achievements in STEM through textbooks and university events.
- **Long-Term Cultural Change:** Implement cultural reforms in universities and society to address gender biases.
- **Evaluation of Support Mechanisms:** Regularly assess and improve support programs to meet the needs of female STEM students.

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