

Gender Disparities and Female Performance in Physics: A Case Study Examination

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Abstract: This study investigated the factors influencing female students' academic success in Physics and examined gender differences in performance at Navrongo Senior High School. Using an explanatory sequential mixed-method design, the research combined qualitative interviews with quantitative analysis of standardized Physics test scores. Quantitative results showed that although female students slightly outperformed their male counterparts (mean scores of 70.6 and 69.7, respectively), the difference was not statistically significant ($t = -0.36$, $p = 0.717$, Cohen's $d = -0.066$). This finding suggests that gender alone does not determine performance in Physics. Qualitative findings highlighted the critical role of effective study habits, positive attitudes toward Physics, classroom participation, teacher support, and peer collaboration in achieving academic success. Female students particularly emphasized the importance of an inclusive and supportive classroom environment that fosters confidence and engagement in a traditionally male-dominated field. The study challenges stereotypes about girls' participation in Physics and underscores the influence of social relationships, teaching strategies, and personal motivation on achievement. It concludes that promoting female success in Physics requires collective efforts centered on inclusive practices, responsive teaching, and sustained encouragement. The study recommends promoting structured study habits, improving students' perceptions of Physics through positive messaging, enhancing engagement, and expanding experiential learning opportunities to support equitable achievement.

Keywords: Performance, Female, Disparity, Self-Efficacy, Stereotype, Peers, Gender

I. Introduction

Despite the vital role females play in the socioeconomic development of a nation, they remain marginalized in performance and access to education, most especially in Physics in developing countries (Beroiza-Valenzuela and Salas-Guzmán, 2024). According to the 2024 UNESCO report (Changing the Equation: securing STEM futures for women), women hold just 22% of science, technology, engineering and mathematics (STEM) jobs in G20 countries, with only one in ten ascending to leadership positions (UNESCO, 2024). This gender gap not only discourages female participation but has 'profound human rights implications for Physics economic advancement' (Lee and Pollitzer, 2016).

Marah and Ansah (2024) Affirmed that this tenacious marginalization is attributed to factors such as 'systemic barriers, financial challenges, cultural influences, encouragement, exposure to Physics, and positive mindset'. Also, sociocultural barriers, economic obstacles, and institutional biases were identified as the major setbacks to female performance in Physics (Nazli and Noman 2023).

A systematic review conducted by Zúñiga-Mejías and Huinchahue (2024) underscores the existence of gender disparities within the education system. Their study revealed cultural and societal challenges that impact Physics education among learners. For instance, certain cultures frown towards educating females with claims that 'a woman's place is in the kitchen,' which is a misconception that influences their perception about female education (Packham, 2016). To this end, Pathak (2022) maintains that 'cultural misconceptions' are evidence of low female participation and performance in Physics. Moreover, society plays a very critical role in female Physics performance since societal attitudes, such as gender stereotyping and biases, negatively influence female interest and choice in Physics education (Dernadeta et al., 2022; Pathak, 2022; Perera et al., 2024).

Furthermore, economic factors such as financial limitations influence female interest and performance in Physics (Marah and Ansah, 2024; Onyebuchi Nneamaka Chisom et al., 2024). The practical nature of Physics education requires more sophisticated material resources, which usually poses undue pressure on governments, parents, institutions and other stakeholders in the provision of these materials. But due to financial limitations and the preconceptions society has towards females in Physics education in general, there is a disparity in the kind of support females receive to excel in Physics (Nazil and Noman, 2023).

Gender disparities in Physics education are significantly influenced by institutional partiality, such as gender driven methodologies, biased institutional policy, institutional prejudice, and limited female STEM institutions have proven to be very influential in determining female participation in STEM fields (Owuondo, 2023). Onyebuchi Nneamaka Chisom et al., (2024) Asserts that teaching and learning innovations and technological integration in Physics education show significant potential for female advancement in STEM, most especially in Physics education.

There are several factors which militate against the effective participation and performance of females in Physics, which are classified into three broad categories: sociocultural, economic and institutional factors, which are further grouped as internal and external factors based on the tenacity of this study. This study explores the existence of gender disparities in Physics performance and confirms the existence of both internal and external factors that affect female performance in Physics. In mitigating the

existing disparity, this study proposes a cyclopedic strategy that entails ‘shifting attitudes, securing financial independence for women, and incorporating gender-sensitive regulations to establish an unbiased and all-inclusive education system’ (Nazli and Noman 2023).

The problem of female underperformance in Physics is multifaceted, involving a combination of educational, psychological, and social factors. These factors contribute to a persistent gender gap in Physics achievement and participation, which is evident from secondary education through to university levels (Beroíza-Valenzuela & Salas-Guzmán, 2024; Quarshie et al., 2023). Understanding these factors is crucial for developing effective interventions to improve female performance in Physics.

Maguswi (2012) indicated that inadequate funding, lack of qualified teaching staff, and insufficient laboratory equipment are significant barriers to effective physics education for females in Zambia. Akweya (2015) added that the effectiveness and efficiency of physics teachers, particularly in girls' schools, play a crucial role in shaping female students' performance in Physics (Akweya, 2015). Despite these education-related factors, psychological and social factors also persist. In this vein, Marchand identified stereotype threat as one hidden psychological factor that subverts female achievement in physics. They are of the view that the presence of stereotype threat can negatively impact female students' performance in physics. Studies show that when stereotype threat is nullified, female performance improves significantly (Marchand & Taasoobshirazi, 2013b). Moreover, Barthelmy et al. (2023) opined that Physics Identity and Self-Efficacy influence performance in Physics. Female students often have lower physics identity and self-efficacy compared to their male counterparts, which affects their academic performance and persistence in physics courses (Bottomley et al., 2023). Last but not least, attitudinal and perceptual factors have influenced how females perceive Physics. Akweya (2015) again asserted that positive attitudes towards physics are linked to better performance. However, societal and educational influences often lead to negative perceptions of physics among female students (Akweya, 2015).

In spite of the fact that these factors highlight the challenges faced by female students in Physics, it is important to consider the broader educational context. Efforts to improve female performance in Physics should not only address these specific issues but also promote a more inclusive and supportive learning environment that encourages all students to pursue and excel in Physics, the tenets on which this study is based.

II. Literature Review

The factors influencing female performance in physics are intricate and multifaceted, encompassing psychological, social, educational, and cultural elements. Effectively addressing these factors necessitates a comprehensive approach that includes interventions aimed at enhancing self-efficacy, reducing stereotype threat, improving teaching methodologies, fostering inclusive departmental cultures, and considering intersectional identities. By understanding and tackling these influences, educators and policymakers can strive to create more equitable learning environments that support the success of all students in the field of Physics.

Constructivist Approach to Learning Physics and Female Performance

To effectively address the factors that affect female performance in physics, Bruner's Theory of Constructivism emerges as a relevant educational framework. This theory highlights the active role of learners in constructing their understanding and knowledge through experiences and interactions (Johnson, 2016). This approach aligns well with the factors identified in various studies. Constructivism advocates that learning is an active and contextual process of building knowledge rather than simply acquiring it (Chun, 2024). This perspective can be particularly effective in addressing the gender disparities observed in physics education.

Constructivism is vital for engaging female students in physics by emphasizing hands-on experiences and interactive learning environments, which can significantly enhance girls' attitudes and performance (Suryati et al., 2024). Effective teaching strategies rooted in constructivist principles, such as inquiry-based learning and critical thinking, can greatly influence female students' success in physics (Suryati et al., 2024). Educators have a pivotal role in inspiring confidence and interest in young women.

By providing opportunities for hands-on success, constructivism boosts self-efficacy, reduces test anxiety, and leads to improved performance (Stang et al., 2020). Constructivism highlights the importance of supportive environments. The Social Cognitive Perspective complements constructivism by addressing gender disparities, focusing on social and psychological factors that shape learning and identity in physics (Kelly, 2016).

Self-Efficacy, Confidence and Female Performance in Physics

An individual's belief in the ability to succeed in a specific task is a considerable factor influencing female performance in Physics. Studies have pointed out that females often report lower self-efficacy in Physics compared to their male counterparts, which can negatively impact their performance and persistence in the field (Henderson et al., 2020; Kalender et al., 2020b). Research suggests that self-efficacy is highly correlated with performance and success, career aspirations, and student persistence, particularly in Physics. (Henderson et al., 2020). Additionally, men and women evaluate their Physics self-efficacy differently, with women, on average, reporting lower self-efficacy toward Physics (Henderson et al., 2020).

The foregoing points out clearly that individuals' confidence and beliefs about learning greatly influence how they learn in Physics. Females most often report lower self-efficacy in Physics, which can negatively impact their performance as self-efficacy is found to highly correlate with performance, career aspirations and persistence in the field (Kalender et al., 2020a). This suggests a holistic approach to developing stronger belief systems in 'women in Physics' that will foster higher self-efficacy in females.

The Effects of Stereotyping on Female Performance in Physics

Ideally, everyone would enjoy the same opportunities to succeed, but they do not. The pathways to success in STEM careers are strewn with potholes and pebbles for women, while men benefit from more evenly paved and signposted routes (Rykers, 2016). Gender stereotypes are widely shared assumptions about the traits, behaviors, and roles of women and men (Dasgupta and Stout, 2014).

Stereotypes can be explicit (openly expressed) or implicit ("leaked out" unconsciously in spontaneous speech or body language). Barthelemy et al. and Gonsalves et al. illustrate that explicit and implicit stereotypes equating "real physicists" with men are prevalent within experimental physics communities in North America and Western Europe (Barthelemy et al., 2016; Gonsalves et al., 2016). The issue of gender bias is experienced across other groups like the Swiss, Austrian, and German, as indicated by Hofer. Her study results showed a consistent gender bias against girls early in teachers' careers, which diminished with experience for Swiss, Austrian, and German female teachers (Hofer, 2015).

For instance, Barthelmy et al. (2016) conducted interviews with 21 women in graduate physics and astronomy programs and analyzed the data gathered for their individual experiences of sexism. Although a subset of women did not report experiencing sexual discrimination, the majority experienced subtle insults and slights known as microaggressions (Barthelemy et al., 2016). One of the respondents in their study reported that:

"[An] international student asks why women in the US are called 'chicks.' People begin to give him direct answers, but he interrupts and says, 'I think it is because you like chickens for their legs. Not their brains.'" Everyone laughs (some with some trepidation) and looks at me to see my reaction. ... [I] felt quite singled out and embarrassed, in addition to feeling like I was somehow expected to defend myself, in addition to brushing it off."

The above excerpt points to the existence of sexual discrimination and microaggressions in Physics. They added that other participants also experienced more traditional hostile sexism in the form of sexual harassment, gender role stereotypes, and overt discouragement. These results indicate the existence of sexism in the current culture of physics and astronomy (Barthelemy et al., 2016).

Gonsalves et al (2016). revealed that, due to the sexual discrimination and microaggressions against females in Physics, women within male-dominated science and technology disciplines often position themselves as "one of the boys," thereby distancing themselves from a traditional femininity that is perceived as incompatible with doing science or engineering (Gonsalves et al., 2016). For example, their study 'Masculinities and experimental practices in physics: The view from three case studies' affirms this assertion from the interview excerpt from a female respondent in the study captured below:

"I like being among guys, I like that jargon and that attitude a lot of the time, I would be more nervous if it were only women. I've had a horse, you know. Only women in a stable. Not so easy, I can tell you."

Eaten et al. (2019) further clarified that faculty in physics exhibited a gender bias favouring the male candidates as more competent and more hireable than the otherwise identical female candidates. Further, physics faculty rated Asian and White candidates as more competent and hireable than Black and Latinx candidates (Eaton et al., 2020).

The effects of stereotyping on female performance in physics are significant and have many facets, primarily influenced by stereotype threat, societal perceptions, and media representation. Research indicates that negative stereotypes can hinder women's performance and self-efficacy in physics, contributing to the gender gap in this field (Marchand and Taasobshirazi, 2013a).

Stereotype threat occurs when individuals fear confirming negative stereotypes about their group, which can lead to decreased performance. In Marchand and Taasobshirazi's study, females exposed to stereotype threat conditions performed worse than those in a nullified condition, highlighting the detrimental impact of such threats on their physics performance (Marchand and Taasobshirazi, 2013b). The activation of stereotypes, such as asking students to indicate their gender before assessments, has been shown to exacerbate performance gaps, with females often underperforming compared to males under these conditions (Maries et al., 2018). Studies in other disciplines have also found that activation of a negative stereotype about a group, or stereotype threat, for example, asking test-takers to indicate their ethnicity, can lead to poorer performance of the stereotyped group (Maries, Karim and Singh 2019).

Ertl and Peachter (2017) also discovered that attributing girls' achievement to diligence instead of talent could serve as a stereotype threat, which influences their later performance in STEM. Their results also point out that direct support, particularly by parents, can have a negative influence on female students' self-concept. Activities meant to support pupils directly may backfire and reinforce stereotypes instead (Ertl and Peachter, 2017).

Porandia (2024) declared that gender biases in media portrayals of female physicists contribute to the stereotype that physics is a male-dominated field. Analysis from various countries revealed that female representation in academic literature is low, averaging only 11.9%, which perpetuates negative stereotypes and discourages female participation in physics (Porandia 2024). Also, the language used in media often reflects assumptions of biological determinism, further entrenching stereotypes that can affect young women's self-perception and aspirations in physics (Porandia, 2017).

Female students often report lower self-efficacy in physics compared to their male counterparts, despite similar performance levels. This discrepancy is influenced by societal stereotypes that suggest physics is a male domain (Li et al., 2020; Gao et al., 2024). Gao et al. indicate that gender stereotypes negatively predict academic self-efficacy in physics for girls. At the same time, boys are less affected by these stereotypes, leading to a disparity in confidence and performance outcomes (Gao et al., 2024). Jugovi and Ivana also confirm that girls usually have low self-concept. Their study revealed that girls had lower self-concept and success expectations in physics despite achieving higher grades. Self-concept of ability was the strongest predictor of physics grades, while the utility value of physics influenced educational intentions for both genders (Jugovi and Ivana, 2017).

A study by Appel et al. (2011) revealed that people are aware of stereotypes portraying women as less proficient in STEM test preparation than men. Women's note-taking activities are impaired under stereotype threat, particularly when domain identification is high. Moreover, stereotype threat impaired women's performance in evaluating the notes of others. The study thus shows that stereotype threat not only hinders stereotyped individuals' capacity to demonstrate their abilities but also impairs behaviours that develop them (Appel et al., 2011).

In conclusion, stereotypes can be explicit or implicit, and the prevalence of these stereotypes equating 'real physicists' with men is experienced across cultures. Stereotypes range from sexual discrimination and microaggressions to traditional hostile sexism occurring in the form of sexual harassment, gender role stereotypes and overt discouragement.

Due to these stereotypes, females within male-dominated science and technology disciplines often position themselves as 'one of the boys' to cope with the prevailing discrimination. Stereotyping affects females in physics in diverse ways, including low self-concept and low self-efficacy, which are predictors of physics grades.

Contribution of Pedagogy to Female Performance in Physics

The teaching methods and classroom environment also play a crucial role in shaping female performance in Physics. It is indicated that the quality of teachers and their instructional strategies can significantly impact students' academic performance in Physics (Afolabi & Olajuyigbe, 2018; Assem et al., 2023). For instance, studies have found that constructivist instructional strategies can help bridge the gender gap in Physics classrooms by engaging female students and encouraging their learning and development (Afolabi and Olajuyigbe, 2018). Additionally, the use of real and virtual experiments is shown to contribute differently to female students' motivation to learn Physics, with virtual experiments being more effective in enhancing their self-efficacy and motivation (Radulović et al., 2022). Additionally, the competitive and individualistic nature of Physics can discourage collaboration and hinder women's progress in their careers (Singh, 2022).

There is a need for periodic organization of career development programs for in-service teachers to enhance their effectiveness and good judgement in the selection and use of teaching methodologies that are tested. Institutions should move from the traditional lecture method to the use of experiments and hands-on activities that will motivate female students in Physics.

It is evident in research that the physics community often perpetuates the culture of gender stereotypes and can be unwelcoming to women, leading to feelings of isolation and marginalization (Santana and Singh, 2024). For instance, females in Physics often face discrimination, a lack of mentoring, and fewer opportunities for career advancement, which can negatively impact their performance and retention in the field (Singh, 2022).

Intersectionality, which considers how different social identities (e.g., race, gender, class) intersect and interact, is an important lens for understanding the experiences of women in Physics (Barthelemy et al., 2023b). Women from diverse backgrounds face unique challenges that can impact their performance and persistence in Physics (Barthelemy et al., 2023a; Vidor et al., 2020). For instance, women with colour often experience both gender and racial biases, which can compound the challenges they face in Physics (Barthelemy et al., 2023a). Additionally, gender intersects with other identities such as socioeconomic status and sexual orientation to shape the experiences of women in Physics (Barthelemy et al., 2023a; Vidor et al., 2020).

The factors affecting female performance in Physics can vary across different cultural contexts. Cultural factors such as societal attitudes towards women in STEM fields can influence female students' attitudes and performance in Physics (Akweya, 2015; Pongsophon, 2024). For example, in some cultures, girls are discouraged from pursuing Physics due to societal norms and expectations, while in other cultures, girls may be more encouraged to study Physics (Akweya, 2015). Additionally, cross-cultural differences in teaching methodology and educational policies can also impact female performance in Physics (Gutiérrez Moreno et al., 2023; Pongsophon, 2024).

III. Methodology

The research employs a mixed-method research approach. The approach combines both qualitative and quantitative methodologies, allowing for a more and a deeper explanation of the topic (Heigham and Croker, 2009). Explanatory sequential, a

quantitative phase followed by a qualitative phase, was employed. The quantitative phase involves the collection of performance data (second term) from SHS 3 physics students at Navrongo Senior High School. The data included exam scores. The aim is to identify any significant gender differences in academic performance.

After the quantitative data were collected, a qualitative phase followed, and semi-structured interviews with a subset of participants from the quantitative phase were utilized. The quantitative component gathered data on the performance of Physics students to ascertain the level of disparity that may exist, while the qualitative component focused on exploring the factors that contributed to the observed performance disparities. By conducting interviews with female students, the study aims to capture more authentic themes from their perspective (Fetters et al., 2013)

Data Collection

The purposive sampling technique was employed in selecting the final year SHS science class, a physics class. It comprised a total of 118 students, 87 males and 31 females. The results of students in three physics tasks: class test, homework and end-of-term exams were retrieved from school records, to serve as secondary data for statistical analysis. The mean score for the three tasks was calculated for each student and used for the analysis.

In the qualitative phase, semi-structured interviews were conducted. Collins et al. (2006) and Creswell (2002) suggested a minimum of (3) to (5) participants for qualitative case studies. Therefore, this study included five (5) participants to ensure data saturation. The participants were recruited through deliberate criterion sampling of gender-related attitudes and variables affecting female students' performance. The participants were selected based on individual performance in the second term physics exam scores: high, average, and low achievers.

The interview was conducted in English. The interview guide focused on internal factors, as well as external factors. The interviews were audio-recorded, transcribed verbatim, and analyzed using thematic analysis to identify key themes related to factors that contributed to their performance (Braun & Clarke, 2006).

Data Analysis

Quantitative data were analyzed using descriptive and inferential statistics. The analysis helped to identify significant differences in performance metrics between male and female students in Physics. The t-test analytical technique was employed to compare means across both genders. For the quantitative phase, results from standardized Physics tests were used to guarantee credibility.

For the qualitative data, thematic analysis was used to identify, analyze and interpret patterns within the interview transcripts. The process involved coding the data, developing themes, and analyzing the findings concerning the research objectives. The triangulation of the qualitative conclusions with quantitative results provided a well-rounded understanding of the gender disparity and factors contributing to female performance in physics. Member checking was used for the qualitative phase, in which participants checked the accuracy of the findings of the study.

IV. Findings and Discussions

The results of the data analysis carried out to address the research objectives are presented and discussed under this section. The objectives of the study were taken into consideration when organizing and interpreting the findings. To give a broad picture of students' performance by gender, descriptive statistics such as means and standard deviations are first displayed. After that, inferential statistics are used to see if there are statistically significant differences in the physics performance of male and female students using the independent samples t-test.

The results were further interpreted in light of the research context, theoretical viewpoints, and earlier studies. The goal of the discussion was to offer significant insights into the implications of gender differences or lack thereof in physics performance and how these findings relate to or deviate from previous research.

Female Performance in Physics

Table 1 shows descriptive statistics on performance. The average score for male students (N = 87) was 69.69 (SD = 15.04), whereas the mean score for female students (N = 31) was marginally higher at 70.61 (SD = 10.93).

Table 1: Group Descriptive Statistics of Performances					
	GENDER OF STUDENT	N	Mean	Std. Deviation	Std. Error Mean
SCORE IN PHYSICS	Male	87	69.69	15.042	1.613
	Female	31	70.61	10.932	1.963

On average, girls performed better than boys, but the 0.92-point gap is not very significant. The standard deviations also imply that, in contrast to their male counterparts, whose scores are more widely distributed, the scores of female students are more concentrated around the mean.

The assumption of homogeneity of variance was not satisfied, according to Levene's test for equality of variances ($F = 4.581$, $p = 0.034$) in Table 2, indicating that the variances of the two groups are not equal.

Table 2: Homogeneity of Variance Test			
		Levene's Test for Equality of Variances	
		F	Sig.
SCORE IN PHYSICS	Equal variances assumed	4.581	.034

Consequently, the t-test findings under "Equal variances not assumed" were taken into account. The two-tailed p-value of 0.717 obtained from the independent samples t-test in Table3 is significantly higher than 0.05. This demonstrates that there is no statistically significant difference between the mean Physics scores of male and female students.

The lack of a significant difference is further supported by the t-value of -0.363, indicating that the difference between the sample means is small and in the negative direction. This suggests the groups are very similar.

Table 3: Independent Samples Test

		t-test for Equality of Means							
		t	df	Significance		Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
				One-Sided p	Two-Sided p			Lower	Upper
SCORE IN PHYSICS	Equal variances assumed	-.313	116	.377	.755	-.923	2.948	-6.762	4.916
	Equal variances not assumed	-.363	72.603	.359	.717	-.923	2.541	-5.988	4.141

Furthermore, the effect size analysis in Table 4 shows a negligible effect size (Cohen's $d = -0.066$, Hedges' $g = -0.065$), suggesting that gender explains a negligible percentage of the variation in Physics scores. Cohen's (1988) guidelines state that effect sizes below 0.2 indicate negligible practical significance.

Table 4: Independent Samples Effect Sizes					
		Standardizer ^a	Point Estimate	95% Confidence Interval	
				Lower	Upper
SCORE IN PHYSICS	Cohen's d	14.095	-.066	-.475	.345
	Hedges' correction	14.186	-.065	-.472	.342
	Glass's delta	10.932	-.084	-.494	.327

These results are in line with a number of studies that found that, under equitable teaching and assessment circumstances, there are no appreciable gender differences in physics performance (Kahle & Meece, 1994; Hyde, 2005). Recent research has shown that gender gaps are closing, particularly when students have similar learning opportunities and support systems, despite some literature suggesting that male students may perform better than female students in science-related subjects because of social or cultural influences (Else-Quest et al., 2010).

Factors Influencing Female Performance in Physics

The thematic analysis revealed six factors contributing to females' performance in physics. These six factors are: effective study habits, perception, class engagement, instructional approach, teachers' support and peer support.

Effective Study Habits

The qualitative data revealed that some participants believed constant learning and regular revision contribute to students' academic success in physics. For instance, Participant P1 asserted that:

I try to learn physics three or four times a week and solve past questions.

Also, participant P2 claimed that:

Persistence in studying and solving problems makes it more interesting to me.

Furthermore, participant P3 shared that:

What has helped me to perform well in physics is that I always make sure that I learn physics at least three times a week, and I try to memorise what I have learned after reading. I try to answer the questions under that subject, under that topic, in my test book.

Again, participant P4 expressed that:

I learn physics three times a week, since it's not easy for me.

And participant P5 claimed that:

Me being able to perform well in physics is due to me, is due to my frequent studies. Sometimes, like, at least, to me, at least, I study physics three times a week.

Participants underscored disciplined revision routines (e.g., studying three times weekly and working with past questions), reflecting attributes of self-regulated learning. Prior research robustly connects such habits - consistent practice, goal-setting, and structured review - to enhanced science achievement, especially among girls.

Class engagement

The qualitative data revealed that active concentration in class contributes significantly to students' academic success in physics. For instance, Participant P2 asserted that:

Listening keenly to what my teacher says and asking my colleagues when I am in doubt, and even my teacher has enabled me to perform well in physics.

Participants credited attentive listening and active participation as instrumental to understanding physics. Research shows that interactive engagement techniques, which promote attention and participation, particularly benefit females in STEM by fostering confidence and conceptual clarity.

Perception

The qualitative data revealed that the mindset of students toward physics positively influences their effort and determination to succeed. For instance, Participant P3 asserted that:

My experience in learning physics so far is, when I first came year one, I used to like physics because the teacher that was teaching us used to always tell us that physics is a very good subject, and then it is the central subject, and when you pursue physics, you're able to get a lot of opportunities in the future. So I made up my mind that physics would be one of the best subjects, and so I used to learn physics, and I understood.

A recurring finding was the power of a positive mindset, cultivated through early affirmation from teachers. One student remarked that her teacher emphasised physics as central and promising, leading her to embrace the subject wholeheartedly. This supports existing literature that positive framing reduces stereotype threat and enhances women's resilience in physics.

Instructional approach

The qualitative data revealed that instructional approaches, particularly the integration of practical lessons, significantly improved students' understanding of difficult physics concepts. For instance, Participant P1 shared that:

Physics practical's have made me understand different ways in physics.

Again, participant P3 asserted that:

Yes, since we started, I have found challenges in some of the concepts in understanding them. But now that we are doing practicals, I think the practicals have also made me understand some of the concepts.

Also, participant P5 claimed that:

My support for physics learning is researching physics, the physicists, and getting to know more about the experiment and performing more physics practicals

Hands-on learning emerged as a transformative tool in the study. Students who engaged in practical experiments noted improved comprehension of concepts. In Ghana, similar studies demonstrate that practical work boosts scientific skills and conceptual understanding in physics. Global active-learning research further supports this, showing female students disproportionately benefit from experiential teaching.

Peer Support

The qualitative data revealed that peers play a significant role in participants' success in physics, with several emphasizing its importance repeatedly. For instance, Participant P2 asserted that:

Engaging in group studies has also enabled me to perform well

Also, participant P3 shared that:

When I find challenges in studying the subject or studying topics in this subject, I always seek help from my colleagues

Again, participant P4 claimed that:

I learned from my classmates after the teacher left the class and asked questions.

The importance of peer collaboration and group study surfaced strongly in the data. Female students' reports echo broader evidence highlighting peer influence as a core element in girls' sustained confidence and engagement in STEM subjects.

Teachers' Support and Encouragement

The qualitative data revealed that teacher support plays a crucial role in helping students succeed in physics, with several participants repeatedly emphasizing its importance. For instance, Participant P3 expressed that:

When I find challenges in studying the subject or studying topics in this subject, I always seek help from my teacher.

Also, participant P4 claimed that:

So far, my learning in physics is not easy, but I'm able to cope with the teacher for support.

Female students consistently sought help from teachers, citing this support as important. Findings from Ghanaian contexts link positive instructor recognition to heightened self-efficacy and persistence, vital for female retention in physics.

Figure 1 is a concept map that illustrates the various factors contributing to females' high academic performance in physics, highlighting the complexity and interrelated nature of influences that shape female student outcomes. At the core of the map is the central idea: "Factors contributing to females' high academic performance in physics." Surrounding this idea are six critical elements: instructional approach, effective study habits, perception, class engagement, peer support, and teacher support, that collectively contribute to academic success.

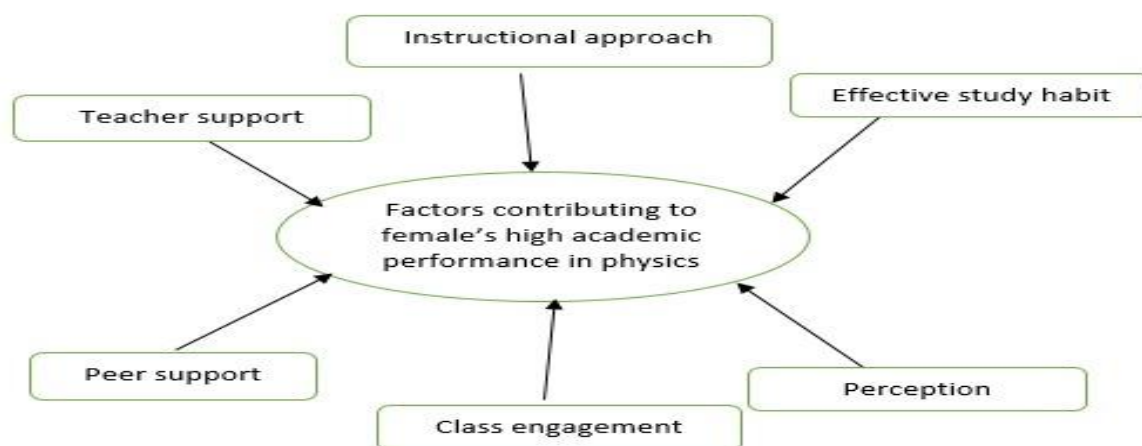


Figure 1. Factors contributing to females' high academic performance in physics (Author's construct, 2025).

In a nutshell, the preceding concept map demonstrates that female students' success in physics is the result of a dynamic interplay of several factors. These include not only personal attributes such as effective study habits and positive perceptions but also social and instructional elements like peer and teacher support, class engagement, and teaching methods. Understanding and strengthening these interconnected areas can pave the way for more equitable and improved outcomes in physics education for female learners.

V. Conclusion

In conclusion, even though women performed marginally better than men in this study, the difference is essentially insignificant and statistically insignificant, though interesting to note. These results imply that variables other than gender, like effective study habits, positive perceptions of physics, class engagement, instructional approach, teacher support, and peer support, have a greater impact on physics performance. These findings affirm that female achievement in physics is not the result of singular effort but a dynamic interaction of personal initiative, pedagogical strategies, and social relationships.

The voices of the participants brought to light the critical importance of a supportive and engaging learning environment where female students feel motivated, guided, and capable. They demonstrated that when given the right tools and encouragement, they not only persist in a traditionally male-dominated subject but also excel.

Importantly, the findings challenge prevailing assumptions that girls are naturally less inclined toward physics. Instead, they highlight the potential that emerges when systemic barriers are replaced with intentional support, meaningful engagement, and equitable learning experiences.

As such, fostering female academic success in physics must be a collective effort, grounded in responsive teaching, inclusive practices, and sustained encouragement.

VI. Recommendations

Based on the conclusions made, the following recommendations are proposed for educational stakeholders, especially teachers, curriculum developers, and school leaders:

1. Promote Structured Study Habits

Encourage time management strategies and provide access to past physics exam questions to aid in consistent revision. Schools can organize study skills workshops focused on science subjects, tailored to female learners.

2. Enhance Student Perception through Positive Messaging

Physics teachers should consistently communicate the relevance and applicability of physics in daily life and future careers. Success stories of female physicists should be shared regularly to counter stereotypes and foster identification.

3. Strengthen Classroom Engagement

Teachers should create interactive lessons that involve open-ended questions, peer discussions, and practical demonstrations to keep female students engaged and actively learning, allowing space for girls to ask questions, express confusion, and explore without fear of judgment.

4. Increase Practical, Experiential Learning

Schools should invest in well-equipped physics labs and encourage hands-on activities to deepen understanding and interest. Practical lessons should be embedded regularly in lesson planning rather than treated as occasional supplements.

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