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Motivation and Mathematics Achievement: A Case Study of Grade 11 students in Ghana

Florence Christianah Awoniyi*

Department of Teacher Education, School of Education and Leadership, University of Ghana, Legon, Accra, Ghana.
Postal Address: School of Education and Leadership, Department of Teacher Education,
P. O. Box LG 1181, University of Ghana, Legon, Accra (+233)267846867

**E-mail address: fcawoniyi@ug.edu.gh*

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Abstract

This study investigated the relationship between motivation and performance in mathematics using Deci and Ryan's Self Determination Theory. The participants were 2,575 grade 11 students from 10 senior high schools in the Cape Coast Metropolis, Ghana. The study employed a quantitative research approach and used a questionnaire and an achievement test to collect data. Descriptive and inferential statistics were used to analyze the data. The study found that only amotivation and introjection, among the five sub constructs of motivation considered in the study, recorded statistically significant contributions ($p < .05$) to students' achievement. Teachers, lecturers, and researchers may need to seek practical ways to promote intrinsic motivation in students for better engagement with mathematics. The study also indicated the likelihood of different kinds of amotivation with varied influences on the learning of mathematics. As a result, more investigation is required.

1. Introduction

There is a high failure rate in mathematics among senior high school students in Ghana, as reported by various examination bodies, despite the widespread usage of mathematics in everyday life (Butakor, 2016). For example, in the June 2012 examination administered by the West African Examination Council (WAEC), only 49% of applicants who took the mathematics core paper received at least a credit pass (C6 and above). Because mathematics is an essential subject, every high school graduate must obtain a C6 to be eligible for tertiary education. The implication is that in 2012, more than half of the candidates were not qualified for admission to higher education. The situation got worse in the subsequent years. In 2013, only 36.8% of the candidates obtained at least a C6. The Grade C6 or better pass rates for 2014, 2015, 2016, 2017, and 2018 were 32.4%, 25.04%, 32.83%, 42.73% and 38.33% respectively. Though there was a slight improvement in 2017, when 42.73% of the candidates achieved Grade C6 or better, it dropped to 38.33% in 2018. The implication is that over 61% of the candidates who wrote the school certificate examination in 2018 could not advance to the next level of schooling. Although the last three years' performances are above average, that is, 65.31%, 65.71%, and 54.11% for 2019, 2020, and 2021, respectively, there has never been an excellent performance in the last 20 years. Parents, teachers, students, and other stakeholders in the education sector continue to be concerned about this dismal performance.

There is substantial evidence that motivation promotes academic performance in students (Bailey & Phillips, 2015; Dogan, 2017; Fereidooni Moghadam, Bavarsad, Rezaie, & Cheraghian, 2017; Kori et al., 2016; Mustami & Safitri, 2018; Obiosa, 2020; Schick & Phillipson, 2009). Indeed, a body of experimental research has demonstrated that academic motivation tends to be an effective predictor of school performance (Deci, Vallerand, Pelletier, & Ryan, 1991; Dogan, 2017; Fereidooni-Moghadam, Bavarsad, Rezaie, & Cheraghian, 2017; Fortier, Vallerand, & Guay, 1995; Isik, Wilschut, Croiset, & Kusurkar, 2018; Komarraju, Karau, & Schmeck, 2009). This explained the position of Bruinsma in 2004

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(as cited by Kori et al., 2016) that higher motivation results in higher academic performance. Unfortunately, Ghanaian students are not doing well in mathematics even though they "like" and "value" mathematics, as reported by Mullis et al. (2012). According to the authors, grade eight students in Ghana are motivated both intrinsically and extrinsically to learn mathematics. Their average score for liking learning mathematics (intrinsic motivation) is one of the highest in the study (TIMSS), and their average score for utility value of mathematics is higher than any other participating country. What kind of motivation promotes learning?

Motivation to learn is defined as making teaching visible to students so that they can learn to become their own teachers (Hattie, 2012). According to the author, students' becoming their own teachers is the core attribute of lifelong learning or self-regulation and of the love of learning that is envisaged by all and sundry. Likewise, teachers are to become learners of their own teaching so that they can understand the impact they have on the learning of their students. Hattie (2012) presented 252 effect sizes ranging from –0.90 to 1.57 using the Visible learning principle. The hinge-point was at 0.40. This means that half of the influences on achievement are above this hinge-point (the zone of desired effects) and half are below it as well. About half of our students are in classes that get this effect of 0.40 or greater, while half are in classes that get less than 0.4 effect.

Hattie's (2012) claim is similar to the findings of Deci and Ryan (1985) when the authors divided motivation into two subconstructs: extrinsic and intrinsic motivation. The 0.40 ("hinge point") effect size of Hattie could be seen as the borderline between extrinsic and intrinsic motivation in Deci and Ryan. On the list of 252 effect sizes of Hattie, 0.69 effect size was assigned to "deep motivation and approach" while 0.42 effect size was assigned to "motivation" (Waack, 2018). The two sub-constructs by Hattie could be seen as Deci and Ryan's intrinsic (which is internal, self-regulated, and an end in itself) and extrinsic (which is external and a means to an end), respectively. However, Deci and Ryan further divided extrinsic motivation into four sub-constructs and intrinsic motivation into three sub-constructs. This is in addition to the obvious fact that the authors stated that it is possible for one not to be motivated at all (that is, amotivation). Hence, Deci and Ryan are preferred in this study to identify the exact sub-construct that can hinder or facilitate learning in order to boost performance. The current study is not about teachers' clarity or wanting to know what strategies to implement when teaching for maximum impact, neither is it about setting learning intentions and various outcomes, etcetera, as indicated by Hattie's meta-analysis findings; rather it is about students' clarity, knowing what propels them to learn. Hattie's theory and principles deal with practical ways of tackling learning challenges, but the current study focuses on identifying the problems that bring down the performance of students in mathematics, first and foremost, by using motivation as a medium. Thus, providing educators and researchers with some of the problems that are begging for practical ways to stop success leakages in mathematics performance. This could be likened to a laboratory scientist identifying a patient's problem through lab tests and a medical doctor interpreting the results to prescribe appropriate medicine.

The present study explored the role of motivation, in the performance of Ghanaian students in mathematics. The exploration focused on the motivational factors that are capable of predicting students' performance in mathematics.

1.1. Objective of the study

To study aimed at finding out which motivational factors predict the performance of Grade 11 students in mathematics. The research question of the study: Which motivational factors predict the mathematical performance of Grade 11 students in Ghana?

2. Literature Review

2.1. Mathematics Education in Ghana

Senior high school is a post-primary basic education programme that prepares the students for middle-level jobs as well as tertiary education. Hence, its importance for individual and national development. Due to persistent mass failure, it has become very challenging for senior high school graduates to progress to the tertiary level of the educational ladder, to acquire employable skills in either technical universities, colleges of education, or universities. Although efforts are made to implement the nation's mandate regarding education as contained in the Constitution (Republic of Ghana, 1992) through free education at all basic levels, the nation, due to mass failure at WASSCE (the national examination), is yet to reap the benefits of access and equity in basic education. Most of the senior high schools in Ghana provide comprehensive secondary education that would enable the graduands to proceed to tertiary institutions, while a few provide only technical or vocational education. Students at senior high schools in Ghana offer Visual Arts, General Arts, General Science, Business, Technical, and Home Economics, etcetera.

All the aforementioned programmes offer four core subjects and four elective subjects. The core subjects are Core Mathematics, English language, Social Studies, and Integrated Science, and in addition, they each offer four elective subjects. The elective combinations are varied to fit the various future demands of the students, the desired university programmes, and national goals. For example, the General Science programme offers Physics, Biology, Chemistry, and Elective Mathematics as elective subjects. The General Arts programme offers either Literature, Government, Christian Religious Studies, and Economics as elective subjects, or Government, History, Christian Religious Studies, and French or Twi (Ghanaian language). The Business programme has Financial Accounting, Economics, Elective Mathematics, and Business Management options; or Financial Accounting, Cost Accounting, Economics, and Business Management options; or Elective Mathematics, Cost Accounting, Economics, and French.

The Visual Arts programme elective subjects are General Knowledge in Arts, Sculpture, Ceramics, Pottery options; or Basketry, Graphic Design, Textile/Picture Making, General Knowledge in Arts options; or Leather Works/Jewellery, General Knowledge in Arts, Graphic Design, and Picture Making/Economics. Home Economics offers Food and Nutrition, Biology, Management in Living, and General Knowledge in Arts; or Clothing, Biology, Management in Living, and General Knowledge in Arts. Finally, the Technical Programme offers a varied combination of subjects: Metal, Auto Mechanic, Welding, Electricals, Elective Mathematics, etc.

Some Ghanaian educators (e.g., Ansah, Quansah, & Nugba, 2020; Ansah, Mensah, & Wilmot, 2020; Bosson-Amedenu, 2017; Fletcher, 2018) have established that there is a crisis in mathematics achievement among students. Despite the widespread usage of mathematics in everyday life, many senior high school students struggle with mathematics and perform very poorly on their final examinations in most jurisdictions in Ghana. The West African Secondary School Certificate Examination (WASSCE) results from 2012 to 2018 attest to this. Nonetheless, since studies have established that motivation promotes academic performance in students, understanding motivation as an affective variable might help readers appreciate its role in learning.

2.2. Intrinsic motivation

It may be claimed that adhering to an activity necessitates the use of glue or a hook, and motivation appears to be the magnet that draws and keeps students interested in numerous learning adventures. Depending on the underlying circumstances, this attraction can be internal or external. The idea of individual interest, enjoyment, or liking has been connected to internal attraction, also known as intrinsic motivation (e.g., Bailey & Phillips, 2015; Gaspard, Dicke, Flunger, Schreier, & Hafner, 2015; Ryan & Deci, 2020). That is, the term intrinsic motivation has to do with when a person sees a task as an end in itself. Intrinsically motivated students seek and prefer new challenges, explore, learn and enjoy their classes more, use more effective learning strategies, and show sustained student involvement (Ryan & Deci, 2020).

2.3. Extrinsic motivation

Extrinsic motivation, or external attraction, is the force that motivates people to perform or act for reasons other than their current action (Bailey & Phillips, 2015; Wigfield & Cambria, 2010). As a result, rather than being a goal in and of itself, it functions as a means to an end. Extrinsically motivated students learn because they seek good grades, marks, honour, or respect, and the joy of learning the subject is unimportant. In other words, extrinsically motivated students engage in activities for some consequences that are external to the task itself. Engagement in the task may be to acquire rewards or avoid punishment. Studies have established that intrinsic motivation is associated with higher grades while extrinsic motivation is associated with lower grades (e.g., Kaufman, Agars, & Lopez-Wagner, 2008).

In the mathematics classroom, however, Walter and Hart (2009) believe that the "commonly held distinctions between intrinsic and extrinsic motivations may be insufficient to inform our understandings of student motivations in learning mathematics" (p.162). Similarly, Matthews, Hoessler, Jonker, and Stockley (2013) noted that the distinction has, over time, proven to be less persuasive than anticipated (Matthews, Hoessler, Jonker, & Stockley, 2013). As indicated in Figure 1, Deci and Ryan (1985) classified motivation into six sub constructs (i) amotivation, (ii) external regulation, (iii) introjection, (iv) identification, (v) integrated regulation, and (vi) intrinsic motivation.

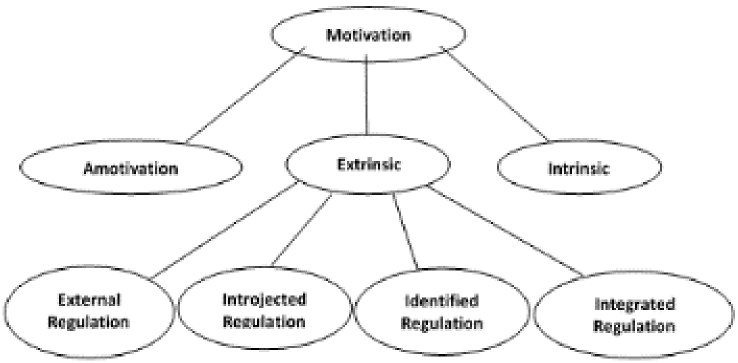

Figure 1. The six motivational sub constructs. Adapted from Deci and Ryan (1985)

2.4. External and Introjected Regulations

External regulation is carried out in response to external demand or the possibility of a reward (Deci, 1972; Vallerand et al., 1992). Individuals will only perform to gain a reward or a result, not just for the sake of having pleasure. It is dictated by the need to appease external demands, such as those imposed by parents and teachers. The drive behind doing something for a reason other than the present action is known as external regulation motivation. People with external regulation motivation are target oriented; personal pleasure and joy have no meaning for them, but they are subject to adaptation to the value of the reward (Ryan & Deci, 2000a). Introjected motivation is motivated by ego (Deci & Ryan, 1995), and failure to perform well or study diligently causes guilt or anxiety. This indicates that people go along with a task because they think they should and feel guilty if they do not.

2.5. Identified and Integrated regulations

Regulation through identification is actively appreciating a goal or rule so that it is seen as personally important and begins to be integrated into the student's identity (Wang, Hagger, & Liu, 2009). According to these authors, the learner adopts the object's advantage, grasps its logic, and acquires a sense of self determination as a result of following the rule. Extrinsic motivation, which is fueled by identified regulation, is closely linked to the student's personal objectives. Once regulation is identified, action begins to be integrated into the student's sense of self. Integrated regulation, according to Deci and Ryan (1985), is a type of extrinsic motivation that happens when rules are fully assimilated into oneself so that they are incorporated into one's self-evaluations and ideas about personal requirements. Integrated motivations have certain characteristics in common with intrinsic motivation but are nonetheless classified as extrinsic because the goals are pursued for reasons other than the self's inherent delight or interest in the work.

2.6. Amotivation

Amotivation is seen as lacking an intention to act (Ryan & Deci, 2000b); being unmotivated. When amotivated, people either don't act at all or behave with a lack of passion, they just go through the motions (Ryan & Deci, 2000b). Amotivation is linked to sentiments of inability to accomplish a task or realize the worth of a particular activity (Fairchild, Horst, Finney, & Barron, 2005). In a study of the relationships between affective domains and mathematics performance of high performing students in Singapore, Lim and Chapman (2015) found that amotivation and intrinsic motivation were the strongest correlates of mathematics performance among the six sub constructs of motivation.

Though some studies attest to the impact of academic motivation on the performance of students, few studies prove the contrary to the assertion. For example, Cetin (2015) in a study with students in the Early Childhood Education Department in a university in the USA found no correlation between the students' academic motivation and their grade point average (GPA). The findings of Cetin were corroborated by Tus (2020), who found that motivation has no significant relationship with students' academic performance. One possible explanation for no significant relationship between motivation and academic performance could be that there are other mediating factors playing a role. For this study, the categorization of Deci and Ryan (1985) was adapted.

3. Method

3.1. Population and sample

This study used a quantitative research approach, which included the distribution of questionnaires and the administration of an achievement test. Ghanaian senior high school students are made up of tenth graders, eleventh graders, and twelve graders. However, eleventh graders were engaged in this study because the study required that participants have the same teacher for at least a year before the data collection period. When the data was being collected, the tenth graders had not yet adjusted to their new school environment, while the twelfth graders were preparing for their final national examinations. Thus, only eleventh graders met the necessary conditions for the study.

There were 6, 317 eleventh graders in the target population, but 3,342 students from ten secondary schools were randomly sampled to participate in the study. However, 2,575 students, representing 77%, participated fully in the quantitative data collection. The students were from various programmes (Visual Arts, General Arts, General Science, Business, Technical, and Home Economics. For the demographic profile of the participants, see the Table 1.

Table 1. Demographic profile of students

Demographic information	Response	Frequency	Percent
Age groups	15 and below	203	7.88
	16 – 18	2273	88.27
	19 – 21	95	3.69
	22 and above	4	0.16
Gender	Male	1396	54.21
	Female	1179	45.79
School	School I*	247	9.59
	School C**	250	9.71
	School D**	281	10.91
	School F	243	9.44
	School B	312	12.12
	School H*	230	8.93
	School A **	347	13.48
	School J	157	6.10
	School G	219	8.50
	School E	289	11.22
Programmes of study	Science	865	33.59
	Business	386	14.99
	Technical	86	3.34
	General Arts	729	28.31
	Home Economics	305	11.85
	Visual Arts	204	7.92

*Single sex school (Female); ** Single sex school (Male); Total sample size 2575

3.2. Instruments

A student questionnaire and an achievement test were employed as study instruments. There were 35 closed ended questions on the student questionnaire. The Academic Motivation Scale (AMS) was adapted, as modified by Lim and Chapman (2014). The questionnaire had 35 closed ended items instead of the original 21 (Likert scale: 1 for "Strongly Disagree" (SD), 2 for "Disagree" (D), 3 for "Neutral" (N), 4 for "Agree" (A) and 5 for "Strongly Agree" (SD). They had been tailored to the Ghanaian setting by removing several double-barrelled questions and simplifying the language to make it easier to grasp. During the factor analysis of the pilot test data, the elements that aligned onto two or three separate sub constructs were completely discarded, before the final administration to the students. Finally, factor loadings of less than .3 were suppressed. The setting of the achievement test was guided by the Senior High School syllabus and a sample of national examination past mathematics questions. The test comprised 40 multiple choice questions. The two instruments were pilot tested after it had been validated by four mathematics education experts.

3.3. Statistical Techniques used in the Present Study

3.3.1. Construction and Piloting of the Achievement test

Using the scheme of work, lesson plans, and lesson notes provided by the Heads of Departments of the ten senior high schools and their teachers, the author shortlisted the topics already covered by the students in all ten schools. Although there were some variations on the topics already covered, only the topics that were common to all the schools were shortlisted. These were used along with the sample of past national examination mathematics questions (WASSCE) to construct test items for the achievement scores. Sixty items were constructed and shown to four mathematics education experts. Based on their advice, some items were removed while some were re-constructed before the piloting was carried out. For the piloting, there were 50 multiple items. However, some items were skipped by some students in some of the schools during the piloting.

Students were asked to express their opinions after the test. Some said one of the topics covered on the test was just taught two days prior to the test and that they were yet to assimilate what the topic was all about. As a result, the researcher decided to check the extent of coverage of each topic before finalizing the items for the main study. Items from topics that were newly covered within two weeks prior to the test were removed. Finally, 40 items were administered to the students. Most of the students took 75 minutes to hand in their scripts on their own, without being stopped, while a few of the students finished in less than an hour. Thus, after finding the average of the time spent on the test, 60 minutes were stipulated for the achievement test for the main study.

3.3.2. Parametric test

The study's sample size (2,575) was found sufficient to supply adequate power (Pallant, 2005; Stevens, 1996) hence normalcy of the data was examined. The skewness (−.092) and kurtosis (−708) are both within the range of ±1, and the actual mean (53.72) is nearly identical to the trimmed mean (53.90), indicating a normal distribution (Field, 2013). Although both Kolmogorov Smirnov and Shapiro Wilk significant values violated normality due to the over sensitivity of the normality tests to large sample sizes, this did not affect the results of the parametric test (Field, 2013; Oztuna, Elhan, & Tuccar, 2006). Normal plots were used to visually check for normality (Altman & Bland, 1995; Field, 2009).

Normal probability plots were inspected (Figure 2), and the straight line indicated normality. A box plot of the achievement test's distribution of scores also indicated normality. There were no outliers in the data, as shown by the box plot (Figure 3). A normality check was also performed on the residuals to verify their eligibility for regression analysis. Figure 4 and Figure 5 display the Normal Q Q Plot and the scatter plot of the regression standardized residual of the achievement test scores respectively. The points in the Regression Standardised Residual's Normal Q Q plots lie in a pretty straight diagonal line from bottom left to top right, indicating no notable departures from normality. The residual is approximately rectangular in shape, with a cluster of scores in the middle. At each number of the projected score, it displayed a pileup of residuals in the plot's centre and a normal distribution of residuals trailing off symmetrically from the centre. The correlation test carried out revealed a negatively weak but statistically significant correlation between the achievement test and motivation with a value of –.161.

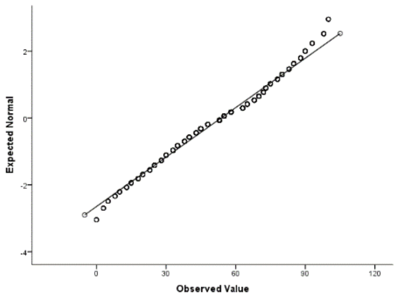

Figure 2. Normal Q-Q Plot of Achievement test scores

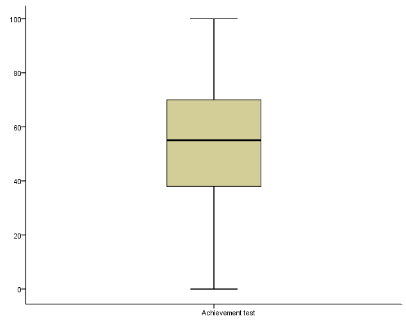

Figure 3. Box plot of the distribution of scores for the Achievement scores

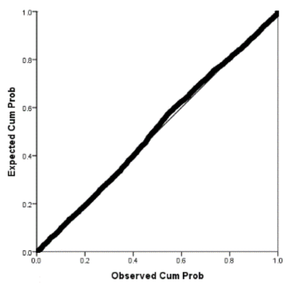

Figure 4. Normal Q-Q Plots showing the regression standardized residual of Achievement test scores

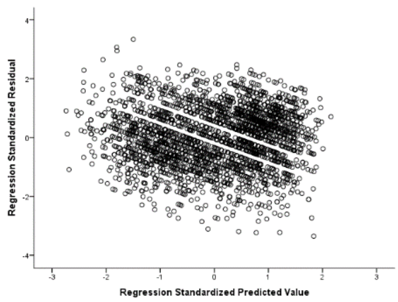

Figure 5. Scatter Plots showing the regression standardized residual of Achievement test scores

3.3.3. Factor analysis

The 35 items were subjected to a principal component analysis (KMO =.953, Bartlett tests = 35549.013, α =.655), and five factors with eigenvalues exceeding Kaiser's criterion of 1 explained 51.53% of the variance. The scree plot revealed inflexions that justified the retention of the five factors: ‘amotivation' subscale (14 items, =.841, M = 2.00, SD =.62), ‘identified regulation' subscale (11 items, =.885, M = 4.22, SD =.69), ‘introjection regulation' subscale (5 items, =.763, M = 3.16, SD =.93), ‘external regulation' subscale (3 items, =.666, M = 3.56, *SD* = 1.12) and ‘intrinsic' subscale (3 items, α = .661, M =

3.81, SD = .77). The item "I am doing my best in mathematics so that I can get the best grade in the national examination" was factored in three places (external, identified, and intrinsic), but it was kept for the external and identified subscales based on the author's understanding of the literature reviewed for the study. As a result, there was evidence that the motivation variable (M = 3.09, SD = 0.31), had a significant impact on their mathematics learning. In the same way, the mean of each of the three sub constructs approximated 4 (except for 'amotivation' and 'introjections') and therefore had high effects on the respondents' learning of mathematics, within the same range of variations.

4. Results and Discussion

4.1. Amotivation

Table 2 to Table 6 give the percentages, mean and standard deviations of the sub constructs of motivation.

Table 2. Distribution of Items regarding Amotivation

ITEMS	SA	A	N	D	SD	MEAN	STD
Solving mathematics problems is boring.	40.3	36.5	6.9	10.4	5.9	3.95	1.19
I don't see how mathematics is of value to me.	53.4	34.5	2.6	6.9	2.6	4.29	.99
Trying to solve mathematics related problems does not appeal to me.	28.1	42.7	8.4	16.1	4.7	3.73	1.17
The subjects which require mathematics are waste of time.	55.4	34.0	3.0	4.5	3	4.34	.96
I would rather have someone give me an answer to mathematics question than solve it by myself.	44.3	36.6	5.0	10.2	3.9	4.07	1.12
I don't enjoy doing mathematics.	30.8	43.9	8.2	12.5	4.6	3.84	1.13
I feel that it is a waste of time studying mathematics.	67.9	24.5	1.9	3.7	2.0	4.53	0.86
I can't see why I should study mathematics.	53.6	32.8	3.6	6.3	3.7	4.26	1.04
It does not make any difference whether I learn mathematics.	36.2	42.3	6.6	11.4	3.5	3.96	1.10
I feel helpless studying mathematics.	31.0	49.3	6.0	9.7	4.1	3.93	1.06
For me, solving mathematics problems is a waste of time.	37.8	43.5	5.7	8.9	4.1	4.02	1.08
Mathematics will not be important for the rest of my life.	60.7	28.4	3.5	5.0	2.4	4.40	.95
Mathematics is not useful to me.	28.4	47.2	8.3	12.5	3.6	3.84	1.08
I am studying mathematics because it is a compulsory subject in senior high school.	19.1	32.5	6.1	16.0	16.2	2.88	1.40

SA: Strongly agree, A: agree, N: Neutral, D: disagree, SD: Strongly disagree

Table 2 shows that the majority of respondents (92%) agreed or strongly agreed that learning mathematics is a waste of time. Moreover, 89% of those polled agreed that mathematics would be useless for the rest of their life. Similarly, 76% said mathematics is unimportant to them, but more than half said they are studying it because it is required. This indicates that they are not motivated in studying mathematics and would be happy to abandon it whenever possible. This is in line with the position of Fairchild et al. (2005) that individuals are amotivated when they lack the intent to pursue an activity.

4.2. External regulation motivation

External regulation motivation is dictated by the desire to satisfy external pressures. Table 3 presents the result of the students on external regulation motivation. According to the findings (see Table 3), the majority of respondents (70%) indicated a strong grasp of mathematics for future aspirations, and 58% planned to major in disciplines that require mathematics at university. About 95% of respondents (M = 4.58, SD = 0.74) learn mathematics in order to achieve the highest possible WASSCE grade.

Table 3. Distribution of Items regarding External Regulation Motivation

ITEMS	SD	D	N	A	SA	MEAN	STD
I am doing my best in mathematics so that I can have the best grade at WASSCE.	1.2	2.0	1.9	27.5	67.4	4.58	.74
I am studying mathematics because I plan to major in a mathematics related programme at the university.	12.0	22.9	6.6	32.7	25.7	3.37	1.39
I will need a firm mastery of mathematics in my future work.	4.8	16.0	9.4	39.5	30.3	3.74	1.19

SD: Strongly disagree, D: Disagree, N: Neutral, A: agree, SA: Strongly agree

4.3. Introjected regulation motivation

This is the type of behaviour that motivates people to show that they can maintain their self worth. Table 4 presents data on the introjections regulation motivation.

Table 4. Distribution of Items regarding Introjected Regulation Motivation

ITEMS	SD	D	N	A	SA	MEAN	STD
I am studying mathematics to show myself that I am an intelligent person.	10.3	27.7	8.1	34.4	19.5	3.25	1.32
I am studying mathematics because I want to show myself that I can do well in mathematics.	10.5	16.2	5.0	39.7	28.6	3.60	1.33
I am studying mathematics because I want to show to others (e.g., teachers, family, and friends) that I can do mathematics.	30.6	39.5	5.0	16.3	8.5	2.33	1.29
I work very hard in mathematics because I want to be respected as an intelligent student.	8.5	23.9	9.4	37.0	21.2	3.38	1.28
I am studying mathematics because of the fact that when I do well in mathematics, I feel important.	9.7	27.7	9.0	35.9	17.6	3.24	1.29

SD: Strongly disagree, D: Disagree, N: Neutral, A: agree, SA: Strongly agree

Although roughly 25% of the students stated that they are studying mathematics to show others, such as teachers, friends, and family, that they can perform mathematics, as many as 54% stated that they are studying mathematics to feel significant when they do well in mathematics. Similarly, 58% of the students claimed they work hard in mathematics because they want to be seen as smart. The majority of respondents stated that learning mathematics is motivated by a strong sense of self worth and ability.

4.4. Extrinsic identified regulation

Table 5. Distribution of Items regarding Extrinsic identified regulation

ITEMS	SD	D	N	A	SA	MEAN	STD
I am studying mathematics because I think that mathematics will help me better prepare for my future career.	1.9	5.2	3.6	41.6	47.7	4.28	.91
I am studying mathematics because studying mathematics will be useful for me in the future.	2.1	3.7	2.4	36.4	55.5	4.39	.87
I am studying mathematics because what I learn in mathematics now will be useful for the course of my choice in university.	3.6	9.0	4.3	36.4	46.7	4.14	1.08
I am studying mathematics because I want to have “the good life” later on.	2.3	7.9	5.5	47.4	37.0	4.09	.97
I am studying mathematics to have an opportunity to study a programme of my choice later on.	2.3	8.2	4.3	42.4	42.7	4.15	.99

I am studying mathematics to obtain a more prestigious job later on in life.	3.0	9.9	5.8	42.4	38.9	4.04	1.05
I am studying mathematics because I believe that mathematics will improve my work competence in the future.	1.8	4.3	3.2	33.3	57.3	4.40	.89
Using mathematics effectively will help me in my future studies.	2.1	4.8	4.0	43.8	45.3	4.25	.90
I am studying mathematics because I am sure I can use mathematics in the future.	3.2	6.0	3.7	44.2	42.9	4.18	.98
I am studying mathematics to broaden my knowledge.	2.0	4.7	3.0	48.0	42.2	4.24	.87

SD: Strongly disagree, D: Disagree, N: Neutral, A: agree, SA: Strongly agree

Table 5 shows that around 91% of respondents claim to be learning mathematics because they believe it will help them improve their job skills in the future. Furthermore, roughly 83% of the students agreed or strongly agreed that the mathematics they are learning today will improve their university programme of choice. In a word, they're interested in mathematics since it aligns with their objectives. This is a part of the rationale for the Ghanaians' mathematics syllabus as stipulated by the Curriculum Research and Development Division, Curriculum Research and Development Division (2010):

> *The student is expected at the Senior High School level to develop the required mathematical competence to be able to use his/her knowledge in solving real life problems and secondly, be well equipped to enter into further study and associated vocations in mathematics, science, commerce, industry and a variety of other professions (p. ii).*

4.5. Intrinsic motivation

This has to do with engaging in an activity for the inherent enjoyment or interest in the task. Table 6 presents data on intrinsic motivation.

Table 6. Distribution of Items regarding Intrinsic Motivation

ITEMS	SD	D	N	A	SA	MEAN	STD
I am studying mathematics for the pleasure that I experience when I learn how things in life work because of mathematics.	5.7	18.2	10.0	45.8	20.3	3.57	1.17
I am studying mathematics for the pleasure that I experience when I am able to solve questions.	8.2	26.6	9.7	38.7	16.9	3.30	1.25
I am studying mathematics because I want to feel the personal satisfaction of understanding mathematics.	4.9	13.6	6.2	47.5	27.9	3.80	1.13
I am doing my best in mathematics so that I can have the best grade at WASSCE.	1.2	2.0	1.9	27.5	67.4	4.58	.74

SD: Strongly disagree, D: Disagree, N: Neutral, A: agree, SA: Strongly agree

Table 6 shows that roughly 56% agreed that they study mathematics for the joy they get from being able to solve problems. The majority (75%) also stated that they are learning mathematics for the inward sense of pleasure that comes from mastering the subject. Furthermore, 66% of students are learning mathematics because they appreciate learning how things work in the real world as a result of mathematics. This seems to support the earlier claim by some of the respondents where less than 20% claimed amotivated and the majority seemed to have a zest for mathematics despite the various challenges encountered. In general, between 56 and 75% of those polled said they chose to study mathematics. That is, they are intrinsically motivated. These groups of students are learning mathematics for the pleasure and satisfaction it brings (Deci & Ryan, 1985; Vallerand et al., 1992), hence perseverance should be expected from them, as suggested by Vallerand and Bissonnette (1992).

However, if 56 to 75% of the respondents in this study are intrinsically motivated, why do they still have problems with low achievement in mathematics as reflected in various examination results (Fletcher, 2018)? The answer to this question is contained in the interview results, which are not delineated in this paper.

4.6. The relationship between motivation and students' mathematics achievement

To determine the sub constructs of motivation that predict the performance of students in mathematics, the achievement test scores (Table 9) was employed as the dependent variable, while the mean scores for the motivation sub constructs were used as the independent variables. Regression analysis was carried out on the motivation variable (Figure 6, Tables 7 and 8), which is made up of five sub constructs: *amotivation*, *identified regulation*, *introjections*, *intrinsic* and *external regulation*, with statistically significant correlation coefficients of −..333, .182, −.126, .138, and .073 respectively, with ($\beta_1 = -.334$, $\beta_2 = -.016$, $\beta_3 = -.190$, $\beta_4 = .019$, $\beta_5 = .014$) accordingly. The motivation variable (R square =.142 and Adjusted R Square =.140) shared a 14% variation with achievement scores. Statistical significance (p <.05) is achieved by the model.

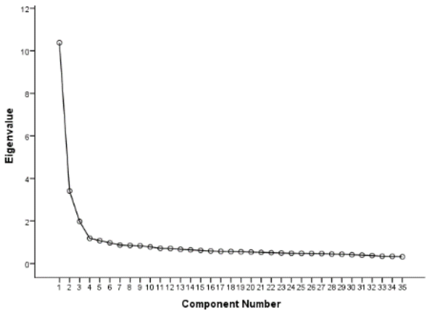

Figure 6. Scree Plot for Motivation Variable

Table 7. KMO and Bartlett's Test for Motivation variable

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.953
Bartlett's Test of Sphericity	Approx. Chi-Square	35549.013
	Df	595
	Sig.	.000

Table 8. Total Variance Explained of Motivation Variable

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	10.382	29.662	29.662	10.382	29.662	29.662	5.856	16.732	16.732
2	3.412	9.749	39.412	3.412	9.749	39.412	5.412	15.464	32.196
3	1.979	5.654	45.066	1.979	5.654	45.066	2.761	7.888	40.084
4	1.186	3.388	48.453	1.186	3.388	48.453	2.526	7.216	47.301
5	1.076	3.076	51.529	1.076	3.076	51.529	1.480	4.228	51.529
6	.973	2.780	54.309						
7	.867	2.477	56.786						
8	.850	2.428	59.214						
9	.834	2.383	61.598						
10	.779	2.227	63.825						
11	.715	2.042	65.867						

12	.708	2.022	67.889
13	.666	1.903	69.791
14	.641	1.831	71.623
15	.619	1.767	73.390
16	.590	1.687	75.077
17	.571	1.630	76.707
18	.565	1.615	78.322
19	.552	1.576	79.898
20	.538	1.538	81.436
21	.523	1.494	82.930
22	.510	1.458	84.388
23	.496	1.417	85.805
24	.482	1.377	87.182
25	.480	1.373	88.555
26	.474	1.353	89.908
27	.469	1.339	91.247
28	.445	1.272	92.519
29	.436	1.247	93.766
30	.412	1.176	94.942
31	.394	1.127	96.069
32	.376	1.074	97.143
33	.342	.978	98.121
34	.339	.970	99.090
35	.318	.910	100.000

Extraction Method: Principal Component Analysis.

Table 9. Descriptive Statistics for Achievement scores

		Statistic	Std. Error
Mean		53.72	.400
95% Confidence Interval for Mean	Lower Bound	52.94	
	Upper Bound	54.51	
5% Trimmed Mean		53.90	
Median		55.00	
Variance		411.149	
Std. Deviation		20.277	
Minimum		0	
Maximum		100	
Range		100	
Interquartile Range		32	
Skewness		-.092	.048
Kurtosis		-.708	.096

Amotivation made the strongest unique contribution of 6.5% to explaining the dependent variable, while introjections made a unique contribution of 2.5%. Meanwhile, only amotivation and introjections recorded statistically significant contributions ($p < .05$).

Thus, the regression model with $F(2, 2572) = 210.645$, $p<.05$ is:

Achievement scores = 88.912 – 0.582 (amotivation) – 0.189 (introjections) (1)

The statistical model (equation 1) revealed that lacking the intent to learn or learning without passion and learning mathematics only for self-esteem or to protect one's ego brought down the performance of students in this study.

Despite the composition that makes up the schools in the metropolis, the results from the achievement test indicate an average performance of approximately 54%, since the actual mean (53.72%) is nearly identical to the trimmed mean (53.90%). Put differently, it is at the level of a 0.40 effect size (Hattie, 2012). The students were well aware that the outcomes, whether good or bad, would have no bearing on them. The highest possible effect size could have been 0.42, which represents external motivation if they were to use the results for further benefits. That is, going by the Hattie theory of visible learning. On the other hand, if they had deep motivation, that is, intrinsic motivation, their effect size would have been 0.69 (Hattie, 2012). This is based on the position of Epstein (2012) that the interaction between motivation and cognition promotes learning that enhances performance.

One of the findings of the study is that the majority of students are extrinsically motivated to learn mathematics because they want to obtain the top grades in the West African Secondary School Certificate Examination (WASSCE). The finding that the students are more extrinsically motivated supports the findings of Mullis, Martin, and Foy (2012), who discovered that Ghanaian students value mathematics more than they like mathematics, ranking first among all participating countries in 'valuing mathematics' but seventh in 'liking mathematics’. However, despite their 'valuing' of mathematics, students lack the passion for the learning of mathematics. The focus on the high stake national examination and the desire to please parents or teachers, or protect their self esteem compel them to learn mathematics. The focus on national examinations takes precedence over any reason for studying mathematics in this study because the item that measured this assertion was highly patronized by those who are intrinsically motivated as well as by those who are extrinsically motivated. It presupposes that without the national examination, only a few students will be willing to study mathematics or its related disciplines, albeit, when they did, it would be for either self gratification (in the form of introjection) or career gratification (in the form of identified regulation).

The study equally revealed that the respondents were highly amotivated. The Mean and Standard deviation obtained for the sub construct ‘amotivation’ ($M = 4.00$, $SD = .62$), indicated the presence of amotivation, and the regression analysis indicated that amotivation and introjection mainly explain the variance in achievement scores. Amotivation is linked to sentiments of the inability to accomplish a task or lack of the ability to appreciate the worth of an effort, or lacking the intention to act or acting without passion. This definition presupposes that amotivation could be due to different factors. That notwithstanding, although people are amotivated in different ways and have quite varying experiences and outcomes, previous research studies treated amotivation as a single construct. The present study indicated the likelihood of different kinds of amotivation with varied influences on the learning of mathematics. As a result, more investigation is required.

Furthermore, the majority of the students agreed that mathematics would not just be useful to them but would be crucial for the rest of their lives. Nonetheless, half of the respondents said they are learning mathematics to meet the Ghana Education Service's requirement for compulsory core subjects. Their *valuing* and appreciation of mathematics do not culminate in their desire to study mathematics. This may be seen as a sign of amotivation based on the reviewed literature. But their *valuing* of mathematics contradicts the meaning of amotivation. This seems to suggest that for this study, amotivation is not a single construct, despite the fact that Deci and Ryan (1985) take it to be a single construct. Furthermore, the students are already extrinsically motivated. Thus, the absence of amotivation and the promotion of intrinsic motivation may go a long way towards changing or reversing the trend of students’ performance in mathematics in the Metropolis.

This study affirms the theory of Deci and Ryan, on which the study was based, and the Visible Learning theory of Hattie. Deci and Ryan indicate that only intrinsic motivation can produce lasting learning in students. That is, until students learn mathematics for the sake of having fun with it, any academic gain would be speculative. Similarly, Hattie indicates that until students become their own teachers, self-regulating learning that promotes greater performance, will continue to elude our educational system.

5. Conclusion

The study showed that 14% of the variation in the students' achievement scores in mathematics could be explained by motivation. The findings show that other factors are at play when it comes to the students' mathematics achievement. Amotivation and introjections recorded statistically significant contributions to the achievement of the students in mathematics. Furthermore, it was found that the students in this study were not motivated solely by extrinsic or intrinsic factors. Other factors such as introjections and amotivation played a role in motivating students or otherwise to learn mathematics. The majority of the students in this study saw value in the learning of mathematics but lacked the intent to act in favour of mathematics. *'Valuing'* is evidence of external motivation, while 'lack of intent to act' suggests amotivation. Thus, there is a need for further research into amotivation as a multi-dimensional sub construct of motivation. Ego motivates introjected motivation, and failure to do well or study diligently creates guilt or anxiety. This suggests that students in this study participate in a task because they believe they should and will feel bad if they do not. That is, their learning mathematics is not borne out of enjoyment of the task. It is therefore not driven by intrinsic motivation which internally coerces a person to participate in an activity for the sake of self satisfaction with its value lasting a person for life. Students that are intrinsically motivated are more likely to devote more time to the subject and, as a result, do better. Conversely, students who are only extrinsically motivated may do tasks assigned to them for an external incentive that propels them to initiate actions towards a set goal or carry out the task which can come to a stop if there is neither reward nor stimulus. This can cause poor mathematics performance. It is suggested that teachers, lecturers, and researchers may need to seek practical ways to promote intrinsic motivation in students for better engagement with mathematics.

5.1. Limitation

The current study has some notable limitations. The research data was acquired from only one of the six metropolises in Ghana. The results shown here may not accurately reflect what might be obtained in the entire country. Furthermore, the study's population was made up of eleventh graders because the study required that participants should have had the same teacher for at least a year before the data collection period. Only the eleventh grades met this condition because when the data was being collected, the tenth graders had not yet adjusted to their new school environment, while the twelfth graders were preparing for their final national examinations. As a result, many students in the metropolis were unable to participate in the study.

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