Journal of Mathematics and Science Teacher
2023, 3(1), em024
e-ISSN: 2752-6054
https://www.mathsciteacher.com/

MODESTUM

Research Article **OPEN ACCESS**

Mediation and moderation effect of mathematics interest and teaching quality between self-concept and mathematics achievement

Michael Fosu [1*], Yarhands Dissou Arthur [1], Francis Ohene Boateng [1], Benjamin Adu-Obeng [1]

[1] Department of Mathematics Education, Akenten Appiah-Menka University of Skills Training and Entrepreneurial Development, Kumasi, GHANA
***Corresponding Author:** fosumykel31@gmail.com

Citation: Fosu, M., Arthur, Y. D., Boateng, F. O., & Adu-Obeng, B. (2023). Mediation and moderation effect of mathematics interest and teaching quality between self-concept and mathematics achievement. *Journal of Mathematics and Science Teacher, 3*(1), em024. https://doi.org/10.29333/mathsciteacher/12622

ARTICLE INFO

Received: 16 Jun. 2022

Accepted: 30 Oct. 2022

ABSTRACT

Purpose: This study investigated the mediation and moderation effect of mathematics interest and teaching quality on the relationship between self-concept and mathematics achievement.

Design/methodology/approach: The study was conducted at Sakafia Islamic Senior High School (SHS) and Kumasi Academy SHS in Ghana. A sample comprised of 300 students who offered general arts, general science, and home economics were randomly selected from a population of 1,200. The study adopted a descriptive survey and analysis such as exploratory and confirmatory factor analysis, discriminant validity, and reliability analysis from Cronbach's alpha was estimated using SPSS (version 23) and Amos (version 23).

Findings: From the hypothesis, the findings revealed that self-concept partialy mediate mathematics achievement through mathematics interest and teaching quality also showed moderating effect between interest and achievement. The study also found out that self-concept, mathematics interest and teaching quality have direct effect on students' performance.

Research limitations/implications: The study investigated the moderation effect of teaching quality, which was found to be insignificant. This is an imperative for further study to critically analyzed it effect on other antecedents.

Practical implication: The study informed teachers teaching mathematics and in other different programs to be equipped with knowledge of how students perceive mathematics so as to select the appropriate teaching approach to influence their interest and belief in the study of mathematics.

Originality/value: There are studies by some researchers combining these variables under study with other factors to influence students' performance however, little attention was on the effect mathematics interest and teaching quality to impact student performance through self-concept.

Keywords: self-concept, teaching quality, mathematics interest, mathematics achievement

INTRODUCTION

Background to the Study

Mathematics is a significant course taught in schools all over the world, and this is due to its importance in a variety of areas, more specifically in the advance of science, humanities, and creativity (Ezenweani, 2006). The discipline of mathematics is important because of its applications in education, administration, state security, innovation, return, and mechanical forms, to name a few. As a result, many have always seen college students' mathematics satisfaction as a sign of the overall well-being of institutes and the nation's not uncommon location intellectual aptitude (Kolawole & Oluwatayo, 2005). Mathematics therefore can be said to improves learners' skill to meditate reasonably, analytically, precisely, efficiently, and competently (Tella, 2008). This is why mathematics is a compulsory subject for every learner throughout our educational system before the tertiary level in West Africa of which Ghana's curriculum exhibit this feature (Abreh et al., 2018). By this reason, some educational researchers advocate students' proficiency and the possessing ability in solving mathematics problems. It has hence gotten to be crucial on behalf of mathematics teachers to determine the best mathematical concepts that can be reinforced among students. From the groundwork laid above, mathematics teachers have devise strategies to find factors that may be controlled in support of mathematics performance and stifle the negative factors that affect students' progress. Due to this, several endeavors were made through governments over the past years to the development of the overall performance of mathematics among senior high school (SHS). In spite of governments' endeavors, mathematics fulfillment has now no longer skilled plenty alter; there are reliably

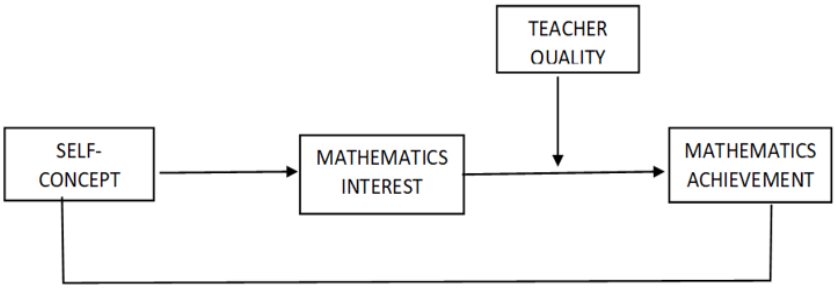

Figure 1. Conceptual framework (Field Survey, 2022)

low overall performance tiers in mathematics among SHS learners (WAEC, 2016, 2018). The chief examiner's report of 2021 WASSCE examination comparing 2020 WASSCE examination stated that student's pass in mathematics was declined by 11% such that, 65.71% had A1-C6 in 2020 and 54.11% in 2021 (WAEC, 2021). The net essential poor performance in mathematics in open assessment of students might, hence, be attached to compelling factors associated in schools (Borisade, 2011). It is unfortunate, on this manner, that during later times, several SHS college students confront with mathematics and carry out quite ineffectively of their ultimate examinations in maximum wards (Bosson-Amedenu, 2017; Fletcher, 2018). This pastime has affected contrarily on college students' interest in the attention of mathematics riding to steer their overall performance within the observe of mathematics. This has additionally ended up disturb for these students, guardians, and different stakeholders in schooling in the nation. As a significant marker aimed at the fulfillment of the instruction plan 2030 (SGD 4), it is seen that instructional analysts, professionals, and policymakers is identified as a teaching quality strategy (UN ESCAP, 2015).

Evidently, this poor performance is attribute to some antecedents and among these variables confronting their performance researchers have devise strategies to stifle the low achievement and helps improves student's achievement. These precursors self-concept, student's interest and teaching quality are identified by some researchers as determinant of mathematics achievement. By this, teaching quality with some emanating schools' mechanisms have been found as the factors donating to improve mathematics attainment (Artur et al., 2022). Punithavathi (2011) investigated to discover the connection among self-concept and educational overall performance of college students in the pre-tertiary level. The conclusion of the research found out a vital link among self-concept and educational achievement. In a similar study, Hinnant-Crawford et al. (2016) alleged by stating that students' self-concept has a great deal of influence on students' academic success, and that, in any event, the amount of effort students put in when learning mathematics contributes greatly to their self-concept in terms of academic success. Self-concept is explained as a discernment of one's own greatness, deficiency, intellectual state, and esteem (Huitt, 2004; Slavin, 2003). Again, research by Tsoto et al. (2016) confirms that student's interest promotes their success in mathematics and that interest is shown to enhance students' desire in studying mathematics and was concluded to impact their achievement in mathematics. According to Quansah and Ankoma-Sey (2020), the excellence of the teaching relationship is a game-changing factor in the classroom and is regarded to have a significant impact on academic achievement. The analysis between teaching quality and mathematics achievement by Arthur et al. (2022) established that the direct impact of teaching quality influence mathematics performance by 18.5% of which their relationship was significant. Fenster (2014) holds that exceptionally powerful teachers make sure a extrude in learners' academic getting to know in each the long time and the short term. Hence, teacher quality in many schools setting is the most powerful constituent for progressing in learners' accomplishment and lessening students' fulfillment gaps. This assumes that teacher excellence takes an indicator on college students' fulfillment as well as their identified poor success in mathematics. Therefore, this research sought to find the mediation and moderation effect of mathematics interest and teacher quality between self-concept and mathematics achievement.

Countries have to be compelled to see carefully into teacher-students related factors so that significant conclusions can be defined and thus set up plans to move forward students' achievement. Research by Reeve et al. (2015) concluded that the linkage of interest and mathematics achievement stood significant. They stood that interest coordinate as an indicator of mathematics overall performance. In a similar spirit, Thien and Ong (2015) pointed out that during PISA 2012, emotional factors such as mathematics self-confidence and mathematical interest were no longer entirely related toward students' mathematics performance Malaysia. From the above analysis in other countries, the researcher sees these variables under study help students to better their mathematics performance and, in this course, it informed the researcher to critically examined the usefulness of the variables in our country Ghana. This is because our region requires intense examination to light up the additives for bad overall performance in mathematics subjects. In recognize of those unsure discoveries, the researcher taken into consideration through way of means of including to current literary works, the mediating effect of mathematics interest and the moderation impact of teacher outstanding (quality) between self-concept and achievement in mathematics, that's a recognized hole and inconsequential in the checked on literary works. Hence, this look is at a goal to discover the mediation and moderation impact of mathematics interest and teacher quality on the connection among self-concept and mathematics achievement.

Figure 1 discusses the conceptual framework of the study. The teacher quality serves as the moderation role between mathematics interest and mathematics achievement and in the same way the mediating variable is the mathematics interest. This is mediating between self-concept and mathematics achievement. This projects the objectives and the research questions/hypothesis of the study.

Theoretical Framework

The current study investigated the mediation and moderation effects of interest in mathematics and teacher quality on the relationship between self-concept and mathematics performance. We hypothesized the relationship between self-concepts, mathematics interest, and teacher quality on the mathematics achievement. The empirical evidence has been divided into four categories based on the stated relationships on the basis of the research questions established on the variables under the study i.e., self-concept, mathematics interest, teacher quality and mathematics achievement

H_1: Self-concepts have a direct impact on mathematics achievement

Shavelson et al. (1976) described self-concept as a private mindfulness shaped by the experience of one's current circumstance. Subsequently, the logical self-concept is often described as one's very own individual mindfulness logical capacities, formed by one's own involvement with learning and performance related settings. Self-concept and achievement are additionally examined to be proportionally associated by which they have a strong contributing connection (Goetz et al., 2013). within the school setting where learners' self-concepts in various subjects are reliably shown that they're reasons for mental results; but on the opposite hand, are triggers of advantageous mental results (Clem et al., 2020). The growth of self-concept has been precisely shown as multi-faceted and space explicit (Arens et al., 2011). The finding observed particular self-concepts within the various school setting with an overall learner's self-concept as a general build to influence students' achievement. Customarily, specialists either conflated the skill and influence parts of learners' idea (e.g., Jansen et al., 2014) or the need put more accentuation on self-concept of capability over effect. Subsequently, learners' self-concept has been reliably estimated by either joining the skill and influence angles or overwhelmingly utilizing ability perspective alone (Pinxten et al., 2013). Nonetheless, lately, learners' self-concept it's been experimentally exhibited that self-concept of skill (corresponding to insight) and self-concept of effect (comparable to feeling) are plainly recognizable (e.g., Arens et al., 2011; Pinxten et al., 2014). While the power part is worried about the degree to which understudies see themselves to possess capacities during a particular school subject (e.g., I'm great at math.), the influence part is about the degree to which a private appreciates partaking during a subject (e.g., I prefer math). Hence, we'll analyze both the power and influence parts of self-concept in math.

Student self-concepts are typically progressively coordinated and extraordinarily intended for a selected school subject, with the general learners' self-concept at the highest (Brunner et al., 2010). Logical self-concepts are, as an example, later examination achievements (Swann et al., 2008; Valentine et al., 2004), student interests (Goetz et al., 2013), learners' choices. It's generally expected observed that the connection between learners' concept and student performance is corresponding (i.e., cooperation models like Pekrun & Perry, 2014), and better achievements work on self-concept. It means to create the past self-concept, that is, on account of the limit advancement process) and therefore the higher self-concept works on the presentation (the past exhibition is controlled, that is, the private development process).

H_2: Mathematics interest has direct impact on mathematics achievement

The overall perspective on the job of interest in the instructive interaction is that interest advances learning. To be sure, interest hypothesis expects that experience of interest can animate accomplishment by expanding commitment and consideration (Harackiewicz et al., 2016). For interested learners, the learning system can work on various wellsprings of learners' consideration and agreeable impacts at work. Interest among learners have been displayed to put forth more prominent academic attempt (Trautwein et al., 2015), to acknowledge learning objectives (Harackiewicz et al., 2008), and more likely control their learning.

Lee et al. (2014) stated that all of these add to better performance. In spite of this hypothetical conduct, observational proof on the effect of the significance of performance is blended. In spite of the fact that reviews report a positive connection among interest and performance (Zhang & Wang, 2020), likewise in math, which the study was based on cross-sectional by Jansen et al. (2016) and through longitudinal study from Koller et al. (2001) had information showing no significant link between interest and success in matheamtics. One reason for the zero and adverse consequences is that convictions and interests in skills have normal ways to progress through comparative stimulating and self-administrative components. Assuming that the impacts of skill convictions are controlled, the leftover impact of interests might mirror a motivating force to extend the investigation of specific elements (Fredrickson, 1998), which although significant for future objectives and choices in managing the space (Blustein, 1989), may have a direct unfavorable impact. to finish the responsibility (Pinxten et al., 2014; Sansone et al., 2015).

In this review, including numerical self-concept, we expected the connection among interest and performance to remain zero or correlated (Tosto et al., 2016). This forecast ought to be contrasted and the assumption for a beneficial outcome on the interest in the goals of numerical practice. The job of past performance in structuring later interest has not much attention or investigated. According to the viewpoint of the overall interest hypothesis (Hidi & Renninger, 2016), the possible impacts of early reimbursement are just restricted. According to the SCCT's perspective, interests are viewed as formed by applicable instructive encounters, including performance standards and convictions and assumptions regarding their own viability, which they support. A few experimental examinations that propose that previous presentation might have some impact on later interests (Tosto et al., 2016). For instance, Tosto et al. (2016) observed that presentation in math in the 3rd and 5th grades was linked with little changes in numerical interest in the 5th and 8th grades of American understudies. Also, Pinxten et al. (2014) observed that the primary accomplishment in math addressed the fundamental expense of 4th-year understudies in Flemish. Nonetheless, the constructive outcomes of past mathematical performance on later number related companions were little and dropped to zero when they arrived at 7th level. The recognition experience can fill in as a fundamental opportunity for growth as a wellspring of involvement for beginning turn of events and refinement of interests. In light of hypothesis and past proof, we expect that prior numerical shows relate to a fundamental degree of interest in arithmetic, as expressed by Pinxten et al. anticipated to be positive and that

the impacts of ensuing changes in financing costs might be generally little. It is far-fetched that the singular learners experience showed in earlier years would fundamentally affect changes in key financing costs, particularly temporarily. All-encompassing growth opportunities, which incorporate accomplishment as well as various growth opportunities and verbal and social convictions, can later influence changes in higher interest.

Some examination has recommended that, contrasted with different subjects, there is a moderately solid connection among interest and accomplishment in math (Schiefele et al., 1992). In such manner, Maree (1994) expressed that the accompanying elements are of importance to the students' advantage in math:

1. Students' sentiments assume a significant part in knowledge interest.
2. Students' advantage and capacity are emphatically related. As per Maree (1994), the better a student acts in math, the more he/she will like the subject as well as the other way around.

H_3: Self-concept has an indirect impact on mathematics achievement through mathematics interest

The idea about self-concept, interest and accomplishment have been as something similar and these variables stay interact after some time by some researchers. Research by Marsh et al. (2005) has utilized proportional impact models to inspect the impact between self-concept, interest, and achievement. As of late, Marsh et al. (2016) utilized complementary impacts models to look at the impacts of the circumstance between self-concept, effort, and learner's success. By this analysis made, it is critical to blend the idea of self and accomplishment with interest since interest and self-concept can be fundamentally related (García-Perales & Palomares-Ruiz, 2020). Contrasted with the development of characteristic interest, Yu and Singh (2016) made sense that interest is characterized as "the delight that presents to one the assignment". While interest is remembered as a means of influence to decisions and serves as a motivating mechanism to students, which is related with math accomplishment. The assumption hypothesis did not speculate whether interest influences further self-concept (Wigfield & Cambria, 2010). The outcomes showed that interest and self-concept were interrelated and were fortified in that superior self-concept prompted better self-concept and further developed self-concept coordinated to well self-concept in understudies. In another study by Thien and Ong (2015) identified that the relationship between mathematics interest and mathematics accomplishment was seen insignificant. In more current research, this study was shown unrelated by Yu and Singh (2016). This study used Malaysian students as a factor of the study. The consequences exposed that interest and self-concept were interrelated and were strengthened in that improved self-concept led to better self-concept and improved self-concept directed to well self-concept in students.

H_4: Teacher quality has a moderation effect on mathematics interest and mathematics achievement

Teacher quality has shown to be multipart event and there is little agreement on how to define and measure it (Seidel & Shawlson, 2007). Various explanations of types of teacher preparation and knowledge include what ought to be imparted to learners and how information should be passed on to be effective in the classroom (Darling Hammond, 2000). Recent analysis, which informed about teacher quality stressed how teachers' involvement with student academic progress differs reckoning on several variables like teachers' academic and skilled background, classroom practices, and years of experience. Countries have to be compelled to look rigorously about how teacher-student relationship can be established so that meaningful conclusions can be framed and by this, there will be lay out plans to further develop learners' achievement. During this study, we tried to analyze how teacher quality is related to student accomplishment and student interest. Research by Arthur et al. (2017) and Fauth et al. (2019) concluded that teaching quality has a significant impact on students' interest and hence impact their achievement. The observational writing examining indicators of students' interest and achievement have resolved the matter pertaining to teacher quality effect by estimating the effect of distinctive teacher factors and estimating the effect of the general teacher quality Lazarides and Buchholz (2019). Further, experimental examinations that interface teacher quality and success among students are restricted to some researchers in the US. Few reports of writings have analyzed teacher quality attributes related with higher learners' accomplishment in different nations most especially Ghana (Arthur, 2019; Arthur et al., 2017).

Numerous exact examinations among researchers in the US have recognized the attributes of teacher quality that are related with higher student's accomplishment. Two sorts of reviewed from writings have been led to concentrate on the effect of teacher quality as per Knight (2012) as

(a) concentrates on that examined variety in educator impacts by estimating contrasts between classes in accomplishment gains in the wake of controlling for foundation qualities (Hanuskek & Rivkin, 2006).

(b) relapse concentrates on that explored the connection between instructor qualities and understudy accomplishment in the wake of controlling for foundation attributes (Zuzovsky & Donitsa, 2015). Notwithstanding, the discoveries have been seen as not significant and inconsistent.

Regarding long stretches of showing teaching experience, it is decidedly and essentially related to students' success in Taiwan. This confirms (Monk, 2007) discoveries that teacher's long stretches or years of involvement with students to gain experience have a positive relationship. In similar case, I tracked down no connection between these same variables in context. This finding is predictable with (Zuzovsky & Donitsa, 2015) who saw as just peripheral and measurably inconsistent beneficial outcomes of teacher's experience on learner's success in the field of mathematics and science. One more indicator of teacher quality is teacher pedagogical readiness. It was reliably answered to affect learner's achievement (Metzler & Woessmann, 2010). Within "teaching quality" refers to certain teacher behaviours that promote students' demands for autonomy (a sense of self-determination and freedom from control), competence (a sense of efficiency and confidence in social interactions), and relatedness (feeling connected and backed up by important others) (Arens & Morin, 2016).

Table 1. Demographics of students (Field Survey, 2022)

Demographics	Frequency (n)	Percentages (%)
Gender	300	100.0
Male	161	53.7
Female	139	46.3
Age	300	100.0
13-16 years	42	14.0
17-20 years	233	78.0
Above 20 years	25	8.0
Program	300	100
General arts	115	32.9
General science	115	32.9
Home economics	120	34.2
Class	300	100.0
Form 2	166	55.3
Form 3	134	44.7

METHODOLOGY

Research Design

The goal of a research design is to lay out an approach for assembling empirical evidence to answer the study questions (McMillan & Schumacher, 2006). The study used a descriptive survey as its research design. A research design is said to be descriptive if the form of study from which the sample of people is given a questionnaire at a specific time to characterize their attitudes, opinions, behaviors, perceptions, or attributes (Creswell, 2012).

Sampling and Sample Technique

A research sample is a group of persons who are active contributors of information in a study and for whom data is being collected (Imenda & Muyangwa, 2006). The sample size employed for the study was 300 from the population of 1,200 students whose form was form 2 and form 3 from Sakafia Islamic SHS and Kumasi Academy SHS. The number of samples, which were used for the study falls in line with the suggestion from Yamane (1973) who revealed a formula for calculating the ideal sample size for any survey design. This is illustrated, as follows:

$$n = \frac{N}{1+Ne^2}, \tag{1}$$

where n is sample size, N is population size, which is 1,200, and e is error (0.05) confidence level 95%. Thus, we got

$$n = \frac{1{,}200}{1+(1{,}200)\times(0.05)^2} = 300. \tag{2}$$

The technique used in selecting the sample was based on simple random approach. Simple random sampling procedure was applied for the data collection because it ensures that the key characteristics of individuals in the population are included in the sample and every individual selected was not based on bias means but were selected randomly. The sample for the form 2 were 164 students and 134 for form three.

Data Collection Instrument

At the initial stage of the data collection, a letter was written demanding consent to involve the selected SHS schools' students as my respondents to the questionnaire was done. The participants' privacy and confidentiality were taken into consideration. The researcher developed the research questions in two parts with part A as socio-demographic data and part B based on the four variables being studied, i.e., self-concept, teacher quality, interest, and mathematics achievement. The part B was measured based on 5-Likert scale grading from 5 (strongly agree) to 1 (strongly disagree). The total items were 37 questions in all, and this was developed based on the objectives of the study.

From **Table 1**, the response indicates that, out of 300 respondents, 161 respondents representing 53.7% were males and the remaining 139 respondents representing 46.3% were females. 42 respondents representing 14.0% were between the age ranges of 13 to 16 years. 233 respondents representing 78% were between the age ranges of 17 to 20 while 25 respondents representing 8% were between the age ranging from 21 and above. In term of classes, 166 respondents representing 55.3% were form 2 and form 3 students consisted of 134 representing 44.7%.

Reliability Analysis

The consistency of the instruments in tapping information from more than one responder is referred to as reliability. The reliability coefficient was analyzed with SPSS (version 23) among the variables under study. The analyzed values were 0.924, 0.904, 0.726, and 0.931 for self-concept, mathematics interest, teaching quality, and mathematics achievement, respectively after the Cronbach's alpha reliability test. DeVellis (1991) stated that reliability coefficient of more than 0.60 is considered quite respectable for establishing the appropriateness of an instrument, thus, this coefficient was deemed high enough to support its usage in study.

Table 2. Descriptive analysis (Field Survey, 2022)

Variables	Mean	Standard deviation
Self-concept	3.702	1.074
I experience less difficulty in learning mathematics than other subjects.	3.84	1.046
I have discovered numerous mathematics issues very interesting and testing.	3.64	1.034
I appreciate attempting to tackle new mathematics issues.	3.79	1.035
I have never been extremely amped up for mathematics.	3.76	1.125
I have discovered mathematics as scary.	3.48	1.129
Teacher quality	4.38	0.788
My teacher is easy to understand every mathematics concept.	4.29	0.789
I know what my teacher expects from me.	4.37	0.814
My teacher gives me interesting mathematics task.	4.51	0.799
My teacher explains a topic again when we do not understand.	4.35	0.750
Mathematics interest	3.601	0.988
I like mathematics.	3.54	0.989
I learn many interesting things in mathematics.	3.63	0.991
I look forward to mathematics lessons.	3.61	0.990
I like to solve mathematics problems.	3.65	0.981
Mathematics achievement	3.788	1.160
I learn things quickly in mathematics.	3.83	1.163
Mathematics is one of my strengths.	3.86	1.152
I think learning mathematics will help me in my daily life.	3.88	1.110
I need to do well in mathematics to get the job I want.	3.67	1.182
I typically perform well in mathematics.	3.70	1.195

Table 3. Exploratory factor analysis (Field Survey, 2022)

Measurement items	Components			
	1	2	3	4
SC1	.695			
SC2	.862			
SC3	.868			
SC4	.837			
SC5	.816			
TQ1		.624		
TQ2		.590		
TQ3		.781		
TQ4		.735		
INT1			.864	
INT2			.903	
INT3			.901	
INT4			.742	
ACH3				.847
ACH4				.847
ACH5				.859
ACH6				.871
ACH7				.752
Total variance explained				71.663%
Kaiser-Meyer-Olkin measure of sampling adequacy				.892
Bartlett's test of sphericity: Approximate Chi-square=3,722.146; df=153; & Sig.=.000				
a. Determinant				2.932E-6

Note. Extraction method: Principal component analysis; Rotation method: Varimax with Kaiser normalization; & Rotation converged in 5 iterations

DESCRIPTIVE ANALYSIS

The study also employed descriptive analysis. This was used to test its normality on the questionnaire using mean and standard deviation. The results based on each construct items are presented in **Table 2**. The mean and standard deviation on each construct informed the researcher that there was a satisfactory normality test.

Exploratory Factor Analysis

SPSS (version 23) was used to estimate exploratory factor analysis (EFA). EFA was used to investigate the interrelated factors such that it was used to determine how each of the observed variables loaded on their right respective latent variables. This was a strategy to decrease a number of the observed variables on the questionnaire whose loading was not at the right position of the latent variable (Surh, 2005). The analysis in **Table 3** defines the coefficient of determinant estimated at 2.932E-6 with a Kaiser-Meyer-Olkin measure of sampling adequacy (KMO) of 0.892. The KMO explained that there was 89% adequacy supposition among the observed variables loading in their right dimension on the latent variables.

Table 4. Confirmatory factor analysis (Field Survey, 2022)

Model fit indices: CMIN=224.880; df=124; CMIN/df=.814; CFI=.972; TLI=.966; RMR=.047; RMSEA=.052; & PClose=.359	**SFL**
Self-concept: AVE=0.725; CR=0.925; & CA=0.924	
I experience less difficulty in learning mathematics than other subjects.	0.876
I have discovered numerous mathematics issues very interesting and testing.	0.905
I appreciate attempting to tackle new mathematics issues.	0.877
I have never been extremely amped up for mathematics.	0.740
I have discovered mathematics as scary.	0.851
Teacher quality: AVE=0.50; CR=0.743; & CA=0.726	
My teacher is easy to understand every mathematics concept.	0.503
I know what my teacher expects from me.	0.834
My teacher explains a topic again when we do not understand.	0.760
Mathematics interest: AVE=0.702; CR=0.903; & CA=0.904	
I like mathematics.	0.739
I learn many interesting things in mathematics.	0.949
I look forward to mathematics lessons.	0.860
I like to solve mathematics problems.	0.789
Mathematics achievement: AVE=0.735; CR=0.933; & CA=0.931	
I learn things quickly in mathematics.	0.842
Mathematics is one of my strengths.	0.884
I think learning mathematics will help me in my daily life.	0.916
I need to do well in mathematics to get the job I want.	0.858
I typically perform well in mathematics.	0.781

Note. SFL: Standard factor loading

The Bartlett's test of sphericity reported a significant p-value of 0.000 from a Chi-square of 3,722.146 and a degree of freedom of 153. In addition to the EFA, the four latent variables reported a cumulative variance of 71.663%. However, all other observed variables, which were not in their rightful place on the rotated component matrix were deleted. **Table 3** gives the final EFA depicting the observed variables under their right latent variables.

Confirmatory Factor Analysis

Confirmatory factor analysis (CFA) was calculated using Amos (version 23). The CFA as used in many related works confirms that it has more applications than other statistical analysis. This is because the CFA can estimate a multiple of statistical test (Dogbe et al., 2020; Lahey et al., 2012). **Table 4** defines the CFA analysis. After EFA analysis, the observed variables from the rotated components were used to analyze the CFA. Factor loading greater than 0.4 were used to analyze the CFA and poor loading below 0.5 of the observed variables from the EFA were deleted.

From **Table 4**, self-concept had five observed variables, teacher quality had four variables, mathematics interest four, and achievement five but the fourth variable of teaching quality was deleted because of poor factor loading while the remaining variables under each of the latent variable had a factor loading above 0.5 and in their right definiteness was used in determining the CFA. **Table 4** gives the CFA analysis.

From **Table 4** analysis, Hair et al. (2010) discuss the definiteness of the model fit of the CFA that CMIN/DF (Chi-square value over the degree of freedom) should be below three with RMR (root mean square residual) and RMSEA (root mean square error of approximation) greater than 0.7 while CFI (comparative fit index) and TLI (Tukey Lewis index) value is calculated to be at least 0.9. Hair et al. (2010) explain that CMIN ensures the least discrepancy value and RMR and RMSEA defines the complete fit indices by estimating the deviation from the model on the various hypothesis stated. On the other hand, TLI and CFI values are constructed in terms of normal-theory on a continuous data, which hypothesized reference line model fit.

Figure 2 shows diagrammatic presentation of CFA.

Discriminant Validity

Average variance extracted (AVE) and composite reliability (CR) was calculated to critically examined the convergent validity and reliability on the final observed variables that estimated the CFA. The convergent validity measures how well each observed items correlate on the same construct with the other observed variables (Trochim & Donnelly, 2001). The expected value of the AVE and the CR should be at least 0.5 and 0.7, respectively. For further analysis of the study and achieving a convergence validity, the AVE and CR was calculated, and the results confirms a least AVE=0.571 and CR=0.725, which support the conditions for AVE and CR by Fornell and Larcker (1981). The discriminant validity was assessed using the approach of other researchers like Arthur et al. (2021) who explained that discriminant validity is obtained when √AVE has a value above the correlation coefficient, which the coefficient values was generated from the CFA output using the covariances.

Table 5 discusses the √AVE against corresponding correlation of the latent variables. From **Table 5**, since √AVE is greater than the correlation values of the latent variables, where the highest √AVE value is 0.857 with the highest correlation coefficient value as 0.61. This explains that discriminant validity is achieved.

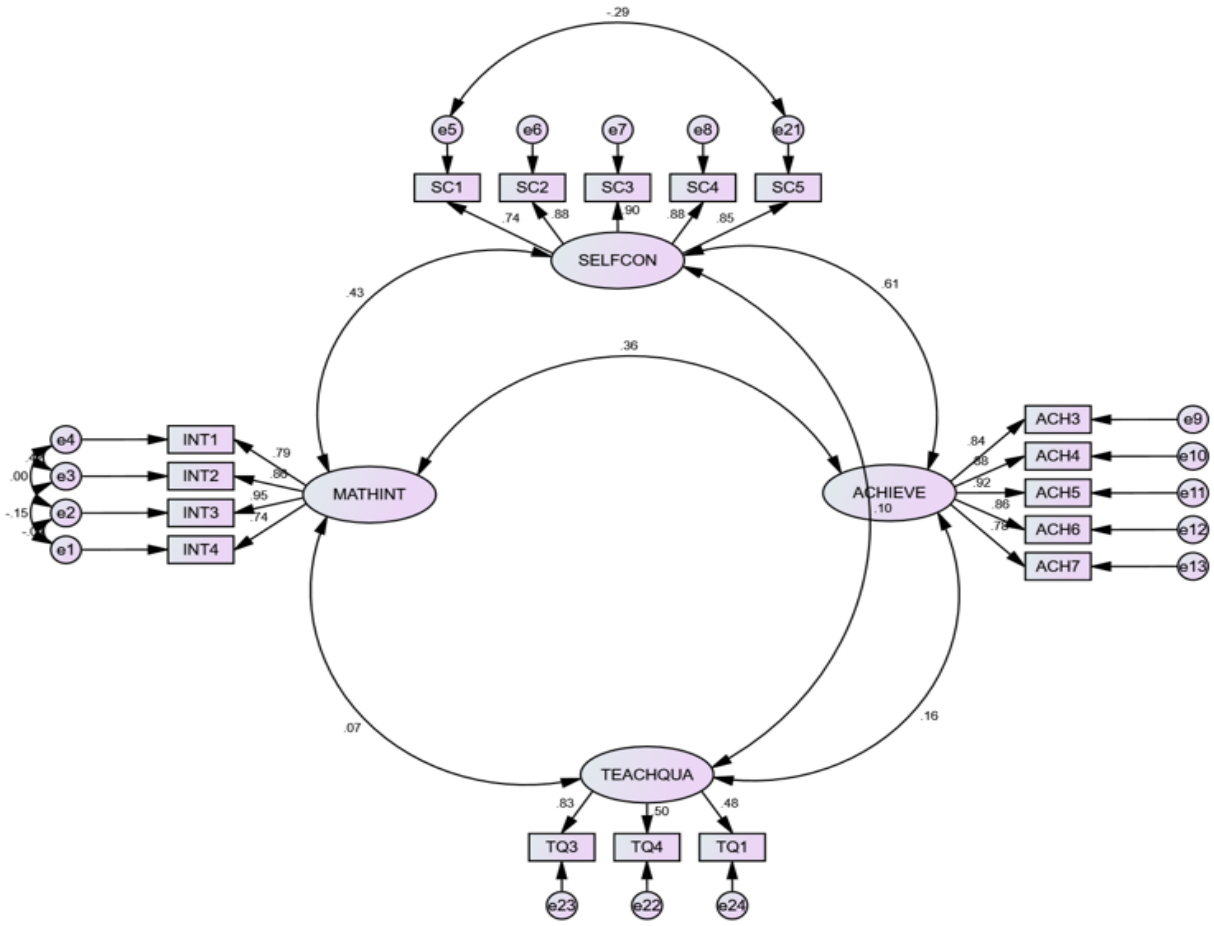

Figure 2. Diagrammatic presentation of CFA (Field Survey, 2022)

Table 5. Discriminant validity (Field Survey, 2022)

Variables	SC	TQ	INT	ACH
SC	**0.851**			
TQ	0.100	**0.707**		
INT	0.430**	0.070	**0.837**	
ACH	0.610**	0.160	0.360**	**0.857**

Note. **~p-value significant at 1% (0.01) & √AVE are bold and underlined

PATH ESTIMATES

Direct Effect

Table 6 evaluates the various direct effect of the hypothesis of the study as the path analysis. The path analysis gives a way of disintegrating the correlation among the various independent variables against the dependent variable, which supports existing theories by other researchers. This was analyzed using structural equation model (SEM) from Amos (version 23). **Table 6** presented the direct effect of the control variables (gender, age, form, and program of study) and the independent (latent) variables (self-concept, interest, and teacher quality) against the dependent variables (mathematics achievement).

From **Table 6**, age and course of study had no correlation with achievement in mathematics, where they were statistically insignificant with age (β=-0.014; CR=-0.665; p-value= 0.506) and course (β=-0.019; CR=-1.435; p-value=0.151). On the other side, gender and form of students resulted statistically significant, which explained that the class in which a student is, and his/her gender can predict his/her achievement in mathematics. The results of gender showed (β=0.015; CR=0.682; p-value=0.045) and form had (β=-0.047; CR=-2.135; p-value=0.033).

According to the path hypothesis, a bootstrap of 5,000 sample and a confidence level of 95% was analyzed through bias-corrected (BC) percentile method. **Figure 3** represent the diagram of the structural hypothesized paths for the study. Results of the analysis showed that the relationship between student's self-concept and achievement in math has a p-value of 0.000, which was statistically significant at 5% and confirms that self-concept has a direct positive influence on mathematics achievement (β=0.656; CR=4.950). ***H₁:*** *Self-concepts have a direct impact on mathematics achievement.* This explains that self-concept contributes to student's performance by 65.6%. ***H₂:*** *Mathematics Interest has direct impact on mathematics achievement,* ascertained that the relationship of interest and performance is statistically significant with a p-value 0.049<0.05. This implies that

Table 6. Path summary (Field Survey, 2022)

Direct path	Standard estimate	CR	p-value
GENDER→ACH	0.015	0.682	0.045
AGE→ACH	-0.014	-0.665	0.506
FORM→ACH	-0.047	-2.135	0.033
COURSE→ACH	-0.019	-1.435	0.151
SC→ACH	0.405	6.139**	0.000
TQ→ACH	0.201	0.144	0.163
INT→ACH	0.587	4.394	0.049
SC→INT	0.733	5.630**	0.000
INT×TQ→ACH	0.268	3.322	0.012
Indirect path	**Standard estimate**	**Lower BC**	**Upper BC**
SC → INT → ACH	0.430	0.10	0.136
Model fit indices: CMIN=224.880; df=124; CMIN/df=1.814; CFI=.972; TLI=.966; RMR=.047; RMSEA=.052; & PClose=.359			

Note. *~p-value significant at 1% (0.01) & *~p-value significant at 5% (0.05)

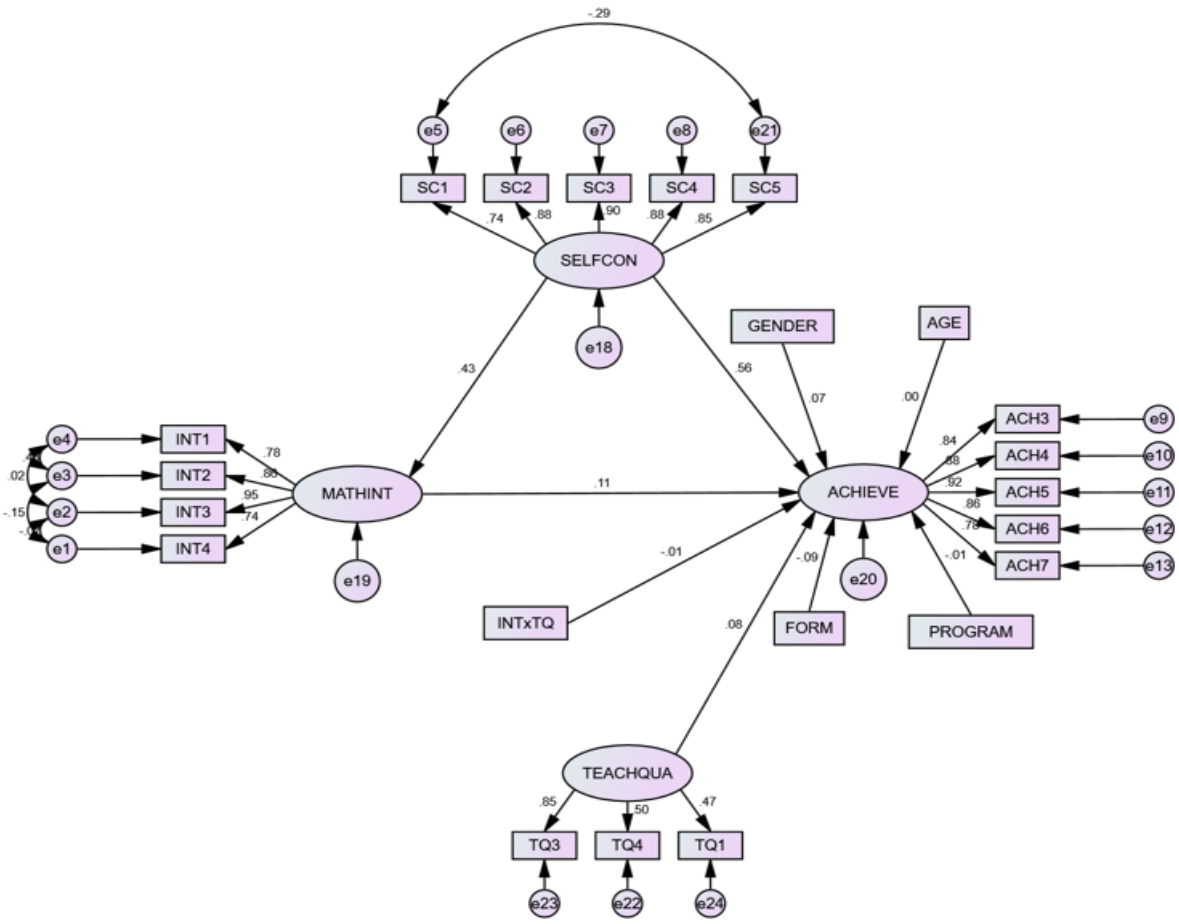

Figure 3. Structural paths (Field Survey, 2022)

there is 58.7% achievement in mathematics when student show interest in the study of mathematics (β=0.587; CR=4.394). In addition to the above, teacher quality has a direct impact on achievement (β=0.338; CR=3.664). Thus, mathematics achievement is increased by 33.8% when teaching quality is enhanced. Similarly, the relationship between self-concept and mathematics interest was positively significant having a direct impact (β=0.733; CR=5.630) with a p-value less than 1%. This recorded the highest percentage of 73.3% informing that students' interest in the study of mathematics is increased when they have self-concept.

Furthermore, the study determined the mediation effect of mathematics interest as another hypothesis path analysis and moderation effect of teaching quality between mathematics interest and achievement. ***H₃:*** *Self-concept has an indirect impact on mathematics achievement through mathematics interest.* This was calculated using the lower and upper bound (BC). The indirect effect recorded a lower bound of 0.10 and an upper bound of 0.136 and all the values have same coefficient as positive. The results showed that the mediation effect was statistically significant, which support that there is 43% impact on self-concept and mathematics achievement through mathematics interest. There is however a partial mediation effect since both Lower and Upper BCs are all positive with not zero intersecting them. ***H₄:*** *Teacher quality has a moderation effect on mathematics interest and mathematics achievement.* The interaction term (INT×TQ) as moderator of teaching quality reported a direct impact on achievement. This is statistically significant with a p-value of 0.012<0.05. This explains that teaching quality was seen to be moderating interest and achievement in mathematics.

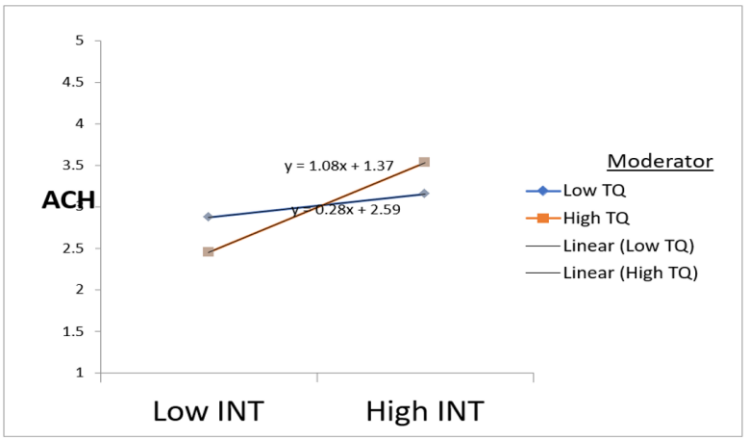

Figure 4. Two-way interaction (Field Survey, 2022)

Figure 4 demonstrates the two-way interaction of the independent variable (mathematics interest) and the dependent variable (achievement in mathematics), which have been influenced by the moderator (teaching quality). From **Figure 4**, as higher level of teaching quality, there is a higher level of mathematics interest predicting higher level of mathematics achievement. It informed that, at lower influence of teaching quality, there is a higher achievement through higher level of mathematics interest.

Discussion of Results

According to some practitioners and some researchers, one of the key attributes in achieving success in mathematics is self-concept. Based on the analysis conducted, self-concept was statistically significant, which supports a number of writings, and it serves as a contribution to literature. For example, Goetz et al. (2013) examined the relationship between self-concept and achievement among other variables. They concluded that there was a strong correlation between self-concept and achievement in mathematics. Punithavathi (2011) investigated to discover the connection among self-concept and educational overall performance of college students in the pre-tertiary level. The conclusion of the research found out a vital courtship among self-concept and educational achievement.

The findings of this study also showed a statistically significant among mathematics interest and achievement in mathematics. This study showed that there is 58.7% achievement in mathematics when students' interest is enhanced. The findings from this study support related work by Sauer (2012) and Tosto et al. (2016). They concluded by stating that interest and achievement in mathematics has a significant impact or direct effect on mathematics achievement. Another study from Zhang and Wang (2020) looked at a similar study between interest and achievement. They concluded with a positive direct link between the variables.

From this study, the findings presented that there was a direct effect of teaching quality and mathematics achievement. The p-value between teaching quality and achievement showed 0.000 at 1% significant. Fauth et al. (2019) study about teaching quality with some variables to predict performance in mathematics. They concluded with a direct of teaching quality and teacher competence has a significant impact on students' performance with this same study supporting their conclusion. This study also supports research by Arthur (2019) whose conclusion showed a direct positive impact between teaching quality and mathematics achievement.

Moreover, this study also focused on the mediating analysis (indirect path) and moderation effect. Teaching quality in this study was hypothesized as a moderator. The interaction term (INT×TQ), which was serving as the moderating effect of the teaching quality reported a p-value of 0.012<0.05. This was statistically significant at 5% confidence interval. This explains that teaching quality was moderating mathematics interest. Furthermore, the indirect path (mediating effect) was examined as statistically significant explaining that self-concept has an indirect effect through mathematics interest on achievement. This was showed to be partially mediating effect.

CONCLUSION

The study concluded that self-concept, mathematics interest and teaching quality have a direct positive effect on students' performance with their significance below 5%. The study also found self-concept as having a partial mediator to mathematics achievement through mathematics interest. However, teaching quality showed no moderating effect between interest and achievement.

Recommendation

The findings of the study suggest the following recommendations:

1. It was recommended that teaching quality strategies must be utilize by school management to promote students' performance. Teaching quality techniques such as supportive climate, cognitive activation and classroom management should be adopted by SHS.
2. The study made use of causal analysis and therefore recommended for the account of longitudinal study of data.

Limitations

Since the study was conducted in Kumasi Metropolis, its findings cannot be generalised to other part of the country to reflect students' success. The schools, which participated for this study were only two and the study would have given a better description of the nature of students' approach towards the study of mathematics if more schools were used. The fact that the findings from the sample of SHS 2 and 3 students offering just three programmes that is, general arts, general science, and home economics were seen as a limitation for generalisation of the findings. In the light of this, no attempt was made to generalise the findings beyond the scope of this study.

Author contributions: All authors have sufficiently contributed to the study and agreed with the results and conclusions.

Funding: No funding source is reported for this study.

Ethical statement: Authors stated that participation to the study was strictly voluntary. Informed consents were obtained from the participants. Personal information was kept confidential.

Declaration of interest: No conflict of interest is declared by authors.

Disclosure: Authors disclosed that all views and results of this study are only that of the authors. This paper was engaged from Micheal Fosu's thesis with the title "Mediation and moderation effect of mathematics interest and teaching quality between self-concept and mathematics achievement".

Data sharing statement: Data supporting the findings and conclusions are available upon request from the corresponding author.

REFERENCES

Abreh, M. K., Owusu, K. A., & Amedahe, F. K. (2018). Trends in performance of WASSCE candidates in the science and mathematics in Ghana: Perceived contributing factors and the way forward. *Journal of Education, 198*(1), 113-123. https://doi.org/10.1177/0022057418800950

Arens, A. K., & Morin, A. J. (2016). Relations between teachers' emotional exhaustion and students' educational outcomes. *Journal of Educational Psychology, 108*(6), 800. https://doi.org/10.1037/edu0000105

Arens, A. K., Yeung, A. S., Craven, R. G., & Hasselhorn, M. (2011). The twofold multidimensionality of academic self-concept: Domain specificity and separation between competence and affect components. *Journal of Educational Psychology, 103*(4), 970. https://doi.org/10.1037/a0025047

Arthur, Y. D. (2019). Effect of the constructivists teaching method, undergraduate students' statistics self-concept, and other psychological constructs in mediating their motivation for learning statistics. *African Journal of Educational Studies in Mathematics and Sciences, 15*(1), 129-142. https://doi.org/10.1016/j.heliyon.2019.e02491

Arthur, Y. D., Asiedu-Addo, S., & Assuah, C. (2017). Students' perception and its impact on Ghanaian students' interest in mathematics: Multivariate statistical analytical approach. *Asian Research Journal of Mathematics, 4*(2), 1-12. https://doi.org/10.9734/arjom/2017/33023

Arthur, Y. D., Dogbe, C. S. K., & Asiedu-Addo, S. K. (2021). Modeling students' mathematics achievement and performance through teaching quality: SERVQUAL perspective. *Journal of Applied Research in Higher Education*. https://doi.org/10.1108/JARHE-06-2021-0243

Arthur, Y. D., Dogbe, C. S. K., & Asiedu-Addo, S. K. (2022). Enhancing performance in mathematics through motivation, peer assisted learning, and teaching quality: The mediating role of student interest. *EURASIA Journal of Mathematics, Science and Technology Education, 18*(2), 1-13. https://doi.org/10.29333/ejmste/11509

Blustein, D. L. (1989). The role of career exploration in the career decision making of college students. *Journal of College Student Development, 30*(2), 111-117.

Borisade, F. T. (2011) Teacher qualities and school factors as correlates of academic performance of secondary school students in mathematics in Ekiti State, Nigeria. *Humanities Journal, 3*, 173-179.

Bosson-Amedenu, S. (2017). Predictive validity of mathematics mock examination results of senior and junior high school students' performance in WASSCE and BECE in Ghana. *Asian Research Journal of Mathematics, 3*(4), 1-8. https://doi.org/10.9734/ARJOM/2017/32328

Brunner, M., Keller, U., Dierendonck, C., Reichert, M., Ugen, S., Fischbach, A., & Martin, R. (2010). The structure of academic self-concepts revisited: The nested Marsh/Shavelson model. *Journal of Educational Psychology, 102*(4), 964. https://doi.org/10.1037/a0019644

Clem, A. L., Rudasill, K., Hirvonen, R., Aunola, K., & Kiuru, N. (2020). The roles of teacher-student relationship quality and self-concept of ability in adolescents' academic emotions: Temperament as a moderator. *European Journal of Psychology of Education, 36*, 263-286. https://doi.org/10.1007/s10212-020-00473-6

Creswell, J. W. (2012). *Educational research: Planning, conducting, and evaluating quantitative and qualitative research*. Pearson/Merrill Prentice Hall.

Darling Hammond, L. (2000). Teacher quality and student achievement: A review of state policy evidence. *Education Policy Analysis Archives, 8*, 1. https://doi.org/10.14507/epaa.v8n1.2000

DeVellis, R. F. (1991). *Scale development: Theory and applications*. SAGE.

Dogbe, C. S. K., Tian, H., Pomegbe, W. W. K., Sarsah, S. A., & Otoo, C. O. A. (2020). Effect of network embeddedness on innovation performance of small and medium-sized enterprises. *Journal of Strategy and Management, 13*(2), 181-197. https://doi.org/10.1108/JSMA-07-2019-0126

Ezenweani, U. L. (2006). *Mathematics and classroom teaching*. University Press.

Fauth, B., Decristan, J., Decker, A. T., Buettner, G., Hardy, I., Klieme, E., & Kunter, M. (2019). The effects of teacher competence on student outcomes in elementary science education: The mediating role of teaching quality. *Teaching and Teacher Education, 86*, 102882. https://doi.org/10.1016/j.tate.2019.102882

Fenster, E. D. (2014). *Implications of teacher tenure on teacher quality and student performance* [Unpublished honors thesis]. Duke University.

Fletcher, J. (2018). Performance in mathematics and science in basic schools in Ghana. *Academic Discourse: An International Journal, 10*(1), 1-18.

Fornell, C., & Larcker, D. F. (1981). Evaluating structural equation models with unobservable variables and measurement error. *Journal of Marketing Research, 18*(1), 39-50. https://doi.org/10.1177/00222437810 1800104

Fredrickson, B. L. (1998). What good are positive emotions? *Review of General Psychology, 2*(3), 300-319. https://doi.org/10.1037/1089-2680.2.3.300

García-Perales, R., & Palomares-Ruiz, A. (2020). Education in programming and mathematical learning: Functionality of a programming language in educational processes. *Sustainability, 12*(23), 10129. https://doi.org/10.3390/su122310129

Goetz, T., Bieg, M., Lüdtke, O., Pekrun, R., & Hall, N. C. (2013). Do girls really experience more anxiety in mathematics? *Psychological Science, 24*(10), 2079-2087. https://doi.org/10.1177/0956797613486989

Hair, J. F., Black, W. C., Babin, B. J., & Anderson, R. E. (2010). *Multivariate data analysis: A global perspective*. Pearson Education.

Hanushek, E. A., & Rivkin, S. G. (2006). Teacher quality. *Handbook of the Economics of Education*, *2*, 1051-1078. https://doi.org/10.1016/S1574-0692(06)02018-6

Harackiewicz, J. M., Durik, A. M., Barron, K. E., Linnenbrink-Garcia, L., & Tauer, J. M. (2008). The role of achievement goals in the development of interest: Reciprocal relations between achievement goals, interest, and performance. *Journal of Educational Psychology, 100*(1), 105-122. https://doi.org/10.1037/0022-0663.100.1.105

Harackiewicz, J. M., Smith, J. L., & Priniski, S. J. (2016). Interest matters: The importance of promoting interest in education. *Policy Insights from the Behavioral and Brain Sciences, 3*(2), 220-227. https://doi.org/10.1177/2372732216655542

Hidi, S., & Renninger, K. A. (2006). The four-phase model of interest development. *Educational Psychologist, 41*(2), 111-127. https://doi.org/10.1207/s15326985ep4102_4

Hinnant-Crawford, B. N., Faison, M. Z., & Chang, M. L. (2016). Culture as mediator: Co-regulation, selfregulation, and middle school performance in mathematics. *Journal for Multicultural Education, 10*(3), 274-293. https://doi.org/10.1108/JME-05-2016-0032

Jansen, M., Schroeders, U., & Lüdtke, O. (2014). Academic self-concept in science: Multidimensionality, relations to achievement measures, and gender differences. *Learning and Individual Differences, 30*, 11-21. https://doi.org/10.1016/j.lindif.2013.12.003

Knight, S. L. (2012). Evaluation of teacher quality. In C. Secolsky, & D. B. Denison (Eds.), *Handbook on measurement, assessment, and evaluation in higher education* (pp. 602-610). Routledge. https://doi.org/10.4324/9780203142189-57

Kolawole, E. B., & Oluwatayo, J. A. (2005). Mathematics for everyday living: Implications for nigerian secondary schools. *Abacus, 30*(1), 51-57.

Koller, O., Baumert, J., & Schnabel, K. (2001). Does interest matter? The relationship between academic interest and achievement in mathematics. *Journal for Research in Mathematics Education, 32*(5), 448-470. https://doi.org/10.2307/749801

Lahey, B. B., McNealy, K., Knodt, A., Zald, D. H., Sporns, O., Manuck, S. B., Flory, J. D., Applegate, B., Rathouz, P. J., & Hariri, A. R. (2012). Using confirmatory factor analysis to measure contemporaneous activation of defined neuronal networks in functional magnetic resonance imaging. *Neuroimage, 60*(4), 1982-1991. https://doi.org/10.1016/j.neuroimage.2012.02.002

Lazarides, R., & Buchholz, J. (2019). Student-perceived teaching quality: How is it related to different achievement emotions in mathematics classrooms? *Learning and Instruction, 61*, 45-59. https://doi.org/10.1016/j.learninstruc.2019.01.001

Lee, W., Lee, M. J., & Bong, M. (2014). Testing interest and self-efficacy as predictors of academic self-regulation and achievement. *Contemporary Educational Psychology, 39*(2), 86-99. https://doi.org/10.1016/j.cedpsych.2014.02.002

Marsh, H. W., Trautwein, U., Lüdtke, O., Köller, O., & Baumert, J. (2005). Academic self- concept, interest, grades, and standardized test scores: Reciprocal effects models of causal ordering. *Child Development, 76*(2), 397-416. https://doi.org/10.1111/j.1467-8624.2005.00853.x

Marsh, H. W., Trautwein, U., Lüdtke, O., Köller, O., & Baumert, J. (2016). Integration of multidimensional self-concept and core personality constructs: Construct validation and relations to well-being and achievement. *Journal of Personality, 74*, 403-455. https://doi.org/10.1111/j.1467-6494.2005.00380.x

McMillan, J. H., & Schumacher, S. (2006). *Research in education: Evidence-based inquiry*. Pearson Education.

Metzler, J., & Woessmann, L. (2010). The impact of teacher subject knowledge on student achievement: Evidence from within-teacher within-student variation. *IZA Discussion Paper 4999*. https://doi.org/10.2139/ssrn.1634795

Monk, D. H. (2007). Recruiting and retaining high-quality teachers in rural areas. *The Future of Children, 17*(1), 155-174. https://doi.org/10.1353/foc.2007.0009

Pekrun, R., & Perry, R. P. (2014). Control-value theory of achievement emotions. In R. Pekrun, & L. Linnenbrink-Garcia (Eds.), *International handbook of emotions in education* (pp. 120-141). Routledge/Taylor & Francis Group. https://doi.org/10.4324/9780203148211

Pinxten, M., Marsh, H. W., De Fraine, B., Van Den Noortgate, W., & Van Damme, J. (2014). Enjoying mathematics or feeling competent in mathematics? Reciprocal effects on mathematics achievement and perceived math effort expenditure. *British Journal of Educational Psychology, 84*(1), 152-174. https://doi.org/10.1111/bjep.12028

Punithavathi, P. (2011). *Creativity, self-concept, and academic achievement among students at the secondary level* [MEd. Thesis, Tamilnadu Teachers Education University].

Quansah, F., & Ankoma-Sey, V. R. (2020). Evaluation of pre-service education programme in terms of educational assessment. *The International Journal of Research in Teacher Education, 11*(1), 56-69.

Reeve, J., Lee, W., & Won, S. (2015). Interest as emotion, as affect, as schema. In K. A. Renninger, M. Nieswandt, & S. Hidi (Eds.), *Interest in mathematics and science learning* (pp. 79-92). American Educational Research Association. https://doi.org/10.3102/978-0-935302-42-4_5

Sauer, K. (2012). *The impact of student interest and instructor effectiveness on student performance* [Master's thesis, St. John Fisher College].

Seidel, T., & Shavelson, R. J. (2007). Teaching effectiveness research in the past decade: The role of theory and research design in disentangling meta-analysis results. *Review of Educational Research, 77*(4), 454-499. https://doi.org/10.3102/0034654307310317

Shavelson, R. J., Hubner, J. J., & Stanton, G. C. (1976). Self-concept: Validation of construct interpretations. *Review of Educational Research, 46*(3), 407-441. https://doi.org/10.3102/00346543046003407

Slavin, R. E. (2003). *Educational psychology: Theory and practice*. Allyn & Bacon.

Swann, W. B. Jr., Chang-Schneider, C., & Larsen McClarty, K. (2007). Do people's self-views matter? Self-concept and self-esteem in everyday life. *American Psychologist, 62*, 84-94. https://doi.org/10.1037/0003-066X.62.2.84

Tella, A. (2008). Teacher variables as predictors of academic achievement of primary school pupils mathematics. *International Electronic Journal of Elementary Education, 1*(1), 16-33. https://doi.org/10.4314/ifep.v16i2.23806

Thien, L. M., & Ong, M. Y. (2015). Malaysian and Singaporean students' affective characteristics and mathematics performance: Evidence from 2012. *SpringerPlus, 4*, 563-577. https://doi.org/10.1186/s40064-015-1358-z

Tosto, M. G., Asbury, K., Mazzocco, M. M., Petrill, S. A., & Kovas, Y. (2016). From classroom environment to performance in mathematics: The mediating role of self-perceived ability and subject interest. *Learning and Individual Differences, 50*, 260-269. https://doi.org/10.1016/j.lindif.2016.07.009

Trochim, W. M., & Donnelly, J. P. (2001). *Research methods knowledge base*. Atomic Dog Publishers.

UN ESCAP. (2015). Statistical yearbook for Asia and Pacific 2015, SDG 4. *United Nations Economic and Social Commission for Asia and the Pacific*. https://www.unescap.org/sites/default/files/SYB2015_Full_Publication.pdf

Valentine, J. C., DuBois, D. L., & Cooper, H. (2004). The relations between self-beliefs and academic achievement: A systematic review. *Educational Psychologist, 39*, 111-133. https://doi.org/10.1207/s15326985ep3902_3

WAEC. (2016). *Chief examiners report for 2016*. West African Examination Council Press.

WAEC. (2018). *West Africa secondary school certificate examinations. Elective mathematics results (2013-2017)*. West African Examination Council Press.

WAEC. (2021). *Chief examiners report for 2021*. West African Examination Council Press.

Wigfield, A., & Cambria, J. (2010). Students' achievement values, goal orientations, and interest: Definitions, development, and relations to achievement outcomes. *Developmental Review, 30*(1), 1-35. https://doi.org/10.1016/j.dr.2009.12.001

Yamane, T. (1973). *Statistics: An introductory analysis*. Harper and Row.

Yu, R., & Singh, K. (2016). Teacher support, instructional practices, student motivation, and mathematics achievement in high school. *The Journal of Educational Research, 111*(1), 81-94. https://doi.org/10.1080/00220671.2016.1204260

Zhang, D., & Wang, C. (2020). The relationship between mathematics interest and performance in mathematics: Mediating roles of self-efficacy and mathematics anxiety. *International Journal of Educational Research, 104*, 101648. https://doi.org/10.1016/j.ijer.2020.101648

Zuzovsky, R., & Donitsa-Schmidt, S. (2017). Comparing the effectiveness of two models of initial teacher education programmes in Israel: concurrent vs. consecutive. *European Journal of Teacher Education, 40*(3), 413-431. https://doi.org/10.1080/02619768.2017.1318377