ISSN No:-2456-2165 https://doi.org/10.38124/ijisrt/IJISRT24OCT1500

Examination of Gender Performance in Physics in Mankranso Senior High School

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Abstract:- Despite ongoing efforts to promote inclusivity in science education, the persistent gender gap in physics remains a pressing concern. This study investigated potential gender differences in physics performance among senior high school students at Mankranso Senior High School in Ghana. A descriptive survey design was employed, utilizing student physics test scores from a stratified random sample (N = 111; 79 males, 32 females) from a population of 184 students. Descriptive statistics and inferential statistical tests were used to analyse the data. Descriptive statistics revealed a slightly higher mean score for females (M = 43.65, SD = 21.78) compared to males (M = 39.39, SD = 21.15). However, a two-sample t-test (t = - 0.721, df = 56, p = 0.474) showed no statistically significant difference in mean physics test scores between male and female students. Levene's test for equality of variances (F = 0.210, p = 0.649) confirmed that the variability of scores was not significantly different between genders. The following conclusion was made, while females have a slightly higher average score (42.31) compared to males (41.29), the difference is not statistically significant. The study emphasizes the importance of creating equitable learning environments, focusing on individual student needs, and promoting inclusive practices that encourage all students to thrive in STEM fields. The following recommendations was made; be aware of potential unconscious biases that might impact how you interact with or perceive students of different genders. Offer students opportunities for enrichment, advanced coursework, or participation in science competitions. Further investigation and consideration of other potential factors influencing performance is recommended to gain a more comprehensive understanding.

Keywords:- *Cross-Sectional Study, Distribution of Scores, Normal Distribution, Gender Differences, Attitudes, Beliefs, Classroom Dynamics.*

I. INTRODUCTION

Physics is perceived to be a difficult course because of its abstract nature (Adeyemo, 2010). Physics is a subject students usually performed poorly in all level of the educational system. As observed by Akanbi (2003) that the trend in the enrolment and performance of secondary school students in science subjects, especially Physics assumed threatening and frightening dimension.

There are many reasons for this poor performance, in the opinion of Akanbi (2003) poor performance in Physics may be due to a number of fundamental reasons, which could be due to shortage of science teachers in quality and quantity, inadequate laboratory equipment and facilities, shortage of suitable Physics textbooks and other factors. Bamidele (2004) observed lack of interest in physics by students due to preconceived idea that physics is a difficult subject has affected the enrolment and performance of students in physics.

The poor performance physics is no gender exception; it cuts across both male and female. It is however very important to find out the level of failure between male and female so as to proffer adequate solution to it. Effect of gender on school science cannot be overemphasized as observed by Bello (2012) that gender difference is characterized by female underrepresentation and underachievement in science.

This study is necessary because of gender disparity in science enrolment and also in job placement in Ghana. O'Connor-Petruso & Miranda's study (as cited in Campbell 2005) have shown that gender differences in science achievement become apparent at the secondary level when female students begin to exhibit less confidence in their science ability and perform lower than the males on problem solving and higher level tasks. In Ghana, Eshun (1999, 2000) also observed a higher achievement of males than females in physics at the secondary school level.

Wilmot (2008) even showed that in Ghana, the difference in mathematics related subjects, achievement between boys and girls begins or becomes apparent at the sixth grade. Mari (2005) believed that gender discrimination in employment is one of the factors contributing to gender inequality in pursuit of science, technology, engineering and mathematics (STEM) education. He stated that many employers of labour, sometimes including female employers prefer employing men to women. Okafor and Okoye (2004) observed that there are more men in civil and other technological courses than women. It is very necessary to compare students' performances in physics based on gender

ISSN No:-2456-2165 https://doi.org/10.38124/ijisrt/IJISRT24OCT1500

to know if male performance in physics is better than that of female which may result into having more male in physics enrolment than female or make male to be more in any job relating to physics.

Some people even believed that male performed better than female in any course that deal with calculation, as observed by Awoniyi (2016) that male candidates performed better, relative to female in subjects requiring quantitative ability. He said male show superiority in science, statistics and accounting.

Aina and Akintunde (2013) in their research on student's performance in Physics in college of education however stated male students are better in performance than female students among college students as determinants of performance in Physics revealed that there is a significant difference between males and females in terms of their attitude towards Physics in favour of male, and this may result into the better performance of the male in Physics.

Tetteh et al. (2018) in their research on Gender differences in performance in mathematics among college of education in Brong-Ahafo region of Ghana however stated that there is no statistically significant difference in performance between male and female pre-service teachers in mathematics in the public college of education in the Brong-Ahafo region of Ghana.

The pursuit of knowledge in science, particularly physics, has historically been associated with a masculine identity (Bybee, 2010). This perception has contributed to persistent gender disparities in STEM fields (National Academies of Sciences, Engineering, and Medicine, 2018), prompting a crucial need to examine the dynamics of gender in physics education. This research delved into the realm of senior high school (SHS) physics, exploring the complex interplay of gender and performance within this critical educational stage.

While strides have been made in promoting inclusivity in science education, the persistent gender gap in physics raises critical questions. Do male and female students experience physics learning differently? Are there differences in their achievement levels, (Guzzetti et al., 2010)? This study seeks to shed light on these questions by examining gender performance in Physics at Mankranso Senior High School, the factors influencing gender performance in physics at the SHS level. This research aim to determine the differences in physics performance between male and female students at Mankranso Senior High School. The null research hypothesis is that there is no difference in performance between male and female students in physics in Mankranso Senior High School.

II. LITERATURE REVIEW

The persistent gender gap in science, technology, engineering, and mathematics (STEM) fields, particularly in physics, has become a pressing concern for educators and researchers (National Academies of Sciences, Engineering, and Medicine, 2018). This disparity reflects a complex interplay of societal influences, classroom dynamics, and individual attitudes and beliefs, all of which can shape students' engagement and performance in physics. A significant body of research has examined the factors contributing to this gap. Studies have identified disparities in achievement levels between male and female students in physics, with females often scoring lower on standardized tests and assessments (Sadler, 2011). This gap can be attributed, in part, to gender-related differences in attitudes and beliefs towards physics. For example, Chiu and Chen (2005) found that female students tend to have lower confidence and interest in physics compared to their male counterparts, potentially due to societal expectations and a lack of female role models in the field.

Furthermore, classroom dynamics can significantly influence student engagement and performance. Sadler (2011) emphasizes the importance of creating inclusive learning environments that support diverse learning styles and encourage active participation. Research by Cheryan et al. (2013) suggests that social cues and stereotypes contribute to women's underrepresentation in STEM fields. The perceived "masculinity" of science can discourage

Female participation and create a sense of exclusion. To address this gap, various initiatives and interventions have been proposed. Guzzetti et al. (2010) advocate for inquiry-based science instruction, a pedagogical approach that has shown promise in engaging students of all genders. Sadler (2011) suggests that teachers focus on fostering a sense of belonging and agency in the classroom, encouraging active participation and critical thinking. Ultimately, promoting gender equity in physics requires a multi-faceted approach that addresses both systemic barriers and individual beliefs and attitudes.

➢ *Theoretical Review*

At the heart of social-cognitive theory lies the concept of self-efficacy, an individual's belief in their capability to successfully perform a task (Bandura, 1997). Self-efficacy is a powerful predictor of behaviour and achievement. Individuals with high self-efficacy are more likely to set challenging goals, persist in the face of difficulties, and ultimately achieve success. Conversely, individuals with low self-efficacy may avoid challenging tasks, give up easily, and underestimate their capabilities.

Research suggests that girls often report lower confidence and self-efficacy in STEM fields compared to boys (Cheryan et al., 2013). This gap in self-efficacy can stem from various sources, including societal stereotypes, limited role models, and a lack of encouragement and support within educational settings. If girls are continually exposed to messages that suggest STEM fields are not for them, they may internalize these beliefs, leading to lower self-efficacy and a reluctance to pursue these fields.

Furthermore, social-cognitive theory emphasizes the role of goal setting in motivating behaviour. Students who set specific, challenging, and achievable goals are more likely to be engaged in learning and achieve success (Bandura, 1997).

ISSN No:-2456-2165 https://doi.org/10.38124/ijisrt/IJISRT24OCT1500

However, societal stereotypes and cultural influences can affect girls' aspirations and the goals they set for themselves in STEM fields, potentially hindering their progress. For example, girls may be less likely to set ambitious goals in physics if they perceive it as a male-dominated field or if they lack confidence in their abilities to succeed.

- *Cognition and Gender*

Social-cognitive theory highlights the importance of observational learning, where individuals learn by observing the behaviours and outcomes of others (Bandura, 1977). When girls see limited representation of women in physics, it can reinforce the belief that it is not a field for them, potentially leading to a lack of interest or engagement. Having visible female role models in STEM fields can inspire girls, demonstrating that success in these areas is possible and fostering their confidence.

Moreover, social-cognitive theory emphasizes the role of self-regulation in learning. Individuals develop self-regulation skills through observation, feedback, and experience, allowing them to set goals, monitor their progress, and adjust their strategies to achieve success (Bandura, 1986). Encouraging students to develop self-regulation skills can be crucial for promoting their persistence and resilience in challenging subjects like physics. Students who are able to effectively monitor their progress, identify areas for improvement, and adjust their learning strategies are more likely to persevere and achieve success.

Social-cognitive theory recognizes that environmental factors, such as socioeconomic background, access to resources, and quality of education, can significantly influence individuals' learning experiences (Bandura, 1977). Students from underprivileged backgrounds may face greater challenges in accessing learning materials, technology, and supportive learning environments, impacting their performance in physics. Equitable access to resources and opportunities is essential for creating a level playing field for all students.

Furthermore, social-cognitive theory emphasizes the role of the classroom environment in shaping student motivation and performance. Teachers play a crucial role in shaping students' perceptions and behaviours. Teachers who hold positive beliefs about girls' abilities in STEM fields and employ inclusive teaching practices can foster a more supportive and equitable learning environment. Creating a classroom culture that encourages collaboration, challenges stereotypes, and provides ample opportunities for girls to engage with physics concepts can foster a more inclusive and welcoming environment.

III. METHODOLOGY

This research delves into the complexities of gender in senior high school (SHS) physics, aiming to uncover underlying dynamics and inform strategies for creating an inclusive learning environment for all students (National Academies of Sciences, Engineering, and Medicine, 2018). The study employs a quantitative approach, focusing on student physics test results as a key indicator of potential gender-related differences in academic performance. The study population encompasses all students enrolled in physics at Mankranso Senior High School.

This research, focusing on gender differences in physics performance at Mankranso Senior High School in Ghana, prioritizes a robust and representative sample to ensure the validity and generalizability of its findings. The study employs stratified random sampling, a powerful technique that enables researchers to gather data that accurately reflects the composition of the population being studied (Bryman, 2016). The target population for this research encompasses all students enrolled in physics at Mankranso Senior High School. This population consists of 184 students, with a significant difference in the number of male and female students enrolled in the subject. To ensure that the research findings accurately reflect the overall student population, it is crucial to select a sample that mirrors the gender distribution. Stratified random sampling is a sampling technique that addresses this need for representativeness. It involves dividing the population into subgroups, known as strata, based on specific characteristics relevant to the research. In this case, the population is divided into two strata: male students and female students. This approach ensures that the sample proportionally reflects the gender composition of the overall population. The population is divided into two strata: male students and female students. The data reveals that 131 students are male and 53 are female, resulting in a 71% male and 29% female distribution within the population. A desired sample size of 111 participants was determined. To ensure the sample reflects the gender distribution of the population, the researchers calculate the number of participants to be selected from each stratum. This is done by multiplying the total sample size (111) by the percentage of each gender in the population. This results in a target of approximately 79 male participants (71% of 111) and 32 female participants (29% of 111). Within each stratum (male and female), a random number generator is used to select the specific students who will participate in the study. This random selection ensures that every student within each stratum has an equal chance of being chosen, minimizing bias and maximizing the representativeness of the sample. This method ensures that the sample accurately reflects the gender distribution of the student population, minimizing bias and increasing the generalizability of findings. A stratified sample allows for more precise estimates of population parameters and stronger statistical analyses, especially when comparing differences between groups. This is particularly relevant to this research, which aims to analyse potential differences in physics performance between genders. Stratified random sampling enables researchers to conduct separate analyses within each stratum (male and female). This provides more detailed insights into gender-specific patterns and trends, allowing for a more nuanced understanding of gender differences in physics performance.

The study utilizes a descriptive survey research design, focusing on collecting and analyzing data on student physics test results. Descriptive research aims to describe and summarize the characteristics of a population or phenomenon

ISSN No:-2456-2165 https://doi.org/10.38124/ijisrt/IJISRT24OCT1500

(Creswell, 2014). The study employs a quantitative approach, relying on statistical analysis to identify patterns and trends in the data. The primary instrument for data collection is a pro forma designed to gather student physics test results. This pro forma includes information such as student ID, gender, and test scores. The data collection process involved obtaining permission from the head of the science department at Mankranso Senior High School to access student records. Ethical considerations were central to the data collection process. Informed consent from students and maintaining data confidentiality was key ethical principles that was adhered to throughout the study (American Psychological Association, 2010).

Table 1 shows the number of physic students enrolled from SHS 1 to SHS 3.

Table 1 Physics Students Enrolled

	Students enrolled	**Males**	**Females**
SHS 3	43	31	12
SHS2	58	41	17
SHS1	83	59	24
Total	184	131	53

IV. RESULT AND DISCUSSION

- *Distribution of Physics Performance*

From Figure 1 the distribution appears to be roughly bell-shaped, indicating a normal distribution or a distribution close to normal. This suggests that most scores cluster around the center of the range, with fewer scores at the extremes. While the distribution is mostly symmetrical, there's a slight left skew, meaning there are slightly more scores towards the lower end of the range (0-9, 10-19) than the higher end (80-89, 90-99). This is evidenced by the higher frequencies in the lower bins. The highest frequency occurs in the 40-49 range, indicating that this is where most of the scores are concentrated. The scores in the 90-99 range could be considered potential outliers, as they are relatively few compared to the frequencies in the middle range.

- *This Figure shows how the Sores are been Distributed.*

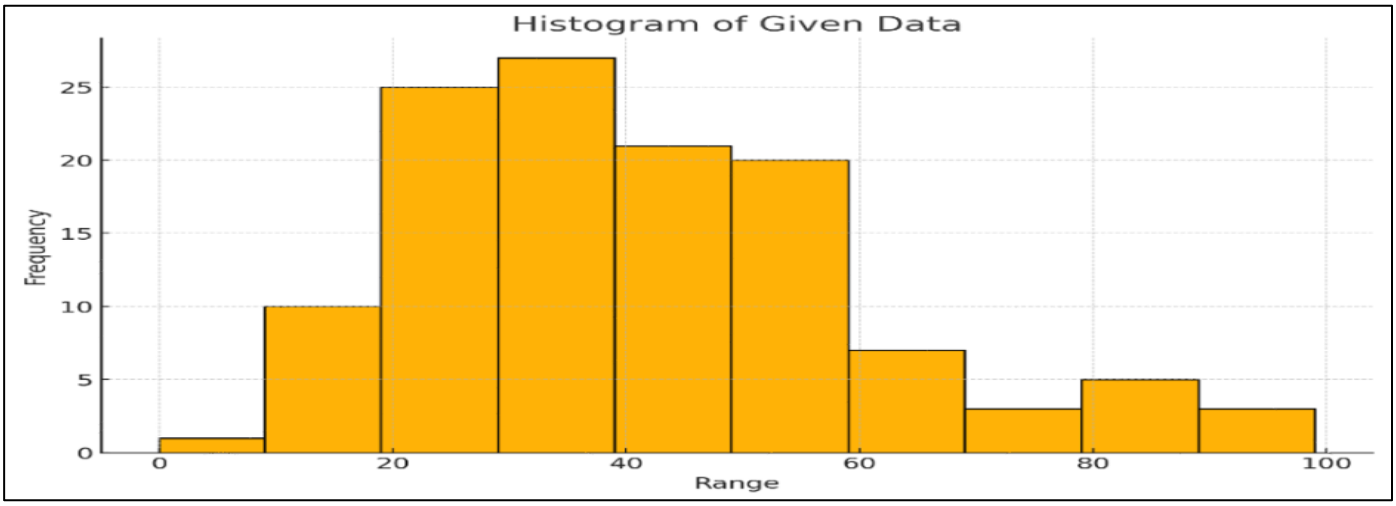

Fig 1 Histogram of Physics Scores

- *Table 2 shows the Physics Scores and their Frequency in a Range.*

Table 2 Frequency table of Physics Scores

Range	**Frequency**
0-10	2
11-20	8
21-30	18
31-40	17
41-50	25
51-60	18
61-70	8
71-80	5
81-90	6
91-100	4
TOTAL	111

ISSN No:-2456-2165 https://doi.org/10.38124/ijisrt/IJISRT24OCT1500

➢ *Gender Performance in Physics*

The data is presented in two tables: a summary of descriptive statistics, and results from statistical tests assessing the equality of means and variances.

This Table 3 describes the physics scores in terms of gender.

Table 3 Descriptive Statistics for Student Scores by Gender

	Gender of students	N	Mean	Std. Deviation	Std. Error Mean
Scores of students	Males	38	39.39	21.154	3.432
	Females	20	43.65	21.784	4.871

The dataset includes 79 male and 32 female students. The larger sample size for males offers greater confidence in the estimates for that group. Female students exhibit a slightly higher mean score (42.31) compared to males (41.29). This suggests a possible trend, but further investigation is needed to determine its significance. Male scores show greater variability (standard deviation of 20.388) than female scores (standard deviation of 17.459). This indicates a wider range of scores among males, suggesting potential factors contributing to diverse performance within the group. The standard error of the mean reflects the accuracy of the sample mean as an estimate of the true population mean. The smaller value for males (2.211) indicates greater confidence in the estimated mean score for males compared to females (2.951).

While females had a slightly higher average score, this difference was not statistically significant. The greater variability in male scores suggests potential factors influencing individual performance within the male group.

➢ *Hypothesis Test*

Null Hypothesis (H_0): There is no difference in the mean physics scores between males and females at Mankranso Senior High School.

Alternative Hypothesis (H_1): There is a difference in the mean physics scores between male and female students at Mankranso Senior High School.

Common significance level of $\alpha = 0.05$ was used. That means a 5% chance of rejecting the null hypothesis when it is actually true (Type I error). Since comparing two means and have the sample sizes, means, and standard deviations, a two-sample t-test was used. Table 4 provides the results of both a t-test assuming equal variances and one not assuming equal variances.

From Table 4, the t-values are -0.259 (assuming equal variances) and -0.277 (not assuming equal variances). The table shows degrees of freedom of 118 (equal variances) and 73.520 (not assuming equal variances). The table provides p-values of 0.796 (equal variances) and 0.783 (not assuming equal variances). Comparing p-value to α: Both p-values (0.796 and 0.783) are greater than our significance level of 0.05. Since the p-value is greater than α, we fail to reject the null hypothesis.

Based on the data in the table, we fail to reject the null hypothesis.

This means that we haven't found statistically significant evidence to support the idea that there's a difference in mean physics test scores between male and female students**.**

Table 4 shows the results of the Independent Samples t-test on physics scores;

Table 4 Levene's Test and t-test for Equality of Means

		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	Df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
Scores of students	Equal variances assumed	.210	.649	-.721	56	.474	-4.255	5.903	-16.081	7.571
	Equal variances not assumed			-.714	37.763	.480	-4.255	5.959	-16.320	7.810

The p-value (0.340) is greater than the typical significance level (0.05). Therefore, we fail to reject the null hypothesis and assume equal variances between groups. Both the t-test assuming equal variances and the one not assuming equal variances yield p-values greater than 0.05 (0.796 and 0.783, respectively). This suggests a lack of statistical significance, implying no substantial difference in mean scores between males and females. The 95% confidence intervals for the mean difference also include zero, further supporting this conclusion.

V. CONCLUSION AND RECOMMENDATION

The frequency table suggests that the distribution of physics scores is generally normal, with a slight left skew. This indicates that most scores are concentrated around the

ISSN No:-2456-2165 https://doi.org/10.38124/ijisrt/IJISRT24OCT1500

middle range, with a few outliers towards the higher end. This information can be valuable for educators to understand student performance and tailor their teaching strategies accordingly.

While females have a slightly higher mean score (42.31) compared to males (41.29), the difference is not statistically significant. From table 4, the table shows t-values of -0.259 (assuming equal variances) and -0.277 (not assuming equal variances). The table shows degrees of freedom of 118 (equal variances) and 73.520 (not assuming equal variances). The table provides p-values of 0.796 (equal variances) and 0.783 (not assuming equal variances) and this tells us that this difference is likely due to random chance. While the data shows a slight average advantage for female students in their mean scores, statistical analysis indicates that the observed difference is not statistically significant. The lack of a significant difference between groups is likely due to random variation and does not support a conclusion that one gender performs better than the other.

➢ *Based on the Conclusions, the Following Recommendations were made:*

- Focus on Individual Needs: Avoid making assumptions about student performance based on gender. Instead, focus on understanding the individual needs and strengths of each student.
- Be aware of potential unconscious biases that might impact how you interact with or perceive students of different genders.
- The fact that most scores are clustered around the middle range might suggest that students are grasping the basic concepts but might need more practice or deeper exploration to achieve mastery.
- The presence of a few outliers in the high range (scores in the 90s) suggests that some students are performing at a very high level. Consider offering them opportunities for enrichment, advanced coursework, or participation in science competitions.

Further investigation and consideration of other potential factors influencing performance is recommended to gain a more comprehensive understanding.

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