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Research Article

Combined effect of curiosity, creativity, and motivation on academic performance of senior high school students

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Abstract

Academic performance has consistently become the primary measure of students progress in school. As a yardstick, it is evident, based on the interaction of students' psychological abilities, such as curiosity, creativity and motivation, which seem to be disregarded. The current study, therefore, investigated the combined effect of curiosity, creativity, motivation, and academic performance in core mathematics and integrated science. Two research hypotheses guided the study. The study adopted a correlational design. A sample of 652 was used through the purposive, simple random, stratified-proportionate, and systematic sampling techniques. Adapted curiosity, creativity, motivation scales, expert-developed core mathematics, and integrated tests were used to collect the data. The data were analysed inferentially with multivariate regression. The study revealed that students' curious behaviours, creative abilities, and motivation are related and complement one another as students pursue their academic goals. At the same time, core mathematics predicted better in integrated science than its inverse. Therefore, schools should allow students to investigate issues in their environment, engage in personalised activities and provide them with stimulating consequences after academic processes. These would help harness their curious abilities, promote creativity and invoke motivation in them.

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Introduction

Education is an invaluable component of every nation. In judging the worth of education, the onus lies in the academic performance of students. Academic performance is an essential criterion used to assess students' success in their studies, making it vital to understand the factors responsible for determining, predicting, mediating, and causing variance in academic achievement (Ahmad & Bruinsma, 2006). Likewise, in Ghana, students' academic performance has become the yardstick for measuring the success or failure of learning processes (Ampofo, 2020; Ampofo & Benedict, 2015; Kwapong, 2021; Seddoh, 2013). Among the factors that play significant roles in the observation or realisation of academic performance of students are curiosity, creativity, and motivation. Litman (2008) defined curiosity as the motivation to search for information concerning a specific learning area. Curiosity is psychological energy that leads learners to engage in explorative behaviours that might result in rewards or prevent information gaps in their memory system. Curiosity is an integral part of a student's success, even if such students are from poor socioeconomic

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backgrounds. For example, a survey among 6,200 learners in the United States found that curiosity was a key factor that made students of low socioeconomic status excel at school (Burgess, Shah, Hough, & Hynynen, 2016). Thus, curiosity has significant pedagogic value in teaching and learning (Nurishlah, Budiman, & Yulindrasari, 2020; Singh & Manjaly, 2022).

Creativity appears elusive and challenging to be understood by researchers for many decades, because it defies a common or a precise definition and explanation. According to Dineen, Samuel, and Livesey (2005), creativity is a process of generating a consequence that is innovative or unique and applicable or appreciated. There are four significant components of creativity: a cognitive factor (intelligence or knowledge), a conative factor (personality or motivation), an emotional factor (the impact of emotional traits on creative potential), and an environmental factor (e.g., familial of school environments) (Ahmadi & Besançon, 2017). These components work together to define how creative an individual can be. Creativity is a crucial component of humanity. In the lives of learners, creativity is beneficial. Professionals in education widely accept it because applying creative ideas in teaching and learning situations can help develop learners' imagination and increase their discovery potential for future economic development (Cachia, Ferrari, Ala-Mutka, & Punie, 2010; Sternberg, 2015). Researchers such as Sawyer (2006) and Craft (2005) suggested that creativity should be an essential educational objective, as contemporary information societies pride schools that focus on training students for creativity. Wolfe and Bramwell (2008) established that creativity in education helps deliver suitable engagement to students and institutions, making students help institutions acquire innovative talents and knowledge. Creative programmes help transfer knowledge across domestic institutions and schools.

Cherry (2016) defined motivation as the process that initiates, guides, and maintains goal-oriented behaviours. Motivation is governed by an individual's need, intensity, and persistence towards the desired goal. Thus, motivation is a goal-directed mental energy that compels people to engage in behaviours that initially, they never had towards an identified goal. In explaining the value of motivation in education, Adamma, Ekwutosim, and Unamba (2018), Elliot and Dweck (2005), and Muola (2010) indicated that nurturing learning and maintaining motivation among students should be a prime area for every teacher because it is an integral part in the overall performance of students. According to Akpan and Umobong (2013), motivation substantially influences success.

The push for nurturing learners to become curious, creative, and motivated has been topical not only for the developed part of the world but those from developing countries. According to Amponsah, Mahama, and Wadieh (2022, p. 369), "the 21st century education system demands an educational model focused not necessarily on improving the intellectual abilities of students but also their ability to own and control their view of themselves through curiosity, creativity, and motivation ". This implies that, schools have a major role to play in training learners to become curious, creative, and motivated in their academic engagements. However, it is possible that the teachers who may be mandated by schools to nurture curiosity, creativity, and motivation in learners might not possess the requisite ability to execute their mandate. For instance, a study exploring in-service teachers' creative nurturing behaviours in Ghana by Mahama (2022) found that most teachers had low levels of creativity nurturing behaviours, hence their inability to nurture their learners to become creative in learning situations.

Empirical Evidence

It is noted that several factors influence academic performance of students (Colangelo & Davis, 2011), and such factors include curiosity, creativity, and motivation as they work hand-in-hand. Researchers have indicated that curiosity, creativity and motivation are intertwined. With this, curiosity is repeatedly related to motivation, novelty, and the quest for success in an academic environment (Barto et al., 2013; Kidd & Hayden, 2015; Gottlieb, Oudeyer, Lopes, & Baranes 2013; Oudeyer & Kaplan, 2007). Rinco (2011) explained that curiosity, creative thinking and motivation were factors that measured and influenced students' success. According to Alzoubi, Al-Qudah, Albursan, Bakhiet, and Abduljabbar (2016), students' creative thinking improved their curious abilities and motivational urges. In a study among Chinese students, Jeng, Hsu, Xie and Lin (2010) found that curiosity, creativity, and motivation worked together to improve students' academic performance and as well, promoted the efficacy of teaching, teaching approaches, and the individual

experiences of teachers. Sudarman (2020) conducted a study among high school students in Karawang, West Java, Indonesia. In the study, the researcher examined psychological behaviours such as curiosity, creativity, motivation, self-esteem, and Academic Performance. The study revealed that the psychological behaviours were related and jointly and positively influenced (predicted) students' academic performance in mathematics and natural sciences. Based on this, Sudarman (2020) advised that teachers should be made to develop students' curious abilities, creativity, and motivation through exploration, presenting challenging teaching materials to them, and providing them with flexibility in adapting to new situations. Likewise, Kashdan et al. (2017) examined students' curiosity, creativity, and motivation. Their study argued that when students were curious about the subject matter, they showed motivation and creativity, where they were able to manage their learning and achievement.

The Present Study

The present study aims to unravel the collaborative influence of curiosity, creativity, and motivation on students' academic performance in Ghana. Curiosity, creativity and motivation are psychological variables that can work in tandem to determine students' academic performance in any educational endeavour (Nauzeer & Jaunky, 2021). For instance, when learners become curious, they show higher motivation levels in attending to information presented to them, increase their effort in seeking and acquiring knowledge, and retain new information for use in the future (Kang et al., 2009). Taken together, several paired variable studies have been conducted among curiosity, creativity, motivation, and academic Performance (Dramanu & Aisha, 2017; Gajda, Karwowski, & Beghetto, 2017; Nami, Marsooli, & Ashouri, 2014; Nurishlah, Budiman, & Yulindrasari, 2020; Steinmayr, Weidinger, Schwinger, & Spinath, 2019; Surapuramath, 2014; Von Stumm, Hell, & Chamorro-Premuzic, 2011) but none of these studies considered merging the constructs, where all can work collectively to influence students' academic performance. The joint contribution of curiosity, creativity, and motivation is an indispensable panacea to learning outcomes of students but it appears such constructs are less saliently considered in developing curriculum for learners in Ghana. Although several educational reforms were made in Ghana since 1987, none captured issues of curiosity, creativity, and motivation until the New Standard-Based Curriculum was developed and implemented in 2019 (Adu-Gyamfi, Donkoh, & Addo, 2016; Mahama, 2022). Even with the New Standard-Based Curriculum, less is discussed about how to train teachers so that they could nurture learners on curiosity, creativity, and motivation (Mahama, 2022). However, it is expected that learners exhibit curious, creative, and motivation abilities in their learning situtaions because, these abilities are noted to have a great effect on their academic success.

Problem of Study

This study, therefore, sought to provide a lid on the knowledge vacuum by determining the combined effect of curiosity, creativity, and motivation on the academic performance of S.H.S students in the Central Region, Ghana, using the following questions:

- What is the combined effect of curiosity, creativity, motivation, and academic performance of S.H.S. students in the Central Region, Ghana?
- What is the predictive ability core mathematics and integrated science performance of S.H.S. two students in the Central Region, Ghana?

Method

Research Model

This research is in the survey model, which is one of the quantitative research types. The characteristics of some variables in a certain group can be accepted in relational survey model types since this study was conducted to determine their relationships with each other.

Participants

A sample of 652 students drawn from 25 Senior High Schools in the Central Region of Ghana was used. These students were in their second year and abreast with issues under investigation. All the students shared similar characteristics

regarding schools where they were drawn, which were not different from all the areas examined or assessed. The average age of the students was M_{age}=16.80±.98. In addition, the gender of students was considered, where female students dominated the sample with a frequency of 288 (50.7%) while male students had a frequency of 280 (49.3%). Comparing with the proposed sample size for the study, it is evident that 288 out of 323 female students made up a return rate of 89.0%, while 280 out of 329 male students made up a return rate of 85.0%.

Data Collection Tools

Five Dimensions of Curiosity Scale

The 5-Dimensions of Curiosity developed by Kashdan et al. (2018) was adapted. Students responded between 1-4 (Strongly disagree-Strongly agree) on a 4-point scale. The 5DC had five (5) dimensions with a total of 25-items. Dimension one (1) was named "Joyous Exploration"; it had five (5) items with a reliability coefficient of .80 and had statements like "I view challenging situations as an opportunity to grow and learn". Dimension two was named "Deprivation Sensitivity" with a reliability coefficient of .67 and had statements like "I work relentlessly at problems that I feel must be solved". Dimension three was named "Stress Tolerance" with a reliability coefficient of .72 and had statements like "I cannot handle the stress that comes from entering uncertain situations". Dimension four was named "Social curiosity with a reliability coefficient of .59 and had statements like "When around other people, I like listening to their conversations". Dimension five was named "Thrill-seeking" with a reliability coefficient of .79 and had statements like "Risk-taking is exciting to me". Some words were modified and a personal pronoun "I" was added to start each statement in order to meet the context of the study. Again, the original scale had scored from strongly disagree to agree strongly. The original scale had scored on a 7-point Likert-type scale but was modified to 4-point to avoid neutral points. This was done to ensure each respondent had a positive or negative opinion of the statements. The structure of the items on the instrument was closed-ended, where respondents were only allowed to select one response set. The scale had a composite reliability coefficient of .71 before data collection and produced a reliability coefficient of .76 after data collection.

Kaufman Domains of Creativity Scale (K-DOCS)

Kaufman Domains of Creativity Scale (K-DOCS) developed by Kaufman (2012) was adapted for the measuring creativity. Students responded between 1-4 (Strongly disagree-Strongly agree) on a 4-point scale. The scale had five dimensions with a total of 50-items. Dimension one was named "Self/Everyday Creativity" with a reliability coefficient of .86 had 11-items and statements like "Helping other people cope with a difficult situation". Dimension two was named "Scholarly Creativity" with a reliability coefficient of .86, had 10-items and statements like "Writing a nonfiction article for a newspaper, newsletter or magazine". Dimension three was named "Performance Creativity" with a reliability coefficient of .87, had 10-items and statements like "Playing music in public". Dimension four was named "Mechanical/Scientific Creativity" with a reliability coefficient of .86, had 10-items and statements like "Solving math puzzles". Finally, dimension five was named "Artistic Creativity" with a reliability coefficient of .83, had 9-items and statements like "Coming up with my interpretation of a classic work of art". Some words were modified, and a personal pronoun "I" was added to start each statement to meet the study's context. Again, the original scale had scored from strongly disagree to agree strongly. The original scale had scored on a 5-point Likert-type scale but was modified to 4-point to avoid neutral points. This was done to ensure each respondent had a positive or negative opinion of the statements. The structure of the items on the instrument was closed-ended, where respondents were only allowed to select one response set. The measure had a composite reliability coefficient of .86 before data collection and produced composite reliability of .79 after data collection.

Academic Motivation Scale (AMS-28)

The Academic Motivation Scale (AMS-28) developed by Vallerand et al. (1997) was adapted. Students responded between 1-4 (Strongly disagree-Strongly agree) on a 4-point scale. The measure had seven dimensions with a total of 28-items. Dimension one, named "Knowledge dimension", had 4-items with a reliability coefficient of .84 and had statements like "Because I experience pleasure and satisfaction while learning new things". Dimension two was named

"Accomplishment dimension", which had 4-items with a reliability coefficient of .78, and had statements like “For the pleasure I experience while surpassing myself in my studies". Dimension three was named "Stimulation dimension", which had 4-items with a reliability coefficient of .78 and had statements like "Because I like going to school". Dimension four was named "Identified dimension", had 4-items with a reliability coefficient of .81, and had statements like "Because eventually, it will enable me to enter the job market in a field that I like”. Dimension five was named “Introjected dimension", had 4-items with a reliability coefficient of .80, and had statements like "Because when I succeed in school, I feel important". Dimension six, named "Extrinsic dimension", had 4-items with a reliability coefficient of .71 and had statements like "Because I want to have 'the good life later on". Dimension seven, named "Amotivation dimension", had 4-items with a reliability coefficient of .84 and had statements like "I cannot see why I go to school and frankly, I could not care less". Some words were modified, and a personal pronoun "I" was added to start each statement to meet the study's context. Again, the original scale had scored from strongly disagree to agree strongly. The original scale had scored on a 7-point Likert-type scale but was modified to 4-point to avoid neutral points. This was done to ensure each respondent had a positive or negative opinion of the statements. The structure of the items on the instrument was closed-ended, where respondents were only allowed to select one response set. The measure had a composite reliability coefficient of .79 before data collection and produced a reliability coefficient of .82 after data collection.

Core Mathematics and Integrated Science Tests

Students' academic performance was measured using Core Mathematics and Integrated Science as proxies. Core Mathematics and Integrated Science were used in this study for several reasons. For example, Foley, Herts, Borgonovi, Guerriero, Levine, and Beilock (2017), Lyons and Beilock (2011) and Maloney, Schaeffer, and Beilock (2013) indicated that students habitually give negative emotions and motivations in mathematics and integrated science. Hence, the choice of these subjects was appropriate as curiosity, creativity and motivation could minimize negative emotions of students concerning mathematics and integrated science. Also, these subject areas were used because they are among subjects that are considered for students' progression from one stage to another in academia at the senior high level. For students to succeed in these subjects, there is a need for curiosity, creativity, and motivation. Again, these subjects are highly related to students' curiosity, creativity and motivation (Cutraro, 2012). For a student to pass well in any of the two subject areas, they must go beyond normal rehearsal or repetitions that come with other subjects like English Language and Social Studies. When pursuing subjects like integrated science and core mathematics, students need to explore, make efforts to come out with novel products and as well, must attach motivation in the process. Experts in the subject areas were contracted to develop the instruments at an agreed fee. The measures contained 100-items, mainly in multiple-choice format (4-options) with 50-items each for integrated science and core mathematics. The Kuder-Richardson (KR-21) reliability for core mathematics was .79, while that of integrated science was .77.

Data Analysis

The researcher performed multivariate regression for both core mathematics and integrated science. In this analysis, the predictor variable was combined curiosity, creativity, and motivation, while the criterion variables were core mathematics and integrated science. This sort of variable combination gives room for multivariate regression to be performed. In multivariate regression, there is the need for more than one dependent variable against one or more independent variable(s). The literature noted that multivariate regression is based on observation and analysis of more than one statistical outcome variable at a time (Hidalgo & Goodman, 2013; Olkin & Sampson, 2001).

Procedure

Ethical protocols such as ethical approval (CES-ERB/UCC/EDU/V14/20-09), informed consent, anonymity, and confidentiality were considered in this study. All students accepted to participate in the study voluntarily. The study was in two sessions. The curiosity, creativity, and motivation measures were filled first by the students, and it lasted for just a day. The second session was for the performance measures, which lasted for two days (a day each for a subject) with activity period of 60 minutes for each subject. The testing took place during regular classes in the selected schools. The researcher administered the tests with the help of trained research assistants.

Results

In this study, it was prudent to test the assumptions appropriately using descriptive statistics before performing the multivariate regression test for the hypothesis. The assumptions tested included the skewness of data, kurtosis of data, and means and standard deviations of the variables used in the study. Table 1 presents the results.

Table 1. *Descriptive Statistics for all the Scales*

	Min.	Max.	Mean	SD	Skewness		Kurtosis	
Measures	Stat.	Stat.	Stat.	Stat.	Stat.	Std. E	Stat.	Std. E
Curiosity Total	51.00	90.00	71.54	7.30	-.255	.103	-.098	.205
Creativity Total	92.00	200.00	143.75	16.50	.209	.103	.438	.205
Motivation Total	51.00	112.00	86.31	9.11	-.654	.103	.483	.205
Core Mathematics	10	48	31.08	7.26	-.080	.103	-.443	.205
Integrated Science	10	47	29.94	5.77	-.373	.103	.361	.205

Table 1 indicates that data skewness based on custom rule values ranged between +1 and -1, and kurtosis custom rule values ranged between +1 and -1 (Hair, Hult, Ringle, & Sarstedt, 2017). Referring to curiosity, it produced a skewness statistic of -.255 and a kurtosis statistic of -.098. This implied that distribution for curiosity was skewed to the left while kurtosis produced a negative value, making the data leptokurtic. This explained that most responses or cases are falling above the average/midpoint on the normal curve. Referring to creativity, it produced a skewness statistic of .209 and a kurtosis statistic of .438. This implied that the distribution for creativity was skewed to the right while kurtosis produced a positive value, making it platykurtic kurtosis. This explained that most cases are falling below the average/midpoint on the normal curve. Referring to motivation, it produced a skewness statistic of -.654 and a kurtosis statistic of .483. This implied that the distribution for motivation was skewed to the left while kurtosis showed positive value, making the data leptokurtic. This explained that most responses or cases are falling above the average/midpoint in the normal curve. Finally, referring to mathematics, it produced a skewness statistic of -.080 and a kurtosis statistic of -.443. This implied that the distribution was skewed to the left while kurtosis showed negative value, making the data leptokurtic. This explained that most responses or cases are falling above the average/midpoint in the normal curve. Integrated science produced a skewness statistic of -.373 and a kurtosis statistic of .361. This implied that the distribution was skewed to the left while kurtosis showed positive value, making the data platykurtic. This explained that most responses or cases are falling above the average/midpoint in the normal curve. Based on the results, it is assumed that the distribution was approximately symmetrical as a skewness value of zero (0) indicates a perfectly symmetrical distribution.

Combined Effect of Curiosity, Creativity and Motivation on Academic Performance

This question aimed to establish combined statistical relationships between the psychological constructs (curiosity, creativity, motivation) and academic performance in core mathematics and integrated science using the multivariate linear regression (MLR). The multivariate linear regression was chosen because the dependent variable, performance, had two dimensions against one combined independent variable. Before performing the test, normality test, linearity, homoscedasticity and multicollinearity assumptions were certified as preliminary test as indicated in the results of hypothesis one and hypothesis two. Because the test involved multiple dependent variables, it was necessary to set a higher alpha level so that the chance of committing Type error (rejecting the null hypothesis where there are no significant results) could be reduced. In doing this, the Bonferroni adjustment proposed by Pallant (2016) was applied. The researcher divided the number of dependent variables by the original alpha level; thus, .05/2=0.025, where .025 becomes the new alpha level. Table 2 presents the results.

Table 2. *Combined Multivariate Linear Regression Results for Psychological Constructs and Academic Performance*

DV	Parameter	B	S. E	t	Sig.	P E S	F	p
Core Maths.	Intercept	3.467	.826	4.199	.000	.030	258.612	.000
	IVs' Combined	.352	.022	16.081	.000	.314	92.367	.000
Int. Science	Intercept	5.943	.965	6.161	.000	.063	258.612	.000
	IVs' Combined	.246	.026	9.611	.000	.140	92.367	.000

R Squared = .314 (Adjusted R Squared = .312) R Squared = .140 (Adjusted R Squared = .139) Significant @ .025

Table 2 shows the results of the multivariate linear regression (MLR) test, where curiosity, creativity, and motivation were combined as one variable and used as a predictor of academic performance in core mathematics and integrated science. Wilk's Lambda test for the omnibus hypothesis that all beta values across the dependent variables equalled zero were statistically significant; thus, F (2, 565) =23.005, W=.925, p < .025. With core mathematics as the dependent variable, R^2 =.314, F=258.612, p < .025. This shows that 31.4% of combined curiosity, creativity and motivation explained the variance in core mathematics performance. With integrated science as the dependent variable, R^2=.140, F=92.367, p < .025. This shows that 14.0% of combined curiosity, creativity and motivation explained the variance in integrated science performance. Individual predictions combined with curiosity, creativity and motivation (Beta=.352) predicted higher core mathematics performance than integrated science performance (Beta=.246). The results produced a large effect size of .46 for core mathematics and a weak effect size of .16 for integrated science performance. This implies that the strength of the relationship in combined curiosity, creativity, motivation and mathematics performance was high.

In contrast, the strength of the relationship in combined curiosity, creativity, motivation and integrated science performance was low. In the two situations, combined curiosity, creativity and motivation predicted higher core mathematics performance than combined curiosity, creativity and motivation prediction in integrated science. On this note, the null hypothesis states that there will be no combined effect of (a) curiosity, (b) creativity and (c) motivation on the (d) academic performance (mathematics and science) of students in Senior High Schools in the Central Region, Ghana was rejected.

Predictive Ability between Core Mathematics and Integrated Science

Testing this hypothesis was to establish a bidirectional statistical relationship between core mathematics performance and integrated science performance using regression. The regression was chosen favouring Canonical Correlation and Pearson Product-Moment Correlation for the non-recursive prediction because it has the power to produce correlations and predictions among the variables, where each variable predicts the other. Table 3 presents results based on curiosity, creativity and motivation pairings.

Table 3. *Regression Results on Mathematics and Integrated Science Performances*

Variable	B	SE	*B*	R	T	Sig.	R^2	Ad R^2	F	p
Core Maths	.332	.030	.418	.418	10.9	.000	.174	.173	119.61	.000
Int. Science	.526	.048	.418	.418	7.45	.000	.174	.173	119.61	.000

*First Pairing Dependent=Int. Science; *Second Pairing Dependent= Mathematics

In testing whether mathematics ability and science ability could predict each other, the results show a moderate positive relationship between students' ability in core mathematics and integrated science (r=.418). The regression results indicate that students' mathematics ability explained 17.4% of the variance in their ability in science [R^2=.174, F (1, 565) =119.61, p=.000]. It was found that students' mathematics ability significantly predicted students' ability in integrated science (β =.526, p=000) better than students' ability in integrated science predicting students' ability in core mathematics. The results mean that a unit increase in students' mathematics ability will increase their ability in integrated science. For effect size contribution of students' mathematics ability to their ability in science, the results revealed an effect size of .21, which was weak using Cohen's (1988) formula. E.g. $f^2=R^2/1-R^2=.174/1-.174=.174/.826=.21$. This

implies that the strength of the relationship between core mathematics performance and integrated science performance is low. It is conclusive to note that students' ability in mathematics can influence their scientific or science ability.

Parsimonious Framework

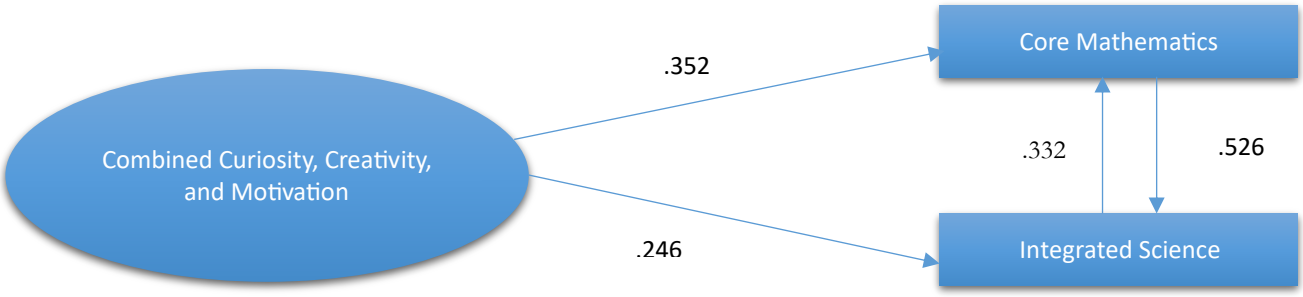

Figure 1. *Combined Curiosity, Creativity, Motivation, Predicting Academic Performance*

Figure 1 indicates the combined curiosity, creativity and motivation predictive ability in core mathematics and integrated science. It is revealed that combined curiosity, creativity, and motivation was better predictor of core mathematics performance than integrated science performance. It means that students' curiosity, creativity, and motivation working together contributed much to their core mathematics performance than integrated science performance. In contrast, core mathematics predicted integrated science better than integrated science predicting core mathematics.

Discussion

The questions one was about the combined predictive ability of curiosity, creativity, and motivation on students' academic performance in core mathematics and integrated science. The study revealed that combined curiosity, creativity and motivation predicted higher core mathematics performance than integrated science performance. The combined curiosity, creativity, and motivation produced a large effect size for core mathematics and a weak effect size for integrated science. This implied that combined curiosity, creativity and motivation had a strong relation with core mathematics performance, while the combined curiosity, creativity, and motivation relationship with integrated science was weak. The finding means that a combination of curiosity, creativity and motivation has the power to improve students' academic performance in core mathematics and integrated science. The revelation buttresses the fact that curiosity, creativity and motivation as psychological constructs work in tandem in the cognitive make-ups of students. With this, students with high levels of curiosity, creativity, and motivation working hand-in-hand may improve their intelligence, which may improve their school achievement. In this realm, schools must take necessary steps to harness the combined development of curiosity, creativity and motivation of students as they work collaboratively to improve upon outcomes of students in school and life in general. The current study's finding confirms Jeng, Hsu, Xie, Lin, and Huang's (2010) study finding revealed that curiosity, creativity, and motivation collaboratively predicted students' academic performance and promoted students' individual experiences.

Furthermore, the current study's finding supports the finding of Sudarman (2020). The study found that combined curiosity, creativity, motivation, and self-esteem significantly predicted students' academic performance. Based on this, Sudarman (2020) implored teachers to develop curiosity, creativity and motivation in students. More so, the current study's finding corroborates the finding of Kashdan, Doorley, Stiksma, and Hertenstein (2017). In their study, curiosity, creativity, and motivation jointly predicted students' learning behaviours and academic achievement.

The question two aimed at testing the predictive abilities of core mathematics and integrated science. In the testing process, both core mathematics and integrated served predictors and criteria on two occasions because the aim was to find out which would predict better. The study revealed that students' mathematics ability significantly predicted students' ability in integrated science much more than scientific abilities predicting mathematical abilities. The

revelation means that as students become mathematically promising, they can become scientifically better. Students' accuracy in calculating scientific principles may depend on their mathematical abilities. Hence, helping students excel in mathematics will go a long way to help them improve their scientific skills. Therefore, it is prudent that teachers in mathematics and science be aware of their relationship and collaborate to provide students with opportunities for meaningful connections between core mathematics and integrated science. Both core mathematics and integrated science produced a weak effect size. This effect size means that the relationship between core mathematics and integrated science was weak, though significant. The current study's finding supports that science incorporates mathematics by using mathematical functions to solve science problems or teach a science principle (Browning, 2011). Empirically, the current study's finding confirmed that of Shelley and Yildirim (2013), which found that students' knowledge in mathematics could be transferred to scientific knowledge, where mathematics and science seem to reciprocate in their interaction.

Furthermore, the current study's findings are in line with Oyedeji's (2011) study among high school students in Nigeria. The study established a positive relationship between the students' mathematics skills and science achievement. Students' mathematical skills significantly predicted their science achievement, where mathematical skills explained 37.4% of the variance in science achievement.

Conclusion

Students in Senior High Schools in the Central Region's curious behaviours, creative abilities and motivation are related and complement one another as students pursue their goals. As students become curious, their creative abilities are energised, and they become motivated when innovative products are realised. For students to become successful, their curiosity must be provoked, their creative abilities are honed, and their efforts be reinforced. Therefore, it is prudent for teachers and parents to find appropriate strategies where students' explorative behaviours could be harnessed, where students could be engaged in independent activities to realise their creativity and make an effort to reward students in the process. Students in Senior High Schools in the Central Region's abilities in mathematics could help in their abilities to study science-related courses or subjects because these broad subject areas are positively related. In this situation, mathematically good students may be scientifically better. It is acceptable that calculation in scientific principles will depend on their mathematical abilities. In realising the linkage, teachers in mathematics and science can collaborate to provide students with opportunities that can bring the two subject areas together as they may complement each other as students study them.

Recommendations for Policy and Practice

It is recommended that there should be a revised focus on training students to pass examinations but includes how knowledge acquired in the classroom can be applied outside the classroom. This can be done when the management of schools allows students to investigate issues in their environment, allow students to engage in personalised activities and provide them with stimulating consequences after academic processes. Also, there is a need for inter-subject area workshops, as mathematics and science are related. Organising these workshops will allow teachers with diverse subject areas to collaborate in finding common ground where different subjects can be taught to students in a complementary manner. Again, Ghana Education Service should take a step further in revising the way and manner they organise workshops for in-service teachers and make it inter-subjects related to include the various subject areas as they could complement each other and improve upon students' academic performance in most school subjects.

Furthermore, the Ghana Education Service, in collaboration with the Ministry of Education and Curriculum Developers, should harmonise curiosity, creativity and motivation in the syllabus so that teachers can teach students to become curious, creative and motivated. Lastly, training programmes for in-service teachers and pre-service teachers should be geared towards the inclusion of curiosity, creativity, and motivation to make it comprehensive for teachers as they engage students in current and future teaching and learning activities.

Limitations of the Study

The study surveyed only senior high students in the Central Region of Ghana, and the findings cannot reflect all other students in the country. Therefore, caution should be taken when discussing and implying the study findings because generalizability is limited.

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Conflict of Interest

There is no issue of conflict of interest in the process of conducting this study. Therefore, nothing of that sort appears to influence the study and its findings in any way.

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