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# Mathematics achievement in high schools, the role of the teacher-student relationship, students' self-efficacy, and students' perception of mathematics

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**ABSTRACT**

The study examined the impact of teacher -students' relationship, student self-efficacy, and student perception on mathematics achievement. The study was a survey, and adopted a structured questionnaire as the instrument for data collection. A total sample of 400 students: 112 males and 298 females were randomly selected from two public senior high schools in the Ashanti region. The data gathered were analyzed statistically using structural equation model. Based on the findings, it was concluded that the influence teacher-student relationship has on mathematics achievement was insignificant whiles students' self -efficacy and students' perception had a positive impact on mathematics achievement. The outcome of the analyses recommends that teachers should aid in promoting students' attitudes toward mathematics as well as promoting their self-efficacy in order to accelerate their mathematics performance.

**Keywords:** mathematics achievement, self-efficacy, student perception, teacher-student relationship

## INTRODUCTION

Over the past three decades, researchers have succeeded in determining varieties of factors that significantly influenced students' achievements, particularly in mathematics (Lubienski et al., 2005; Reardon et al., 2009). Researchers brought up that mathematics' achievement is significantly affected by some contributing factors such as teacher-student relationship, self-efficacy, student perception of mathematics, and many more. The experiences students go through contribute greatly to how they perform in mathematics (Ezenweani, 2006). The performance of students in mathematics has been an incredible worry to both the public and private sectors in education. The knowledge of mathematics is important in various fields of study like designing, software engineering, engineering, development, woodwork, and many others (Tella, 2008). In numerous research studies, there has been an unfriendly consequence of the teacher-student relationship on students' mathematics outcome.

Studies have demonstrated that the connection that exist between teachers and students assumes a significant part in the students' mathematics achievement (Hughes & Kwok, 2007). If teachers need to cultivate a good learning environment, a positive relationship with their students is the key. A student is bound to accomplish better outcomes if they see their teachers as a "buddy" (Pianta, 1999). Many students believe that an absence of affinity among teachers and students shows their poor performance in mathematics. Normally, teachers typically come nearer to students with high-capacity levels, who end up being positive about the subject. This separation unfavorably influences low-capacity students. Murray-Harvey (2015) stated that mathematics is seen to be a troublesome subject and accordingly, a good relationship among teachers and students goes far to help improve student achievement.

As indicated by Ewnetu and Fisseha (2008), the teacher-student relationship has been characterized into four groups, to be specific: connectedness, anxiety, independent/dependent, and peaceful/conflicting. Connectedness clarifies the degree of closeness among students and teachers. This implies that teachers can set up tight positive connections with learners which may argue students' academic performance in mathematics and vice versa. Anxiety in this context explains students' uneasiness towards their teachers. A dependent/independent relationship shows students' degree of reliance/independent on their teachers. This shows students' degree of trust in their teachers, particularly when they deal with an issue in class.

Pajares (2002) characterizes self-efficacy as the certainty that an individual has in his/her ability to perform the activities that one attempts to do. Ormrod (2006) likewise characterizes self-efficacy as the confidence in their capacities to deliver in a specific way to accomplish a specific objective. It is student's confidence in their abilities to produce designed levels of performance that

influence later events of their lives (Xu & Qi, 2019). Sharon and Vialle (1998) in their discoveries, uncovered those learners with a significant degree of self-efficacy show an increase in academic performance contrasted to those who come out with low efficacy. Educators link self-efficacy to the potential and actions of the individual performing the task. Self-efficacy appreciably affects one's action, effort, and manner of accomplishing tasks leading to enhanced abilities and makes one more confident about the desired outcomes. Bandura (2002) states that thinking ahead and expecting results can help to adjust a situation and achieve the desired targets. Concerning the teachers, it has been seen that teachers with a significant degree of self-efficacy have a good attitude in everything. Generally, they have control of their emotions that is, they control their anger in front of their learners, and this behavior brings high outcomes. The study of Haciomeroglu (2019) revealed that emotional and physiological state contrarily predicts mathematics self-efficacy. This discovering shows that an emotional and physiological state assumes a significant part in students' self-efficacy.

Perception might be characterized from physical, mental, and physiological points of view. In any case, this investigation will be restricted to its extension as proposed by Allport (1996), which is the way we evaluate people we come into contact with. The insight students' have on mathematics is based on their past experience, the background of the learner, and the experience obtained from the classroom (Hannula, 2007). Generally, research has indicated that males have a high positive perception towards mathematics (Kaasila et al., 2006). In this research, perception of mathematics is conceptualized as a psychological portrayal or perspective on mathematics, obviously developed because of social encounters, intervened through cooperation at school, or the impact of guardians, teachers, or friends. Students' perceptions about mathematics are identified with their view of learning mathematics (Yahaya et al., 2007). Mathematics perception is characterized as how students actually see mathematics as a subject, and how they feel and consider learning the subject. The insight students have on mathematics remains very critical in educational stakeholder's desire to find a lasting remedy to the issue of low academic outcome and lack of interest in mathematics. These impressions of students about mathematics might be a consequence of encounters students go through in the beginning phases of their educational life.

This study has been intended to see if there are some significant impacts of a teacher-student relationship, self-efficacy, and student perception of mathematics on mathematics achievement.

There has been general concern about the abysmal performance of learners in mathematics. These abysmal performance levels in mathematics are of much concern to educationists and adverse effect on the country's science and technology industry shortly (Tata, 2013). The problem of this study predominantly concerns the mathematics achievement of students in some selected senior secondary schools in the Kumasi metropolitan about some contributing variables, for example, teacher-student relationship, self-efficacy, and student perception of mathematics. The impact of these contributing factors on the mathematics achievement of learners is at the core of this study. To address this problem, this study was designed to investigate the effects that teacher-student relationships, self-efficacy, and student perception have on the mathematics outcome of the learners in some selected senior high schools in the Kumasi Metropolis.

The study came out with the following research objectives:

1. To determine the effect of the teacher-student relationship on mathematics achievement.
2. To examine whether students' perception of mathematics affects mathematics achievement.
3. To find out the effects of student's self-efficacy on mathematics achievement.

### Research Questions

The study made use of the following research questions to guide solve the problem under investigation:

1. What is the effect of the teacher-student relationship on mathematics achievement?
2. What is the impact of student perception on mathematics achievement?
3. How does students' self-efficacy affect mathematics achievement?

### Significance of the Study

The findings of this study are expected to expose some factors that could contribute to students' mathematics achievement in the Kumasi Metropolis. The outcome of the study will aid students to identify their potentials by proving their self-confident when dealing with mathematics problem. Again, this research study will equip teachers of mathematics with the required approach of teaching students with bad perception of mathematics that will elicit better achievement in mathematics. The outcome of the study will also enable stakeholders of mathematics education with the appropriate measures to put in place when developing the mathematics curriculum. Finally, this study will guide researchers on further studies on students' mathematics achievement.

## CONCEPTUAL FRAMEWORK

To determine the factors that influence mathematics achievement among various groups of individuals, numerous studies have been conducted over the past several decades. It has been stated in many literatures that mathematical achievement is influenced by numerous factors, including teacher-student relationship, students' self-efficacy, student's perception of mathematics, and other factors, which are dependent of each other and can influence each other. Again, some of the predicting factors are very complex, so it is very essential to divide them into sub-variables and find out how each sub-variable is related to mathematical success.

### The Impact of Teacher-Student Relationship on Mathematics Achievement

In general, relationships whether positive or negative have profound effects on quality of life. In this regard, we support (Dahal et al., 2019), who state that well-being is directly tied to personal relationships. With this basic understanding of the concept and importance of relationships in our mind, this section focuses more specifically on the importance as well as the effect of student-teacher relationships on learning mathematics.

Students' ability to engage in academic settings is proven to create a conducive teacher-student relationship. Hughes and Kwok (2007), in his study, discovered that the sorts of relationships teachers set up with their students have a significant influence on their academic outcome. Additionally, Daud et al. (2020), in their discoveries, showed that the sort of relationship between the teacher and the student fills in as an association between the two, giving either a helpful or non-favorable atmosphere for a classroom environment. A study conducted by Wasike (2013) uncovered that a powerful teacher-student relationship might be the cornerstone that permits different angles to work well.

### The Impact of Students' Self-Efficacy on Mathematics Achievement

The idea of self-efficacy assumes a focal part in Bandura's social cognitive theory (Bandura, 1982, 1997, 2001). In social cognitive theory (SCT), people are neither constrained by their current circumstance nor are they totally independent (Bandura, 2001). Instead, the link is seen as being mutual, where the domain can restrict the alternatives that are accessible to an individual, and yet, the individual can figure out what piece of the potential environment will be capable (Zimmerman, 1990). Callaman and Itaas (2020) reported that academic self-efficacy matched up with academic achievement in the mathematics examination. The insight that learners have about their academic capabilities aids to predict what they do with the knowledge and skills they possess which eventually determines their academic achievement.

Studies regarding gender differences in mathematics performance and mathematics self-efficacy ratings have also been reported. While some reports have suggested that males are normally obtain higher as far as mathematics self-efficacy questionnaires is concerned than females (Betz & Hackett, 1983). According to May and Glynn (2008), anybody who usually got low mathematical self-efficacy will avoid mathematical problems. Several studies have also revealed a strong connection between mathematics self-efficacy and Mathematics achievement (Bonne & Lawes, 2016). In their decisions, they guarantee that as an individual is being rated high on the mathematics self-efficacy scale, the better this individual performs on problems pertaining to mathematics. As indicated by Toropova et al. (2019), the higher the degree of students' self-efficacy, the greater they were bound to communicate good inclinations towards academics than their friends.

Schunk (1999) discovered more high levels of self-efficacy additionally brought about more noteworthy utilization of learning and metacognitive techniques. Student advancement of self-efficacy was related to four components: prior experience, vicarious experience, verbal persuasion, and physiological state (Bandura, 2002). Prior experience deals with the essential activities the individual build upon when entering a new environment. Vicarious experiences also known as social model are models used by adults and peers when attempting a problem. Verbal persuasion refers to the information obtained as a result of influence of others while working on a task. Physiological and affective states is the state whereby a person becomes emotionally and physically cues, when attempting to execute a new learning. The development of these factors is complex within the classroom setting.

### The Impact on Student Perception on Mathematics Achievement

There are a lot of students who cannot make a difference in mathematics concepts and abilities they have mastered during their studies. The challenges of students grasping the essential concepts will impact mathematics learning. Therefore, this section of the research seeks to investigate whether students' insight about mathematics will affect the achievement in this subject, and thus reflect in their overall academic achievement. According to Mutodi and Ngirande (2014), students' achievement in certain subjects greatly relies on their attitude towards the subject.

Students usually perform better in a certain subject, if they have a positive attitude towards it. As in Arthur et al. (2017), it was uncovered that negative perception of learners about mathematics affects their interest. Specifically, Ma and Kishor (1997), in his study, came out that the connection between student perception of mathematics and achievement had been a major concern in mathematics education research. For instance, Neale (1969) describes the connection between the two as a consequence of a reciprocal impacts. That is perceptions affect achievement and achievement in away affects perception.

### Research Conceptual Model Development

It is well stated in the literature that mathematics achievement is affected by numerous factors, such as teacher-student relationship, students' self-efficacy, students' perception of mathematics, and many more.

Based on the findings reviewed, and some theoretical backings, we assume that students' mathematics achievements are affected by at least the following constructs: their relationship with teachers, their self-efficacy on the subject, and their perception of mathematics in mathematics education. Based on our conclusion from the literature and some theoretical backings with empirical evidence, we present our conceptual framework to indicate the concepts or variables in our study and their inter-connections.

**Figure 1** shows the conceptual framework of the relationship among factors that influence mathematics achievement.

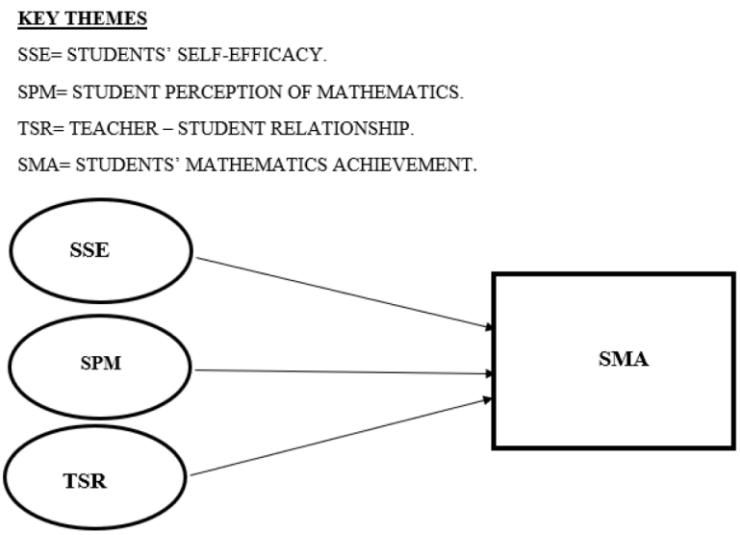


**Figure 1.** Conceptual framework

## METHODOLOGY

### Sample Sizes and Sample Technique

The sample refers to a subset of target populations which the researcher plans to study to generalize the target population (Creswell, 2005). Avoke (2005, p 90-92.) also mentioned that samples generally reflect a subset of the whole population of the researcher's interest. In scientific science, the growing need for a representative statistical sample has generated the need for an effective sample size determination process. In order to address the gap, a table for sample size determination for a given population for easy reference was established in 1970 by Krejcie and Morgan (1970). The sample size for a population of 1392 is 400, according to Krejcie and Morgan (1970) with a confidence level of 95% and margin of error (degree of accuracy) of 5.0%.

In selecting the students, equal number of students, i.e., 200 -first and second -year students were selected from the two senior high schools in Kumasi Metropolis. On the basis to avoid any bias, simple random sampling technique was employed for this study. In the students' survey, simple random sampling was used as it ensures that the sample is accurate through the random selection and all population elements. Simple random sampling ensures an equal chance of being selected for the study for every potential element of the population. It is the type that does not select individuals based on their abilities or background.

In 400 first- and second-year students at the sampled senior high school, a lottery approach for basic random sampling was used. According to this method all population elements were numbered or named on different paper slips of the same dimension. These papers were then folded into a container and mixed. The number of papers necessary to constitute the desired sample size was then selected. The choice of items therefore depended on chance.

### Study Design and Participants

Before beginning of data collection, school leaders were consulted regarding when their respective schools would be visited by the researchers to accumulate the essential data. At the point when the researchers showed up at the schools, they gave a letter to the authority mentioning the data collection approval inside each school. The simple random sampling procedure was utilized to gather data (Fraenkel et al., 2012). On the whole, two schools were chosen from the Kumasi Metropolitan in the Ashanti Region of Ghana. The study accommodates a total of 400 students (112 male and 228 female) with an average age range from 16-18 years old. Students were selected from senior high schools (SHS 1 and SHS2). The study did not include SHS3 students since they were on vacation during the data collection. 246 students were from SHS 1 while 154 were from SHS2. Students were found in their classroom setting while learning. With approval from the head teacher (HT), the teacher would invite the researchers, and afterward permit them to clarify every one of the subtleties of the exploration, just as how the questionnaire would have been replied. Students had to accept voluntarily to participate in the research before being given questionnaires. Students were free to ask questions before and during the filling of the questionnaire about the research or the item for more clarifications. To provide answers to the three research questions based on the four constructs, one dependent variable, and three independent variables, the present study employed a descriptive survey design.

### Data Collection Instrument

The researchers themselves designed the questionnaires based on a sample of research questions. This means the questionnaire items were centered on four constructs: (i) efficacy of students, (ii) teacher-students' relationship, (iii) students' perception of mathematics, and (iv) students' mathematics achievement. Questionnaires were administered in English to students. Apart from personal information items, the questionnaire for students contained about 37 question items. Items within the questionnaire were ranked in a 5- type Likert scale ranging from 1 (strongly agree) to 5 (strongly disagree). The questionnaire items were emphasized on research questions raised in the study, here, series of questions raised under the key themes such as the effect of students' self-efficacy on students' mathematics achievement, effects of teacher-student relationship on students'

**Table 1.** Background of students

| Background | Frequency (N) | Percentages (%) |
|---|---|---|
| Gender | | |
| Male | 112 | 28.0 |
| Female | 288 | 72.0 |
| Age | | |
| 13-15 | 75 | 18.75 |
| 16-18 | 310 | 77.50 |
| 19-21 | 11 | 2.75 |
| 22-25 | 3 | 0.75 |
| 26 & above | 1 | 0.25 |
| Religion | | |
| Christian | 357 | 89.25 |
| Muslim | 39 | 9.75 |
| Traditional worshipper | 2 | 0.50 |
| Other | 2 | 0.50 |
| Program | | |
| Science | 104 | 26.00 |
| General arts | 257 | 64.25 |
| Business | 19 | 4.75 |
| Agriculture | 20 | 5.00 |
| Level | | |
| Form 1 | 246 | 61.5 |
| Form 2 | 154 | 38.5 |

**Note.** N=400

mathematics achievement, and the influence of students' own perception of mathematics on their achievement. The questionnaire consisted of section A and B. The section A consisted of bio data, whiles section B comprised the key themes for the study as stated above. The validity of items was checked to ensure that the content and the format of the questionnaire were appropriate, meaningful, and correct towards the research questions and social constructivism theory that will guide this study.

The internal consistency of the questionnaire was also checked and calculated using Cronbach's alpha approach. Therefore, the reliability estimate for answers on the students' questionnaire was 0.88. For data analysis and presentation, frequency tables were used for the background of students. Also, structural equation model (SEM) was used. To check for the validity and reliability of the data set, exploratory factor analysis (EFA) and confirmatory factor analysis (CFA) were employed.

## Methods of Data Analysis

The items utilized in this study were identified with students' self-efficacy, teacher-students' relationship, students' perception of mathematics, and students' mathematics achievement. This analysis was accomplished for every factor to decide the demographic or background data for the respondents associated with the study. It was examined descriptively to decide the frequency and percentage of every demographic factor, next to the degree of reliability of the data got. Then, an EFA was led on the study items to find out how the items utilized were classified according to the structure of specific variables. The subsequent stage was to check the hypothesized model through a SEM demonstrating utilizing CFA and path analysis.

From **Table 1**, the total number of respondents was 400. Out of these respondents, 112 of them were male which represent 28.0% and 228 were female, representing 78.0%. 75 respondents were aged between 13-15, 310 respondents were aged between 16-18, 11 from 19-21 years, 3 from 22-25 years, and one respondent were aged above 25.

Also, it can be seen from the table that, out of the 400 respondents, 357 of them were Christians, 39 Muslims, two of them were traditional worshippers and two of them had their religion other than the one stated in the questionnaire. Due to the time factor and the availability of the respondents, four out of the six programs in the questionnaire answered the questionnaire. Out of these, 104 respondents were science students, 257 were general arts sudents, 19 were business students and 20 of them were agric students. Also, from the descriptive statistics, there were 246 SHS1 students and 154 SHS2 students.

## Reliability Analysis

A reliability test is very necessary for estimating the potentials of items used in the instrument. Reliability refers to the correctness and solidity of the points or marks, i.e., the internal consistency of an instrument's measurement scale (Kimberlin & Winterstein, 2008). According to Sekaran and Bougie (1992), increasing in alpha values are proportional to the value of reliability. Moreover, Tavakol and Dennick (2011) stated that the alpha values were low because of a weak association between the items, and thus, item removal should occur.

### *Test of normality*

Here the researchers looked at the item-by-item descriptive statistics, using mean scores and standard deviation. The measurement items were all measured on a 5-point scale of 1-strongly disagree to 5-strongly agree. Results presented in **Table 2** indicated that the measurement items were favorably ranked by the respondents, as most of them had a mean score of greater than three (midpoint).

**Table 2.** Test of normality

| Measurement items | N | Mean | SD | Skewness | | Kurtosis | |
|---|---|---|---|---|---|---|---|
| | | | | Statistic | SE | Statistic | SE |
| ES1 | 400 | 3.933 | 0.736 | -1.865 | 0.134 | 1.469 | 0.267 |
| ES2 | 400 | 2.996 | 0.719 | -1.968 | 0.134 | 3.686 | 0.267 |
| ES3 | 400 | 3.984 | 0.619 | -1.289 | 0.134 | 1.519 | 0.267 |
| ES4 | 400 | 2.945 | 0.712 | -1.770 | 0.134 | 3.143 | 0.267 |
| ES5 | 400 | 4.118 | 0.713 | -1.486 | 0.134 | 1.251 | 0.267 |
| TSR1 | 400 | 3.972 | 0.670 | -1.532 | 0.134 | 1.844 | 0.267 |
| TSR2 | 400 | 2.924 | 0.684 | -1.202 | 0.134 | 1.215 | 0.267 |
| TSR3 | 400 | 3.996 | 0.671 | -1.613 | 0.134 | 2.038 | 0.267 |
| TSR4 | 400 | 4.251 | 0.717 | -1.778 | 0.134 | 3.040 | 0.267 |
| TSR5 | 400 | 3.791 | 0.662 | -1.535 | 0.134 | 1.847 | 0.267 |
| SPM1 | 400 | 3.961 | 0.631 | -1.359 | 0.134 | 1.490 | 0.267 |
| SPM2 | 400 | 4.002 | 0.639 | -1.374 | 0.134 | 1.250 | 0.267 |
| SPM3 | 400 | 3.993 | 0.648 | -1.550 | 0.134 | 2.231 | 0.267 |
| SPM4 | 400 | 4.012 | 0.629 | -1.326 | 0.134 | 1.053 | 0.267 |
| SPM5 | 400 | 3.978 | 0.702 | -1.847 | 0.134 | 3.548 | 0.267 |
| MA1 | 400 | 3.975 | 0.701 | -1.572 | 0.134 | 1.434 | 0.267 |
| MA2 | 400 | 4.002 | 0.639 | -1.514 | 0.134 | 2.132 | 0.267 |
| MA3 | 400 | 3.994 | 0.619 | -1.314 | 0.134 | 1.297 | 0.267 |
| MA4 | 400 | 4.181 | 0.648 | -1.373 | 0.134 | 1.316 | 0.267 |
| MA5 | 400 | 2.948 | 0.725 | -1.510 | 0.134 | 1.957 | 0.267 |
| MA6 | 400 | 3.139 | 0.672 | -1.366 | 0.134 | 1.195 | 0.267 |
| MA7 | 400 | 3.654 | 0.738 | -1.740 | 0.134 | 2.412 | 0.267 |

**Note.** SD: Standard deviation; SE: Standard error

Further, we tested for the normality test, which is one of the key assumptions of multivariate statistics. Multivariate normality means that all variables are univariate normally distributed. Skewness and kurtosis statistic were calculated to determine the normality of the data. The results presented indicated that the distribution of scores on each item is satisfactorily normal as both the skewness and the kurtosis indices obtained are very much within the recommended thresholds of “less than |4|” and “less than |8|”, respectively (Kline, 2011).

### *Exploratory factor analysis*

EFA can be depicted as a strategy that aims to work on the interrelated factors. According to Surh (2005), EFA is a variable decrease strategy that distinguish the latent variables and the factors that underlie the nature of a set of variables. As indicated to Child (2006), EFA is used to investigate nature of factors that may underlie set of variables studied before any additional analysis.

A KMO measure of sampling adequacy and a Bartlett’s test of sphericity were directed to evaluate the suppositions for the associated factors in the underlying arrangement. The KMO measure of sampling adequacy is 0.961, which is far more prominent than 0.5 for the needed factoring value (**Table 3**). As this is a worthy worth as per Hair et al. (2010), it shows that there is a strong relationship among the items. Bartlett’s sphericity test was significant, with a Chi-square value of 5,186.062 with 231 levels of degree of freedom. The significant value for Bartlett’s test was p=0.000; this demonstrates that there is enough correlation to warrant factor analysis. The factor analysis was performed by the analysts to decide the number of factors to be extracted, which was four, as ordered in the questionnaire. A total of four factors were extracted and rotated, and the cumulative variance explained was 65.86%. **Table 3** depicts rotated the component matrix with a turn varimax and factor loading. The rotated varimax strategy was utilized, as it decreases the number of complex factors and can increase the normal yield. The meaning and the significance of the items were inspected to decide if the item ought to be held or taken out. Items with issues were taken out iteratively and the fit indices were analyzed each time an item was erased. The remainder of the leftover things were introduced in **Table 3**.

**Table 3.** Exploratory factor analysis

| Measurement items | Components | | | |
|---|---|---|---|---|
| | 1 | 2 | 3 | 4 |
| ES1 | 0.727 | | | |
| ES2 | 0.705 | | | |
| ES3 | 0.717 | | | |
| ES4 | 0.815 | | | |
| ES5 | 0.716 | | | |
| ES1 | 0.727 | | | |
| TSR1 | | 0.628 | | |
| TSR2 | | 0.733 | | |
| TSR3 | | 0.782 | | |
| TSR4 | | 0.726 | | |
| TSR5 | | 0.68 | | |
| SPM1 | | | 0.745 | |
| SPM2 | | | 0.719 | |

**Table 3 (Continued).** Exploratory factor analysis

| Measurement items | Components | | | |
|---|---|---|---|---|
| | 1 | 2 | 3 | 4 |
| SPM3 | | | 0.654 | |
| SPM4 | | | 0.655 | |
| SPM5 | | | 0.599 | |
| MA1 | | | | 0.594 |
| MA2 | | | | 0.837 |
| MA3 | | | | 0.831 |
| MA4 | | | | 0.603 |
| MA5 | | | | 0.621 |
| MA6 | | | | 0.638 |
| MA7 | | | | 0.749 |
| Total variance explained | | | | 65.856% |
| KMO | | | | 0.961 |
| Bartlett's test of sphericity | | Approximated Chi-square value | | 5,186.062 |
| | | Df | | 231 |
| | | Sig. | | 0.000 |
| Deteminant | | | | 1.73E-006 |

**Note.** Extraction method: Principal component analysis; Rotation method: Varimax with Kaiser normalization; Rotation converged in 4 iterations

### *Confirmatory factor analysis*

As indicated by Yong and Pearce (2013), CFA permit researchers to test the speculation concerning whether there is a connection between the factors analyzed and the burden factor. CFA endeavors to validate a hypothesis and afterwards make use of an analysis diagram to denote the variables. CFA was led to approve the measurements that had been embraced during the EFA. The information was gathered from 400 samples, and four factors of the measurement model were tested using AMOS 23.0. A few adjustments were made to improve the model. One of the changes was the deletion of items with low factor loadings. After the adjustments, the general model indicated that the corresponding index value was p=0.000, the normed Chi-square=426.947 with 199 degrees of freedom, the CFI=0.957, and the RMSEA=0.054. The value produced by the CFI was 0.957. The value was more prominent than 0.90, showing that this model is valid and that there is high compatibility between the model and the data. The subsequent worth of the GFI, which was 0.908 shows that the resulting model is acceptable. Moreover, the RMSEA for this study was 0.054; this value is under 0.08, showing an acceptable value for the RMSEA. This indicated that the fundamental factor of the four constructs indeed is valid and acceptable. The other fit indices, NFI and TLI, were over 0.9 which shows an excellent fit to the 4-factor model. Generally, factor loadings and CR ought not to be less than 0.707 for great convergent validity. From the CFA result of this study, seventeen loadings are greater than 0.707 and seven loadings are between 0.6 and 0.707. one loading is under 0.6. The summary of CFA is presented in **Table 4**, where MFIs show model fit indices and SFL shows standard factor loading.

**Table 4.** Confirmatory factor analysis

| **MFIs: CMIN=426.947; DF=199; CMIN/DF=2.145; CF =.957; TL =.957; RMR=.062; RMSEA=.054; PClose=.195; FI=.905; AGFI=.884** | **SFL** |
|---|---|
| Efficacy of students (EST): CA=0.883; CR=9.179; AVE=0.602 | |
| (ES1) I am confident with mathematics | 0.784 |
| (ES2) I know how to attack difficult questions in mathematics | 0.719 |
| (ES3) I can confidently help my friends to solve their mathematics problems | 0.760 |
| (ES4) I get high scores in mathematics | 0.856 |
| (ES5) I believe I am a mathematics person | 0.755 |
| Teacher-students' relationship (TSRH): CA=0.839; CR=6.421; AVE=0.513 | |
| (TSR1) Uses various strategies teaching aids/device and techniques in presenting lessons | 0.724 |
| (TSR2) Has a good relationship with the students and teachers | 0.641 |
| (TSR3) Has an appealing personality with good sense of humor | 0.765 |
| (TSR4) Is open to suggestions and opinions and is worthy of praise | 0.734 |
| (TSR5) Shows interest in all students irrespectively their ability | 0.711 |
| Students' perception of mathematics (SPMT): CA=0.836; CR=6.508; AVE=0.514 | |
| (SPM1) I enjoy studying mathematics | 0.844 |
| (SPM2) I rate mathematics higher than all the other core subjects | 0.747 |
| (SPM3) I have an interest in mathematics | 0.708 |
| (SPM4) I prefer mathematics to other subjects | 0.650 |
| (SPM5) Mathematics is easy to learn | 0.613 |
| Mathematics achievements (MAC): CA=0.893; CR=9.471; AVE=0.555 | |
| (MA1) Mathematics is more enthusiastically for me than a significant number of schoolmates | 0.596 |
| (MA2) I get good marks in mathematics | 0.864 |
| (MA3) I usually do well in mathematics | 0.866 |
| (MA4) Mathematics helps me to understand other subjects | 0.677 |
| (MA5) Mathematics is an easy subject to pass | 0.666 |
| (MA6) I feel happy when answering mathematics questions | 0.703 |
| (MA7) My present knowledge in mathematics is high | 0.797 |

**Table 5.** Path summary

| | Path | Standard estimate | C.R. | p-value |
|---|---|---|---|---|
| Direct effect | SPMT→ MAC | 0.422 | 4.465 | *** |
| | EST→ MAC | 0.711 | 8.080 | *** |
| | TSRH → MAC | 0.048 | 1.002 | .316 |
| Covariance | EST◀▶SPMT | 0.677 | 8.963 | *** |
| | EST◀▶TSRH | 0.538 | 7.930 | *** |
| | TSRH◀▶SPMT | 0.476 | 7.206 | *** |
| Indirect effect | SPMT→ MAC | 0.000 | No indirect effect | |
| | EST→ MAC | 0.000 | | |
| | TSRH → MAC | 0.000 | | |

**Note.** Model fit indices: CMIN=426.947; DF=199; CMIN/DF=2.145; CFI=.957; TLI=.950; RMR=.062; RMSEA=.054; PClose=.195

### Path Analysis

Path analysis is a technique for disintegrating covariances or connections between two factors in the SEM to decide how much of this covariance is attributable to a theoretically specified causal impact of one factor on the other. The Chi-square value of 426.947 in path analysis indicates the goodness of fit model. Also, RMSEA of 0.054 shows a good fit model for an absolute fit index with a 95% confidence interval since it is less than 0.08, and the other fit indices, NFI and TLI, were over 0.9 which shows a very good fit to the 4-factor model. Also, from **Table 5**, it can be seen that the direct effect of the exogenous variables on the endogenous variable is significant. The direct effect of students' perception of mathematics (SPMT) and efficacy of students (EST) on mathematics achievement (MAC) based on the p-value (***) indicates statistical significance. Thus, students' perception as a predictor of mathematics achievement has a positive impact on mathematics achievement as well as self-efficacy of students. On the contrary, the teacher-student relationship (TSRH) seems to be a predictor of mathematics achievement with a standard estimate of 0.048, but the p-value of 0.316 indicates statistically insignificant. The covariance of the independent variables depicts a positive standard estimate greater than 0.1, which indicates that the equal effects between the independent variables are statistically significant. The summary of the path analysis has been elaborated in **Table 5**.

## DISCUSSION

Based on the outcome of the analysis, the following findings were established. Regarding the effect of the teacher-student relationship on mathematics achievement, the results confirmed an insignificant positive impact on mathematics achievement with a path coefficient (direct effect) of 0.048. This means that the relationship between teachers and their students, despite the extent, does not necessarily predict students' mathematics achievement. Yalcin et al. (2017), in their study, pertaining to teacher-student relationship and mathematics achievement, concluded that students that hold positive perception of their teacher and have teachers that are willing to improve their career tend to have higher mathematics achievement. Also Hughes (2007) in his study discovered that the sorts of relationships teachers set up with their students have a significant bearing on their academic achievement. Also, a study conducted by Wasike (2013) uncovered that a powerful teacher-student relationship might be the cornerstone that permits different angles to work well. Despite the positive relationship, many research studies have indicated between teacher-student connection and students' achievement in mathematics, the findings of this study show that the impact of the teacher-student relationship on mathematics achievement is insignificant. This indicates that the kind of relationship between teachers and their students does not necessarily affect their achievement in mathematics.

Also, students' perception of mathematics achievement was having a path coefficient (direct effect) of 0.422. This coefficient indicates a positive correlation between students' perception of mathematics and mathematics achievement. This value shows that student with good perception and insight of mathematics tends to achieve better in mathematics and vice versa. According to Mutodi and Ngirande (2014), how students perform in certain subjects depends on their perception towards the subject. A clear insight towards the subjects will motivates a person perform better in a subject. As in Arthur et al. (2017), it was uncovered that negative attitude of learners about mathematics affects their interest in the subject. Also, a study conducted by Hagan et al (2020) concluded that the relationship between learners' perception of mathematics and students' mathematics performance was very weak and negatively related. Specifically, Ma and Kishor (1997), in his study, came out that, the connection between students' attitude toward Mathematics and achievement in mathematics had been a major concern in mathematics education research. The findings as compared to other related research studies are in line, which shows a positive correlation.

To sum it up, students who are perceived to have confidence in themselves are capable of excelling in the mathematics subject as suggested and tested by many researchers. Callaman and Itaas (2020) reported that academic self-efficacy is connected with academic achievement in the mathematics examination. The belief that students develop about their academic capabilities helps to determine what they do with the knowledge and skills they possess which eventually determines their academic achievement. Also, research conducted by Odiri (2020) about students' self-efficacy and mathematics achievement concluded that, there was a significant positive relationship between students' self-efficacy and mathematics achievement. That is, a student with high self-confidence in dealing with mathematics problems tends to perform better in the subject and vice versa. In addition, Haciomeroglu (2019), in his study, indicates that there was a significant difference between students' self-efficacy and achievement. Results of the study further reveals that mathematics achievement, and the sources of students' self-efficacy were closely intertwined. Moreover, according to May and Glynn (2008), persons with low mathematical self-efficacy will avoid mathematical tasks or

situations. The finding of this study also indicates a positive correlation between self-efficacy and mathematics achievement. The path analysis showed a path coefficient (direct effect) of 0.711. This value indicates that a student who has belief and confidence in him or herself is highly to perform better in mathematics subject as compared to a student with low self-confidence. The study suggests that teachers should create an environment that will elicit student self-confidence when learning mathematics.

## CONCLUSIONS AND SUGGESTIONS

The embodiment of the study was to better comprehend the impact of mathematics self-efficacy, teacher-student relationship, and students' perception on mathematics achievement of some selected secondary school students, and to investigate whether mathematics achievement could be significantly predicted by mathematics self-efficacy, teacher-student relationship, and the student's perception of mathematics. A structural equation model; exploratory, confirmatory, and path analysis were used to address the research questions. Results of the path analysis indicated that the impact of students' self-efficacy and student perception on mathematics achievement were positively related. Students with high mathematics self-efficacy were associated with high mathematics achievement as well students with a good perception of mathematics. Additionally, results of the same analysis indicated that teacher-student relationships statistically insignificantly predict mathematics achievement. Student self-efficacy and perception of mathematics were significantly positive predictors of mathematics achievement. This finding recommends that students who were certain of their exhibition in mathematics and have a positive impression of the subject would in general have better mathematics achievement. In particular, students who were certain that they could work effectively on mathematics tests, could comprehend the most troublesome material introduced by their mathematics instructors, work really hard on mathematical tasks, and could dominate the abilities being educated in their mathematics classes, who were bound to have better mathematics achievement. This finding proposes that as well as advancing learners' perception toward mathematics, elevate their self-efficacy to upgrade accomplishment in mathematics. Our findings likewise recommend that endeavors are required for advancing mathematics self-efficacy for secondary school students since mathematics self-efficacy was emphatically connected with mathematics achievement. Exploration has shown that self-efficacy could be expanded by utilizing the right educational techniques (Schunk, 1991), like assisting students with defining learning objectives (Bandura, 1997; Schunk,1991), giving a timeline and express criticism (Bandura, 1997), encouraging students to learn more earnestly (Siegle & McCoach, 2007), and utilizing successful students as models (Bandura, 1982).

### Practical Significant and Guidance for Further Studies

Based on the suggestions of the findings, a replication of this study would be helpful in re-examining the validity of its findings for which the researcher was not able to investigate. Further empirical studies using larger sample sizes from different and greater geographical diversity would be helpful in validating the impact of student self-efficacy, teacher-student relationship and student perception of mathematics on students' mathematics achievement in school.

Also, it is recommended that similar research could be conducted at elementary, or at the tertiary level since this study was undertaken at the secondary level. Subsequent research needs to be engaged in the development of more valid and reliable operational definitions on the tested variables and overcoming the limitations posed by the data source used in this study. Also, more structured interviews should be conducted among teachers and students of different senior high schools in Ghana, in order to continuously address the challenges facing.

### Limitation of the Study

The study was limited to two schools in the Kumasi metropolis, which is not enough to make a true inference about the population.

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