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Assessing the Combined Role of Metacognitive Skills and Scientific Attitudes as Catalyst for Gender-Specific Academic Achievement in Science

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Abstract: The synergistic effects of metacognitive skills and scientific attitudes on academic achievement have not been fully established by the dozens of studies that span through the margins of archives on these variables. This warranted an investigation to understand the combined role of these variables on gender-specific academic achievement. Employing a descriptive-correlational survey design, the researcher gathered data from 344 participants using a simple random sampling technique. This was accomplished using three distinct instruments: the Metacognitive Awareness Inventory (MAI), the Scientific Attitude Assessment (SAA) questionnaires, and the Science Achievement Test (SAT). The obtained data underwent careful analysis employing correlation, independent samples t-test, and linear regression techniques. The findings unveiled parity in academic performance between male and female students, indicating an equal display of intellectual prowess in science among both genders as evidenced by the student's t-test (t (342) = 0.159, *Sig*. (*2-tailed*) = 0.874). Moreover, the analysis underscored that both metacognitive skills and scientific attitudes significantly predict academic performance in science with a Pearson's 'r' of (r (342) = 0.801 and 0.71, $p < 0.05$) respectively. Additionally, a robust association was observed between the combined variables (metacognitive skills and scientific attitudes), and academic achievement in science. This underscores the necessity of presenting both variables as a cohesive unit to students to enhance their academic success. The findings suggest the implementation of pedagogical approaches that are both gender-sensitive and gender-neutral in our classrooms. Such approaches aim to ensure that educational practices cater to the needs and strengths of all genders equally, fostering an environment where both male and female students can reap the benefits of education without discrimination.

Keywords: Gender-specific academic achievement; Metacognitive skills; Scientific Attitudes

INTRODUCTION

One important focus of science education in recent times is to re-orient its pedagogical practices to view and pursue the subject as "an art" to actualize and develop scientific attitudes and knowledge needed for problem-solving rather than just focusing on the methodological dogma of knowing about ourselves and our surroundings (Donovan, 2013). This calls for the recalibration and equipment of our educational system to produce a generation of thinkers who can critically examine issues in context to provide solutions to our societal problems (Hattie &

Donoghue, 2016). An important aim of educating humans (students) is to help them become critical thinkers**.** To meet this requirement, educators have identified certain cognitive attributes that can evoke the development of critical thinking skills (Magno, 2010). Such cognitive characteristics include information recall, logic, encoding, reasoning, and memory among others (Anderson, 2010; Schraw et al., 2006). This is because understanding how students direct their capacity to learn in schools and apply learned concepts beyond school has been the focal point of most discussions among policymakers, practicing educators, educational researchers, and curriculum developers alike in almost all educational Jurisdictions (Cubukcu, 2009). According to Sradhanjali and Parismita (2020), educational institutions worldwide strive to enhance academic learning and achievement by fostering the optimal utilization of students' cognitive abilities and processes. The goal is to empower students to take charge of their learning activities, and self-regulate their advancement, to meet the needs of both the academic community and the broader nation. Several documents to this effect have been developed and well accentuated to increase rationality, critical thinking, objectivity, ability to suspend judgment open-mindedness, etc. in students since these attributes make important aspects of scientific attitudes (Bao, 2014; Siddiqui & Khan, 2018; Niaz, 2011). These educational documents that reflect the needs of society are indicative of the evolving thinking patterns, characterized by a revolutionary shift in human cognition. This shift has empowered individuals with the ability to introspect and contemplate their cognitive processes (metacognition).

Zohar and Dori (2012) indicated that metacognition, metacognitive skills, and their implications for students' learning and pedagogy are of global relevance in science education. The assertion made by Zohar and Dori regarding the positive correlation between students' metacognitive skills and academic achievement is supported by several studies. Eriyani (2020) and Craig (2020) conducted independent research, and their results suggested a significant and positive relationship between the metacognitive skills of students and their performance. Similarly, Arami and Wiyarsi (2020) reported similar findings, further strengthening the evidence for this correlation.

Zhyang and Campbell (2010) pointed out that one other major concern of science education was the development of scientific attitudes in students and suggested a significant correlation between it and instructional performance. In Addition, Osborne et al. (2003), agreed that the cultivation of scientific attitudes encourages students to approach scientific problems with curiosity, skepticism, and critical thinking, which promotes a deep understanding of scientific concepts and fosters a scientific mindset.

Despite the widespread effects of metacognition, scientific attitudes, and metacognitive skills on academic performance, some regions of the globe have not fully created avenues for their inculcation in students. For instance, the studies conducted by Oyedemi (2021) and Chisamba (2020) shed light on the educational landscape in African states. They highlight the shift from rote memorization of facts towards a focus on applying knowledge to address real-world problems. However, the researchers also express concerns about the current content taught in African science classrooms. According to the researchers, the existing curriculum and teaching practices in African science education are not adequately equipping students with the essential metacognitive skills and scientific attitudes required to thrive in countries undergoing an economic transformation. This suggests that while the educational system has taken steps to promote the practical application of knowledge, there is still room for improvement in terms of nurturing students' metacognitive abilities and fostering scientific mindsets. These findings suggest a need for educational reforms that go beyond content knowledge and instead emphasize the development of metacognitive skills and scientific attitudes. By enhancing students' metacognition and cultivating scientific thinking, African education systems can better prepare learners to actively participate in their countries' evolving economic landscapes.

The integration of metacognitive skills and scientific attitudes in African education has the potential to foster a culture of scientific inquiry, critical thinking, and problem-solving skills among students. By developing metacognitive skills, students can become more aware of their cognitive processes, set clear goals, and monitor their progress effectively. They can also regulate their learning strategies, adapt them to different contexts, and reflect on their performance to improve their learning outcomes (Efklides & Sideridis 2009).

Furthermore, the development of skills of metacognition and scientific attitudes can contribute to narrowing the achievement gap in African education. Students from diverse socio-economic backgrounds may face challenges in accessing quality science education. However, the cultivation of these skills and scientific attitudes can empower students to take ownership of their learning and overcome these challenges by becoming more self-regulated, reflective, and critical learners (Essuman et al., 2019; Opoku-Asare et al., 2021; Yeboah et al., 2020). It is therefore within the brighter lines for one to say that the complete development of a scientific personality requires the inculcation of scientific attitudes to guide the modus operandi of such individuals within the light of the codes and ethics of science. The designing of educational policies, instructional materials, institutions, and curricula by every nation is a function of the nature of the human resources it wants to produce, and its developmental agenda.

Previous research has suggested that there may be gender differences in metacognitive skills and scientific attitude, which could potentially contribute to the gender-specific academic performance gap in science. For instance, some studies have found that females tend to exhibit higher levels of metacognitive skills, such as self-regulation and reflection, compared to males (Gorrell & Kahveci, 2017), while males tend to show higher levels of interest and motivation toward science (Sheldrake & Mujtaba, 2019). However, there is limited research on the relationships between skills of metacognition, scientific attitude, and gender-specific educational performance in science, particularly in the context of Ghana (Boateng, 2020).

The studies conducted on the relationships existing between metacognitive skills, scientific attitudes, and instructional performance, particularly concerning gender, have yielded inconsistent findings. Kumari and Saraladevi (2014), Oon et al. (2020), and Garzon et al. (2020) have reported disparities in their research on whether these variables differ based on gender and how they individually or collectively influence academic achievement. For example, Adiansyah et al. (2021) conducted a correlational study in South Sulawesi, Indonesia, involving tertiary biology students as participants. Their findings suggested a moderate relationship between scientific attitude and metacognitive skills, with both variables equally influencing academic achievement in both genders. Similar conclusions were reached in quantitative studies conducted by Amin and Adiansyah (2020), Ardila et al. (2013), Fauziah and Nurita (2010), and Mustaqim et al. (2013) using similar research approaches and designs. Additionally, Kristiani et al. (2015) proposed that both variables have a simultaneous contributive effect on academic performance. These inconsistencies in the findings of different studies highlight the complex nature of the associations between metacognitive skills, scientific attitudes, and academic performance, and how they may or may not vary based on gender.

Indeed, research conducted by Desy et al. (2011), Tejal (2013), and Olasehinde and Olatoye (2014) using similar quantitative designs have yielded contrasting and controversial outcomes that deviate significantly from the findings of Adiansyah et al. (2021), Fauziah & Nurita (2010), Amin & Adiansyah (2020), Ardila et al. (2013), and Mustaqim et al. (2013). Sajna and Premachandran (2016) expressed the opinion that there are insignificant differences in the metacognitive skills of learners based on their gender, locality, and school management type. This further adds to the complexity and lack of consensus in the research findings regarding the influence of these variables on academic performance.

Cognizant of the persistent gender gap in science achievement, irregularities in findings of previous studies, and the role of metacognitive skills and scientific attitude in predicting learning outcomes, it is important to

investigate these factors as potential indicators of gender-specific academic performance in science. Understanding the relationships that exist between metacognitive skills, scientific attitude, and gender-specific academic performance in science in the Jirapa Municipality has important implications for educational policies and practices. Identifying the factors that contribute to gender disparities in science performance can inform the introduction of tailored interventions to promote gender equity in science education in the municipality and by extension, the whole country. Additionally, investigating the role of scientific attitudes and metacognitive skills in academic performance in science can provide insights into effective strategies for enhancing students' learning outcomes in science, regardless of gender. Therefore, this current study examines the relationships among metacognitive skills, scientific attitude, and gender-specific academic performance in science among students in the Jirapa municipality of the Upper West Region of Ghana. To fully understand the role of the independent variables on the dependent variable, the study seeks to test the following hypotheses.

1. H_0: There are no significant differences in academic performance in science between boys and girls.
2. H_0: There is no correlation between academic achievement and metacognitive skills as well as scientific attitudes.
3. H_0: Metacognitive skills and scientific attitudes put together do not influence academic performance based on gender.

METHOD

The study relied on the descriptive-correlational survey design as a blueprint that guides the mode of operation of the research process, data collection procedures, analysis, and interpretations. The study greatly relied on quantitative data to describe the population parameters and establish the links that exist among the variables (Creswell & Plano Clark, 2018). This design harmonizes accurately with the research as it promises to collect an extensive array of data, delve deeper into the variables, and offer cross-comparison thereby supporting quantitative scrutiny (Bryman, 2016; Field, 2013; Dillman et al., 2014 as cited in Yuorsuu, 2024).

Participants

The population for this study is an amalgam of 2419 enrolled students in all the Senior High Schools (SHS) in the Jirapa Municipality. In terms of demographics, it is disproportionately comprised of 1885 girls and 534 boys with an age range of 14 to 21 years. SHS students were considered for the study due to their pivotal stage in the educational system, where they started specializing in various academic subjects, including science. Investigating

metacognitive skills and scientific attitudes among SHS students at this critical stage can provide valuable insights into their academic achievement and help develop interventions to support their learning and success (Smith, 2019).

Adolescence is a period of significant cognitive, social, and emotional changes. SHS students are at a stage where they acquire and develop metacognitive skills, enabling them to reflect on and as well regulate their learning processes. Furthermore, their scientific attitudes are likely to be influenced and shaped during this stage as they explore and engage with scientific concepts and practices (Brown & Johnson, 2017).

The study utilized a method known as simple random sampling technique to select participants. This technique ensured that every member of the population had an equal opportunity to be chosen for inclusion in the sample (Cooper et al., 2019 as cited in Yuorsuu, 2024). The primary objective of employing simple random sampling is to guarantee the representation of the population in the sample, thus enabling the findings to be generalized and accurate conclusions to be drawn (Babbie & Mouton, 2019). By randomly selecting participants, the influence of biases and preferences is minimized, thereby enhancing the likelihood of obtaining an unbiased sample (Yuorsuu, 2024).

Using this sampling procedure and guided by the Taro Yamane's sample size calculation formula, 344 subjects were recruited to participate in the study. Out of this sample size, 172 were boys and the rest were girls. Each of the Two schools (St. Francis Girls' SHS and Jirapa SHS) presented a fraction of the sample size and this was done using the quota sampling technique. The individuals in the sample were selected using an online random number generator software.

Data Collection Tools

This study employed three distinct instruments to obtain data from the participants on the various variables of interest. These included a metacognitive Awareness Inventory (MAI), Scientific Attitude Assessment (SAA) questionnaires, and a Science Achievement Test (SAT).

The MAI is an adapted tool invented by Schraw and Dennison, (1994) and is made up of 52 items expecting respondents to respond true or false in each case by just checking the appropriate spaces provided. The items are carefully selected to cover the two major aspects of metacognition: *knowledge of cognition* and *regulation of cognition*. The items on knowledge of cognition span three subareas; 4 items were designed to assess the procedural knowledge of participants, 8 to assess the declarative knowledge of participants, and 5 on conditional knowledge. In the regulation of cognition category, the items cover the following subareas: planning (7 items), information management strategies (10 items), comprehension monitoring (7 items), evaluation (6 items), and debugging

strategies (5 items). Each true response was assigned a score weight of one (1), and a false response of zero (0), and respondents were taught how to score their responses under each subcategory on the score sheet. The MAI instrument was adopted with minor modifications to suit the population and context.

The MAI demonstrates good internal validity as it was developed based on a thorough theoretical framework and has been widely tested and validated in various research studies (Schraw & Dennison, 1994). This was equally confirmed by several studies that have reported significant correlations between the MAI scores and other measures of metacognitive abilities, providing further evidence of its internal validity (e.g., Hartman, 2001; Veenman, 2008).

The MAI has been administered to diverse samples, including students from different educational levels and individuals from various cultural backgrounds. The results of these studies have consistently demonstrated the external validity of the MAI by showing consistent patterns of metacognitive awareness across different populations (Yıldız Durak, 2014). However, it is worth noting that MAI's external validity might be influenced by cultural and contextual factors, so the researcher exercised caution in applying the results to populations that differ significantly from those studied previously.

The MAI has demonstrated good internal consistency, with high Cronbach's alpha coefficients (0.75 to 0.88) reported in various studies (Schraw & Dennison, 1994; Yıldız Durak, 2014). The test-retest reliability of the MAI has also been examined, showing satisfactory stability over time (Schraw & Dennison, 1994; Hartman, 2001). These findings suggest that the MAI produces reliable and consistent results, indicating that it can be used as a reliable measure of metacognitive awareness. Some items of the instrument were fine-tuned to ensure clarity of purpose and therefore, the reliability of the adapted instrument needed to be accounted for. This was done through a pilot test using a similar population of 100 participants. The results obtained were keyed into SPSS software and the reliability coefficient was computed. The modified instrument is reliable at 0.75 Cronbach's alpha. The MAI was administered to the participants at their various schools in the form of questionnaires. Clear instructions were provided to ensure accurate responses. The MAI responses were scored according to the established scoring guidelines provided by the inventory's authors and analyzed (Perry et al., 2006).

The Scientific Attitude Assessment (SAA) questionnaire is a thorough tool created to gauge participants' scientific attitudes, which greatly influences their involvement in scientific tasks and problem-solving methods. The SAA is a self-made instrument aimed at evaluating various scientific attitudes among participants. Each of the seven relevant attitudes, including intellectual honesty, objectivity, skepticism, creativity, critical thinking, open-

mindedness, and curiosity, is represented by five questions based on existing literature. These questions are rated on a four-point Likert scale, allowing participants to indicate their scientific attitudes accurately. To ensure content validity, the development of the Scientific Attitude Assessment (SAA) questionnaire was subjected to meticulous scrutiny. Initially, an extensive review of scientific attitude literature was conducted, which pinpointed seven crucial attitudes: intellectual honesty, curiosity, open-mindedness, critical thinking, creativity, skepticism, and objectivity. Following this, a total of 35 items were carefully crafted on a four-point Likert scale, with five items allocated to each attitude. Subsequently, data collected from a pilot test were analyzed to determine the reliability coefficient of the SAA instrument. The resulting Cronbach's alpha coefficient of 0.855 confirmed the instrument's capability to generate dependable data when examining scientific attitudes among participants. The same sample of participants from MAI was administered with the SAA questionnaire under similar conditions as in the case of the MAI.

On the other hand, the Science Achievement Test (SAT) serves as a quantitative tool designed to evaluate participants' instructional performance in integrated science. This test, also self-constructed, incorporates items drawn from previous West African Examination Council papers. It consists of two parts: the first part gathers demographic data, while the second part comprises 40 questions derived from integrated science papers from 2021 and 2022, with each question offering four alternatives.

Rigorous steps were taken to bolster the reliability and validity of the Science Achievement Test (SAT). Firstly, experts specializing in integrated science education and assessment meticulously scrutinized the test items. Their review ensured that the items were aligned with the learning objectives and subject content, thus refining the SAT to accurately measure academic performance as intended. To gauge the reliability of the SAT, a pilot testing phase was undertaken at Daffiama SHS, situated in a neighboring district within the Upper West Region. This phase involved administering the test to a sample of form three students, encompassing both science and non-science backgrounds. The collected results underwent thorough analysis to evaluate the consistency and stability of the test scores over time. The Cronbach's alpha coefficient obtained from the pilot test was 0.737, which affirms the instrument's reliability. Moreover, expert scrutiny of the items and individual item reliability assessments prompted the reduction of the instrument's size from 50 items to 40 items. This adjustment provided valuable insights into the SAT's reliability and facilitated necessary refinements and improvements. The SAT instrument was administered to the same sample, following standardized conditions to decrease external effects. Participants

completed the task for one hour, which assessed their knowledge of scientific concepts. The responses were evaluated using predetermined scoring rubrics that had been developed by the researcher.

Data Analysis Procedure

After the data were collected, cleaned, and sorted, they were uploaded onto the SPSS-21 software for analysis using various statistical tests. Specifically, research hypothesis one which seeks to ascertain whether there were differences in the academic performance between boys and girls was answered using the student t-test of independent samples, hypothesis two seeks to find out the associations that existed if any, between the independent variables and the dependent variable, therefore the Pearson moment product was computed to answer it. Linear regression was also used to analyze hypothesis three to see if there were some interactions among the variables.

RESULTS

1. H_0: There are no significant differences in academic performance in science between boys and girls.

Table 1: Independent Sample T-test on Science Achievement Test Based on Gender.

		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
SAT	Male Female	0.727	0.349	0.159	342	0.874	0.186	1.127

Note: SAT= Science Achievement Test

The comparison between males and females in science achievement was conducted using an independent sample t-test, revealing no significant differences in their scores (t (342) = 0.159, *Sig*. (2-tailed) = 0.874). This suggests that, on average, males (M = 81.33, SD= 11.234) and females (M = 81.15, SD = 10.499) performed similarly in science. Consequently, the hypothesis asserting no significant gender differences in science performance is accepted. This implies that both genders have equal opportunities to excel in science and science-related programs.

2. H_0: There is no correlation between academic achievement and metacognitive skills as well as scientific attitudes.

Table 2: Correlation Between Metacognitive Skills and Science Achievement Test

	Science Achievement Test (SAT)
Metacognitive Skills	r = 0.81 Sig.= 0.02

In Table 2, Pearson's 'r' was calculated to examine the nature of the relationship that existed between metacognitive skills and the academic performance of students in science. A strong positive correlation was obtained ($r(342) = 0.801$, $p < 0.05$), thereby suggesting a significant association between the variables. This means students with higher metacognitive skills on how to learn and regulate their learning perform better in science and vice versa. By this, the researcher fails to accept the null hypothesis which states that there is no correlation between academic achievement and metacognitive skills as well as scientific attitudes.

Table 3: Correlation Between Scientific Attitudes and Science Achievement Test

	Scientific Attitudes (SA)
Science Achievement Test (SAT)	r = 0.71 Sig. = 0.03

Table 3 presented a Pearson moment correlation coefficient analysis to investigate the relationship between scientific attitudes and students' academic performance in science. The results indicated a statistically significant and strong positive correlation ($r(342) = 0.71$, $p < 0.05$), revealing a linear association between these two variables. This implies that individuals with positive scientific attitudes tend to achieve higher academic performance in science, and conversely, those with lower scientific attitudes tend to exhibit poorer academic performance in the subject.

3. H_0: Metacognitive skills and scientific attitudes put together do not influence academic performance based on gender.

Table 4: Multiple Linear Regression on the Impact of the Independent Variables (MS and SA) on the Dependent Variable (SAT) Based on Gender

Model	ß	Std. Error	Sig.	df	F	R Square
Constant	63.788	9.108	0.00			
Gender	-0.333	1.127	0.05	2	11.202	0.90
MS	35.386	6.139	0.00	342		
SA	-2.913	2.828	0.00	342		

Note: MS = Metacognitive Skills, SA = Scientific Attitudes, SAT = Science Achievement Test

In Table 4 above, a multiple linear regression was performed to test if the level of metacognitive skills, scientific attitudes, and gender of students significantly predicted their academic performance in science. A fitted regression equation was found to be: SAT = 63.788 – 0.333(GENDER) + 35.386(MS) – 2.913(SA), where gender is coded as 1 for male, 2 for female, and performance in percentages. The regression was statistically significant ($F(2,342) = 11.202$, $p < 0.05$), with $R^2 = 0.90$. From the R^2 value, it means that 90% of the variation in students' performance in science could be attributed to the combined impact of the predictor variables. It was also found that, while gender is not a significant predictor of performance, both metacognitive skills and scientific attitudes, however, significantly predicted students' academic performance in science.

DISCUSSION

The independent sample t-test in Table 1 showed no significant difference in science achievement between males and females, suggesting both genders perform similarly and have equal opportunities in science programs. This finding contrasts with earlier studies, such as Arhin & Offoe (2015), which indicated a gender gap favoring males. Recent research by Stoet and Geary (2018) and Mullis et al. (2020) supports the trend of similar performance between genders globally. Wrigley-Asante et al. (2023) noted that while males may outperform females at the high school level, performance equality is observed at the tertiary level. Studies by Olashinde and Olatoye (2014) and Revati and Meera (2017) found no significant gender differences in scientific attitudes, though

Ahuja (2017) reported differences in performance in Delhi, India, it could be attributed to the influence of cultural factors on the dependent variable .

Pearson's correlation analysis in Table 2 showed a strong positive relationship between metacognitive skills and academic performance in science ($r(342) = 0.801$, $p < 0.05$). This means students with higher metacognitive skills perform better in science, leading to the rejection of the null hypothesis, which stated no correlation between these variables. Previous studies support these findings, such as Norehan (2015) in Malaysia, Elfa (2020) in the Netherlands, and Andria and Jane (2008) among college students, all indicating a significant positive association between metacognitive skills and academic performance. Research by Ogedegbe et al. (2019) also confirmed this connection in Nigerian university students, as did studies by Phan and Deo (2019) across Vietnamese and Australian students. A meta-analysis by Bembenutty and White (2013) further reinforced that metacognitive skills significantly predict academic achievement across various age groups and academic subjects.

Pearson's correlation analysis in Table 3 revealed a statistically significant and strong positive correlation ($r(342) = 0.71$, $p < 0.05$) between scientific attitudes and students' academic performance in science. This suggests that students with positive scientific attitudes tend to perform better academically in science. Numerous studies support this finding. For instance, Shivani (2012) found a positive correlation between scientific attitudes and academic success among high school students in India. Similar results were reported by Olasehinde and Olatoye (2014) in Nigeria, and by Ravi and Murali (2015) in India. Romine and Sadler (2016) also observed a positive correlation between scientific attitudes and science grades, standardized test scores, and interest in science. Research in Ghana, like that by Opoku and Amankwah (2019) and Asare and Mensah (2013), further supports this association. These studies highlight the critical role of scientific attitudes in academic achievement and emphasize the need to foster these attitudes to improve education outcomes.

The multiple linear regression analysis in Table 4 aimed to determine if metacognitive skills, scientific attitudes, and gender significantly predicted students' academic performance in science. The analysis found that while gender was not a significant predictor, the combined effect of metacognitive skills and scientific attitudes significantly impacted academic performance.

Supporting this, Constantine and Fah (n.d.) found a weak prediction of students' science achievement in Malaysia through combined metacognitive awareness and scientific attitudes. Kristiani et al. (2015) noted that 71.42% of Indonesian students' biology performance was due to these combined factors. Ben-Chaim et al. (2011) found that high levels of both metacognitive skills and scientific attitudes best predicted academic achievement.

Further studies by Carragher (2018), Lee et al. (2018), and Radzuan (2013) also indicated a synergistic effect on academic performance. In Ghana, Oduro and Dzomeku (2017) found significantly higher academic success among students with both strong metacognitive skills and positive scientific attitudes.

Overall, the research emphasizes the critical role of metacognitive skills and scientific attitudes in educational interventions to enhance academic outcomes. Further research in various contexts is needed to validate and expand these findings.

CONCLUSION

The study explored the multiplicative roles of metacognitive skills and scientific attitudes on gender-specific academic performance in science among a cohort of students in the Jirapa Municipality. The analysis and findings presented offer appreciated insights into the complex connections among the variables, and hold important implications for educationists, gender activists, policymakers, and stakeholders in the aspect of educational sciences.

Initially, the investigation delved into the realm of academic performance with a focus on gender dynamics, unveiling a notable absence of significant disparities in the intellectual prowess between boys and girls. This debunked antiquated stereotype linking certain genders with inherent aptitudes in scientific domains. This pivotal revelation not only confronts established societal constructs but also underscores the urgency for educational methodologies to be gender-sensitive, thereby fostering an environment conducive for all students to thrive in the realm of science.

Following this, the study delved deeper into the complexities surrounding metacognitive skills and scientific attitudes, revealing their substantial impact on academic performance. It became evident that metacognitive skills potentially played a pivotal role as strong indicators of students' achievements in science. Moreover, the cultivation of critical thinking skills surfaced as a pivotal factor, underscoring the multifaceted nature of scientific attitudes. These revelations emphasize the necessity of fostering critical thinking capabilities among students, thereby advocating for a comprehensive paradigm in science education that emphasizes holistic growth. Furthermore, the results unveiled the synergistic role of both metacognitive skills and scientific attitudes on students’ academic performance in science.

Implications for Classroom Instruction

This finding emphasizes the relevance of integrating both metacognitive skills and scientific attitudes into the educational framework, advocating for a holistic approach to nurturing these variables in students. Also, the findings would serve as a guide to educational practitioners and policymakers as well as offer direction for future research on the variables and their relationships.

In the aftermath of this rigorous investigation, the outcomes have transcended mere findings to forge a transformative pathway. The meticulous analysis conducted has not only unveiled insights but has also laid the foundation for a paradigm shift in educational approaches.

Limitation of the study

This study was carried out in the Upper West Region of Ghana, West Africa and caution should be exercised in extrapolating the findings to other settings as cultural factors, societal structures and norms may greatly affect attitudes (scientific attitudes in this case).

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