

Relationship between Senior High School Students' Mathematics Self-Efficacy, Self-concept and Their Mathematics Achievement in Twifo Hemang Lower Denkyira District, Ghana

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Abstract The main aim of this study was to determine the relationship between senior high school students' mathematics self-efficacy, self-concept and their mathematics achievement in Twifo Hemang Lower Denkyira District of the Central Region of Ghana. A probability stratified random sampling technique was used to obtain representatives of the two schools under consideration in the proportion of the population of the two schools. A total of one hundred and fifty (150) form two students were involved in the study. The research design adopted was correlational design and the instruments developed and used for obtaining relevant data for the study was the Likert scale type of questionnaire and achievement test. An independent sample t-test was conducted to find the differences in achievement scores of low and high mathematics self-efficacy and self-concept students. The major result established in the study was that students' mathematics self-efficacy correlated students' mathematics achievement. The result also established that students' mathematics self-concept did not correlate with their mathematics achievement. In view of this, it was recommended that constructs that are related to students' academic performance should be given prominent attention. For example, teachers of mathematics must make frantic efforts at all times to increase students' mathematics self-efficacy when teaching so that students would be able to overcome the challenges they face when learning mathematics subject.

Keywords: *mathematics, self-efficacy, self-concept, achievement test*

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1. Introduction

Mathematics is a compulsory subject in all senior high schools in Ghana. The study of mathematics at these levels was made compulsory because mathematical knowledge in our everyday life is effectively and responsibly very necessary in solving problems and making decisions. Weaknesses among students in learning mathematics will therefore affect the efforts of the nation in developing its human resource base effectively. It has therefore become imperative for mathematics educators to find out how mathematical concepts can be strengthened among students. It is against this background that mathematics educators keep looking for variables which could be manipulated in favour of Mathematics performance and suppress those variables that may be working against students' progress.

Self-efficacy is an important concept in social cognitive theory, which has been widely recognized as one of the

most prominent theories about human learning [1]. The theory is believed by many scholars to be the most important theoretical contribution to the study of academic achievement, motivation, and learning [2].

Bandura [3] asserted that easy success does not heighten self-efficacy, neither do failures lower it. Besides, students may also obtain capability information from knowledge of others especially peers who are the best basis for comparison [4]. Pajares and Schunk [5] opined that students who feel more efficacious will perform better in tasks and achieve at a higher level than those who do not feel confident of their capability.

Researchers have indicated that higher self-efficacy is predictive of higher performance [6].

Self-efficacy again refers to people's judgments about their capability to perform particular tasks. In the study on intermediate variables related to education it was shown that self-efficacy can help improvement of learning methods of students, especially in activities with self-regulation and predict outcomes of academic progress [7].

People with lower self-efficacy quickly get convinced that their behaviour is vain in coping with problems and overlook any more endeavours while people with high self-efficacy eliminate obstacles by self-management skills improvement and patience and have higher strength and control against problems and experience lower uncertainty [8]. According to him, “students with high self-efficacy probably use more self-regulating strategies compared to people with low self-efficacy”. In other words, self-efficient people attempt more to perceive academic materials, think deeper on academic materials, and plan for performing their academic tasks [9].

Researchers have shown that self-efficacy influences such achievement behaviours as choice of tasks, persistence and effort [10]. According to Schunk & Pajares, when self-efficacy perceptions are high, individuals will engage in tasks that foster the development of their skills and capabilities, but when self-efficacy is low, people will not engage in new tasks that might help them learn new skills. Self-efficacy therefore has influence over people's ability to learn, their motivation and their performance, as people will often attempt to learn and perform only those tasks for which they believe they will be successful [11].

. A phenomenal body of researches show the predictive value of self-efficacy beliefs and students' academic achievement across all areas and levels and students' career choices [12]. According to their research, students who are more confident in their capabilities tend to work harder, solve problems more efficiently, monitor their progress regularly, and hence, achieve better than their able peers who do not have high self-efficacy. Similarly, experiencing failure will have a negative impact on one's self-efficacy [13].

Bandura [3] stated that while better performance in mathematics leads to higher levels of self-efficacy, students who have low levels of mathematics self-efficacy are at a high risk of underperforming in mathematics, despite their abilities. If students do not believe in their ability to accomplish particular tasks, they will not exert the effort needed to complete the tasks successfully and a lack of self-efficacy becomes a self-fulfilling prophecy. Though other factors apart from self-efficacy can guide and motivate students, when students do not believe in their ability to succeed in a given task, they need to have much higher levels of self-control and motivation in order to succeed. Unfortunately, students who have low self-efficacy are less likely to regulate their achievement behaviours or be motivated to engage in learning [14].

Students' mathematics Self-efficacy has an effect on their academic learning and mathematics achievement. Students who feel more efficacious will perform better in mathematics tasks and achieve at a higher level than those who do not feel confident of their mathematics capability [5]. As found and stated by Thien and Ong [15], students with a higher level of self-efficacy tend to have higher academic achievement and are more accurate in mathematical computations. They stated that previous mathematics education research indicates that self-efficacy predicts mathematics grades, mathematical problem solving and interests.

Stevens, Olivarez, Lan and Tallent-Runnels [16] evaluated self-efficacy and motivational orientation in 358 Hispanic and Caucasian students in grades 9 and 10. They

found that self-efficacy strongly predicts mathematics achievement and motivation across ethnicity. In Australia, Nielsen and Moore [17] found that ninth grade Australian students' mathematics self-efficacy significantly and positively correlated with their mathematics scores from the previous year. Similarly, Nasser and Birenbaum [18] reported that the mathematics self-efficacy of Palestinian and Jewish eighth grade students had a significant positive impact on their scores on the National Assessment Test in mathematics than English language.

Stevens, Olivarez, Lan and Tallent-Runnels [16] reported that self-efficacy and the sources of self-efficacy were stronger predictors of mathematics achievement than general mental ability. They found that, the relationship between prior mathematics achievement and self-efficacy was stronger for Hispanic students than for Caucasian students. Zarch and Kadivar [19] found that while mathematics ability had a direct effect on mathematics performance, it also had an indirect effect via mathematics self-efficacy judgments. Gutman [20], in his research indicated that, mastery goal orientation positively increases mathematics self-efficacy. The overall effect these literatures pointed out to somewhat a significant relationship between students' mathematics self-efficacy and students' mathematics achievement.

Crawford [21] found out in his study that students' self-concept influences their academic performance; however, the level of effort exerted by students in learning to a large extent contributes significantly to students' self-concept in boosting their academic performance.

Self-concept is a perception of oneself about strength, weakness, state of mind, and value by social and environmental interactions [22,23]. Aziz and Jamaludin, [24] indicated that parental upbringing, continuous failure, depression and internal self-critic influences the development of one's self-concept. Most past researches showed relentless support towards the belief that there is a significant relationship between academic self-concept and academic achievement in secondary and post-secondary students [25,26].

A meta-analysis conducted by Valentine, DuBois and Cooper [27] showed that the relationship between self-concept and achievement is vice-versa. Marsh, Trautwein, Ludtke, Koller and Baumert, [28] also posited that, the anticipated improvement of students' performance is based on the existence of the reciprocal relationship between self-concept and academic achievement. The interpretation of the reciprocal relationship has been traced by Craven, Marsh, and Burnett, [29] as follows: “better students' achievement leads to improvement of self-concept, positive self-concept can help increase students' achievement concurrently”.

Punithavathi [30] also conducted a research to investigate the relationship between self-concept and academic achievement of students at the secondary level. The results of the analysis revealed a significant correlation between self-concept and academic achievement. Furthermore, a study conducted by Subbulakshmi [31] revealed that, there is a significant difference in self-concept and academic achievement among students in different categories of schools, especially in the, state matriculation and central board schools.

Most of these studies support the belief that self-concept is a strong facilitator of academic achievement in

mathematics and that a positive or negative change in self-concept tends to produce a commensurate change in academic achievement or performance [32]. Ahmed, Minnaert and Kuyper, [33] alluded to the fact that there is high number of international studies on the self-concept, which is seen as an important factor in mathematics education.

A recent study by Yara [26] on students' self-concept and students' mathematics achievement in some secondary schools in South-western Nigeria revealed that students with good self-concept perform well in mathematics. Manger and Eikland [34] in their study of the effect of mathematics self-concept on girls' and boys' mathematical achievement, it was found that Norwegian elementary schoolboys showed significantly higher mathematics self-concept than girls. Boys also had a significantly higher mathematical achievement score than girls. However, controlling for mathematics self-concept produced several interesting results. Firstly, there was no significant effect of gender on overall mathematical achievement. Secondly, although the gender difference in achievement favouring boys' increase with increasing task difficulty, no significant effects of gender were found in sub-samples of difficult tasks

1.1. Statement of the Problem

The world we live in now is information and technology-based world which require individuals, who must think critically about complex issues, analyse and adapt to new situations, solve problems of various kinds and communicate their thinking effectively. One subject that easily comes to mind is mathematics. The study of mathematics does not only equip students with knowledge, skills and habits of mind that are essential for successful and rewarding participation in the society, but also conveys an imprint of western thought and plays a very important role in framing a state of mind that tolerates every aspect of education [35]. The more technology is developed, the greater the level of mathematical skills required. It is the hope of every stakeholder of education including teachers and parents that students perform very well in mathematics. In view of this, various attempts are being made by students, parents, teachers among other stakeholders in Ghana to reduce the perennial low performance among students in mathematics. Some of these attempts include the organization of extra classes for students by teachers, parents spending extra monies on their children's education, seminars being organized for teachers to update their knowledge to be more effective in the classroom, government's flagship programme on free senior high school education among others. In spite of all these, most students continue to perform poorly in mathematics [36,37].

This is a source of worry to many stakeholders especially parents whose wards find themselves in this situation and the government of Ghana who spends a large proportion of the nation's resources on education. The West African Examination Council [37] has again stated in the chief examiner's report that the general performance over the years of our students in mathematics has been very low.

In Ghana, several efforts to improve students' cognition and affective outcomes in mathematics have been made by mathematics educators. But a lot still needs to be done as

far as personal and environmental variables are concerned. Professional organizations of mathematics education have also attached great importance to affective factors. For example, National Council of Teachers of Mathematics [38] in their conference program elaborated on teachers' self-efficacy beliefs and mathematical knowledge for teaching. In spite of all these efforts to improve students' performance, their academic performance keeps deteriorating. For example, the chief examiner of the West African Examination Council (WAEC) reported that, performance of students in West African Senior Secondary Certificate Examination (WASSCE) continued to deteriorate from year to year, particularly in the areas of science and mathematics [39]. According to the chief examiner's report, in 2012, 50.6% of the candidates who sat for the West African Senior Secondary Certificate Examination (WASSCE) could not obtain up to grade C6 in their core mathematics examination. This, by extension means that these percentages of students were not able to get access to any of the public universities because of poor performance in their core mathematics, since core mathematics is one of the basic requirements for gaining admission into the tertiary institutions in Ghana. In 2013, the number increased to 63.4%, in 2014, it went up further to 67.6% and in 2015 it worsened to 75.0%, [36,39,40,41].

This situation does not favour Ghana's move towards developing a Science, Mathematics, Technology and Innovation based society and for a country like Ghana, which is a developing country that needs Science, Mathematics and Technology for its development, this continuous poor performance of students in science and mathematics is seriously worrying. This research therefore sought to investigate into how some of these affective variables relate to students' mathematics achievement in Ghana.

1.2. Purpose of the Study

The purpose of this study is to investigate whether there is any significant difference between the achievement test score of students with: low mathematics self-efficacy and self-concept and students with high mathematics self-efficacy and self-concept. The study also sought to find out if there is any relationship between students' mathematics achievement and the two constructs (students' mathematics self-efficacy and self-concept).

1.3. Objectives of the Study

The main objectives of this study are to investigate the relationship between students' Mathematics self-efficacy, self-concept and their mathematics achievement. The study also sought to find out if differences existed in the achievement test score of students with low and high mathematics self-efficacy and self-concept.

1.4. Research Questions

1. To what extents senior high school students developed the two affective constructs, "students' mathematics self-efficacy and students' mathematics self-concept?"

2. Is there any relationship between students' mathematics self-efficacy, self-concept and their mathematics achievement?
3. Can students' mathematics achievement be predicted by their mathematics self- efficacy and self-concept?

1.5. Research Hypotheses

H₀₁: There is no significant difference between the achievement test score of students with low mathematics self-efficacy and students with high mathematics self-efficacy.

H₀₂: There is no significant difference between the achievement test score of students with low mathematics self-concept and students with high mathematics self-concept.

2. Methodology

The research design adopted was the correlational research design. This design is deemed suitable because the study sought to investigate the relationship between student's mathematics self-efficacy, self-concept and their mathematics achievements. The study also investigates whether or not difference existed between low or high mathematics self-efficacy and self-concept students. The target population for this study consisted of all senior High School two students in Twifo Hemang Lower Denkyira District which was 3886, out of which a sample of One Hundred and Fifty students were selected through probability stratified random sampling techniques for the study.

The research instrument used for amassing data in this study were closed-open questionnaire that consists of students' self-efficacy scale (SES) and students' self-concept scale (SCS) and achievement test.

Fivefold Likert scale type of questionnaire such as Strongly disagree (coded as 1), Disagree (coded as 2), Neutral (coded as 3), Agree (coded as 4) and Strongly agree (coded as 5). The responses of students which fall above 3.0 were considered as high self- efficacy and self -concept and responses of students which were 3.0 and below were considered as low self - efficacy and self-concept. The instrument reliability was tested using Cronbach alpha reliability coefficient technique with 0.78 for Students Mathematics Self-efficacy and 0.50 for Students Mathematics Self - concept, was used. In this research, we checked the internal consistency of the instrument.

Statistical Package for Social Science (SPSS) was used to analyse the data obtained from achievement test and questionnaire to obtain a general sense of information and to reflect on its overall meaning. Independent Sample t-test was used to find differences that existed between the achievement scores of students with low mathematics self-efficacy, self-concept and students with high mathematics self-efficacy and self-concept using the means and the standard deviations since an independent sample t-test is used to compare mean value(s) of continuous-level (interval or ratio data), taking into consideration all the assumptions associated with the use of the t-test.

Also simple linear regression was used to predict students' mathematics achievement from students' mathematics self-efficacy

3. Results and Discussion

Research Question 1: To what extents senior high school students developed the two affective constructs; students' mathematics self-efficacy and self-concept?

Table 1. Descriptive Statistics of the Two Subscales (Students' Mathematics Self-Efficacy and Self-Concept) N=150

Subscale	Mean	Std. Deviation
Students' Mathematics achievement	43.587	18.304
Students' Mathematics self-efficacy	2.724	1.048
Students' Mathematics self-concept	2.642	0.916

Scale: 1 = Strongly Disagree; 2 = Disagree; 3 = Neutral; 4 = Agree; 5= Strongly Agree.

From [Table 1](#), students' mathematics self-efficacy (M=2.724, SD=1.048) is high compared to their mathematics self-concept (M=2.642, SD=0.916) This means that senior high school students have developed more mathematics self-efficacy than their mathematics self-concept. This result however did not significantly translate into their performance on the achievement test (M=43.587, SD =18.304). The result shows that the overall performance of students is below average.

Research Question 2: Is there any relationship between students' mathematics self-efficacy, self-concept and their mathematics achievement?

Table 2. Correlation between Students' Self-Efficacy, Self-concept and their Mathematics Achievement N=150

		Mathematics achievement	Self-efficacy	Self-concept
Mathematics achievement	Pearson Correlation	1	0.439	-0.131
	Sig. (2-tailed)		0	0.11

* Correlation is significant at the 0.05 level (2-tailed).

From [Table 2](#), there was a statistically positive and moderate correlation between students' self-efficacy and their mathematics achievement ($r = 0.439, p = 0.000$). Again, from [Table 2](#) above there was no statistically significant correlation between students' self-concept and their mathematics achievement ($r = -.131, p = 0.110$).

Results of the study showed that there was a significant relationship between students' mathematics self-efficacy and their mathematics achievement. This means that when students' confidence level (self-efficacy) is high, their performance in mathematics is likely to be enhanced. The result also suggests that students who have some level of positive view (self-efficacy) about themselves are more likely to be active in their mathematics classes thereby performing better than students who have negative view about themselves as most of the literature indicated. This finding is in consonance with a study conducted by Nielsen and Moore [17] found that ninth grade Australian students' mathematics self-efficacy was significantly and positively correlated with their mathematics scores.

Similarly, Nasser and Birenbaum [18] supported the result when they reported that the mathematics self-efficacy of Palestinian and Jewish eighth grade students had a significant positive impact on their scores on the National Assessment Test in Mathematics.

Again, the study found no correlation between students' self-concept and their performance in mathematics. This finding is an indication that the way students thought of, felt about, acted towards, valued and evaluated themselves in Mathematics (self-concept), is not likely to interfere with their performance in mathematics. This finding is somewhat surprising as it sharply contradicts most research findings. For instance, the views of Valentine, Dubois & Cooper [27] who stated that self-concept is an important linkage to academic achievement. Punithavathi [30] also conducted a research to investigate the relationship between self-concept and academic achievement of students at the secondary level. The results of the analysis revealed a significant correlation between self-concept and academic achievement.

Research Question 3: Can students' mathematics achievement be predicted by students' mathematics self-efficacy and students' mathematics self-concept?

Table 3. Coefficients of Predictors (Students' Mathematics Self-Efficacy, and Self-Concept) and Students' Mathematics Achievement N=150

	R	R Square	Adjusted R Square	F	Sig.	Std. Error of the Estimate
Model 1	.564	.318	.309	34.277	.000	15.218

$p < 0.05$

a. Predictor Variable: Self-efficacy

b. Dependent Variable: Achievement Test Score

The results ($R^2=0.318$, $p=0.000$), $F(1,147)=34.277$ of the regression analysis shows that approximately 32% of the variance in students' mathematics achievement is attributable to variations in students' mathematics self-efficacy. This indicates that students' mathematics self-efficacy is a good predictor of students' mathematics achievement. Table 4 reiterates further that, for every unit increase in students' mathematics self-efficacy, the respondents score on the achievement test increases by 3.922. Thus, the coefficients 3.922 measures the mean change in the average value of students' mathematics achievement as a result of a unit change in the

independent variable (students' mathematics self-efficacy). Based on the result from Table 4 below, the equation for the regression line is given as:

Table 4. Test of Significance of Regression Coefficients of Students' Self-efficacy, Self-concept and Anxiety

Model	Unstandardized coefficient		Standardized Coefficients	t	Sig.
	B	Std. Error	Beta		
Constant	61.787	8.295		7.448	0
Self-efficacy	3.922	1.393	0.224	2.816	0.006

Significant at $p < 0.05$.

Maths Achievement=61.787+3.922(Self-efficacy).

From the model above, 61.787 is the estimated mean value of students' mathematics achievement when students' mathematics self-efficacy is eliminated. Even though the regression equation appears to be very useful for making predictions, it is however limited by the amount of variance it is accounting for in this study. This means that other variables which have not been studied may be equally important for predicting students' mathematics achievement.

H₀₁: There is no significant difference between the achievement test score of students with low mathematics self-efficacy and students with high mathematics self-efficacy.

The result from Table 5 indicates that there was a statistically significant difference between the achievement test scores of low and high self-efficacy students because test score of low self-efficacy students' ($M=37.141$, $SD=15.069$, $N=92$); high self-efficacy students' ($M=53.810$, $SD=18.435$, $N=58$), with the $t(148) = -6.045$ and $p=0.016$. The result means that when students' self-efficacy is low, their mathematics performance will also be low. Similarly, when students' self-efficacy is high, their mathematics performance will also be high. This finding is in consonance with a study carried by Bandura [3], to investigate on self-efficacy towards a unifying theory of behavioural change, results revealed that better performance in mathematics leads to higher levels of Self-efficacy, students who have low levels of mathematics self-efficacy are at a high risk of underperforming in mathematics, despite their abilities.

H₀₂: There is no significant difference between the achievement test score of students with low mathematics self-concept and students with high mathematics self-concept.

Table 5. Results of the Independent t-test on differences between the test scores of Students with Low and High Mathematics Self-Efficacy. N=150

Variable	Group	N	Achievement test score		F	t-value	Sig.
			Mean	Std. Deviation			
Students' Self-efficacy	Low	92	37.141	15.069	5.94	-6.045	0.016
	High	58	53.81	18.435			

Table 6. Results of the independent t-test on difference between the test score of students with Low and High mathematics self - concept. N#150

Variable	Group	N	Achievement Test Score		F	t-value	sig
			Mean	SD			
Student Self-Concept	Low	93	46.882		16.880	.623	2.885
	High	57	38.211				

The result from Table 6 indicates that there is no statistically significant difference in the achievement test scores of low and high mathematics self-concept students because the test scores of low self-concept students' ($M=46.882$, $SD=16.880$, $N=93$); high self-concept students' ($M=38.211$, $SD=19.387$, $N=57$) with the $t(148) = 2.885$ and $p=0.431$. This result shows that differences in students' achievement in mathematics are not necessarily explained by the differences in their levels of self-concept. In other words, the way students feel, their personal experiences, the thoughts they have about themselves and how they tend to label themselves in doing mathematics (self-concept) may not cause any significant difference in their mathematics achievement.

4. Conclusions

Based on the findings of this study, we conclude that students' mathematics self-efficacy is significantly related to students' mathematics achievement. Again, students' mathematics self-efficacy is able to predict students' mathematics achievement. Thus, as students' mathematics self-efficacy increases, their mathematics performance is impacted positively. This research has therefore brought to the fore, the need to pay attention to the impact that students' mathematics self-efficacy has on their mathematics achievement. Finally, this research has indicated that the presence or absence of students' self-concept is not likely to have any significant change on students' mathematics achievement.

5. Recommendations

Based on the findings of the study, the following recommendations are made:

1. The study found that self-efficacy impacted positively on students' mathematics achievement. Therefore, it is recommended that an intervention program should be developed by Ghana Education Service that would help classroom teachers to develop students' mathematics self-efficacy. The program should aim at developing students' problem-solving abilities that would support Common Core state standards. This would increase students' confidence level to learn mathematics, as stated, Lunenburg [11] that, "the basic principle behind self-efficacy theory is that individuals are more likely to engage in activities for which they have high self-efficacy and less likely to engage in those they do not".
2. Since self-efficacy is found to be an essential ingredient in mathematics achievement, it is recommended that teachers are encouraged to engage their students more in regular confidence-building exercises such as mathematical games; like Mancala (Oware), Equate (the board game) and so on that look challenging but enable them to do well.
3. Students should be encouraged to explore mathematical patterns that would strengthen their basic numerical skills and also help them to develop a growth mindset.

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