AKENTEN APPIAH-MENKA UNIVERSITY OF SKILLS TRAINING AND ENTREPRENEURIAL DEVELOPMENT

THE INTERPLAY BETWEEN STUDENTS' MATHEMATICS SELF-EFFICACY, THE CLASSROOM CLIMATE, AND STUDENTS' ATTITUDES TOWARDS MATHEMATICS, EXAMINING THEIR COLLECTIVE INFLUENCE ON STUDENTS' ACADEMIC PERFORMANCE IN MATHEMATICS

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DECLARATION

STUDENT'S DECLARATION

I, **SYLVESTER AKWASI AGYEI,** declare that this thesis, with the exception of quotations and references contained in published works which have all been identified and duly acknowledged, is entirely my own original work, and it has not been submitted, either in part or whole, for another degree elsewhere.

SIGNATURE: ……...DATE: ……

SUPERVISOR'S DECLARATION

We hereby declare that the preparation and presentation of this work was supervised in accordance with the guidelines for supervision of thesis as laid down by the Akenten Appiah-Menka University of Skills Training and Entrepreneurial Development, Kumasi.

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DEDICATION

I dedicate this work to my family.

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TABLE OF CONTENTS

LIST OF TABLES

TABLE **PAGE**

LIST OF FIGURES

FIGURE **PAGE**

ABSTRACT

This study explored the interplay between students' mathematics self-efficacy, the classroom climate, and students' attitudes towards mathematics, examining their collective influence on students' academic performance in mathematics. The study employed a descriptive survey design and a structured questionnaire as data collection tool. The study population consisted of students at Nkawie Senior High Technical School and Toase Senior High School in the Ashanti region of Ghana. The study sampled 382 students from both schools using stratified and simple random sampling techniques. The data was analyzed using Structural Equation Modeling (SEM) with Amos (v. 23) software. Based on the findings, it was concluded that student's mathematics self-efficacy had a significant positive effect on performance in mathematic ($\beta = 0.201$; C.R. /t = 2.975; $p = 0.003$). Classroom climate had significant positive impact on students' mathematics performance ($\beta = 0.188$; C.R. /t = 2.677; $p = 0.007$) and the relationship between students' mathematics self-efficacy and mathematics performance was partially mediated by students' attitude towards mathematics. The study suggested that mathematics instructors should encourage learners to appreciate the study of mathematics and avoid using derogatory comments for wrong answers in mathematics class. Adequate teaching and learning materials should be provided in every classroom at all levels of education to facilitate teaching and learning. Mathematics instructors should relate mathematics to real-life situations in order to help learners develop positive attitude towards mathematics.

CHAPTER ONE

INTRODUCTION

1.0 Overview

This section provides an outline of what the chapter entails. This chapter comprises the Background of the Study, Statement of the Problem, Purpose of the Study, Objectives, Research Questions, Significance of the Study, Delimitations, Limitations and Organization of the Study.

1.1 Background of the Study

Mathematics is a subject that is essential to different fields of study and a prerequisite to other disciplines. Therefore, learners need to have strong foundation in the subject. Awang and Ismail (2006) emphasized "the essence of having a strong foundation in mathematics as a prerequisite for admission into institutions of higher learning in most disciplines". Also, mathematics plays essential role in the development of almost all other sciences including chemistry, physics, or biology (Dejić & Mihajlović, 2014). In view of that Mathematics is a compulsory subject nationwide and it is required for every learner to perform creditably in the subject. For instance, in Ghana every learner is expected to obtain credit pass before getting access to the tertiary level of education. This is true for West African sub-region for basic and secondary school levels.

The essential role of mathematics has called for much attention in West African countries. However, most leaners are not performing well in the subject, particularly in Ghana. The analysis of WAEC results from three consecutive years, 2020 to 2022, revealed that in 2020, from the 375,763 graduates enrolled in the mathematics (core) exams, the percentage candidates who obtained credit pass level and below was 65.71, in 2021, the percentage dropped to 54.11

and recently in 2022, the percentage was 61.39 (WAEC, 2022). The results indicate that there is still work to be done to cater for the remaining percentage that failed. According to HakiElimu (2012), worth of mathematics instructions can be observed per learner's achievement in examination. This means that if learners' performance is below satisfaction in examination, then in one way or the other, mathematics education in schools is worthless. Besides, mathematics does not just foster the acquisition of academic qualifications, as well it develops the individual futuristic abilities, therefore it is imperative for most learners to perform well in the discipline and particularly acquire the skills needed in life.

Several factors account for learners' performance in mathematics, which include among others; learners' self-efficacy, learners' attitude towards the study of mathematics and classroom climate (Kamsurya et al., 2022; Ruiz-Robledillo et al., 2022; de Vera et al., 2022; Ma & Wei, 2022; Zamir et al., 2022).

One of the affective aspects influencing learners' mathematics performance is self-efficacy. Mathematics self-efficacy refers to learners' belief in their abilities to perform tasks in mathematics (Kamsurya et al., 2022). In order words, the confidence learners have in the capability to perform mathematical task to produce the desired outcome (Sağkal & Sönmez, 2021). Most learners regard mathematical tasks as difficult, and so no mathematical task appear to be easy for them. In view of that, most Senior High School students cannot perform simple mathematical tasks Junior High School students can. In that most learners have developed a negative mindset that influences their approach to mathematical tasks and the study of the subject as a whole. These learners are classified as having low self-efficacy. The emergence of fear, worries and anxiety as a result of a lack of trust in learners' efforts to complete mathematical tasks is a sign of low self-efficacy (Sunaryo, 2017). Experience, according to

Bergqvist, Tossavainen, and Johansson (2020), is critical in determining a learner's efficacy for a task. Learners who have failed several times develop low self-efficacy, whereas learners who succeed generally develop an increase in self-efficacy. As a result, learners who doubt their abilities will avoid difficult tasks, viewing them as a personal threat, whereas learners who think that they are capable of mastering a skill or accomplish a task are more inclined to participate, work hard in the face of difficulties, and achieve a higher level (Kamsurya et al., 2022).

Attitude is another factor that strongly predicts learners' mathematical performance (Callaman & Itaas, 2020). Attitude refers to emotional and mental entities that motivate a person to complete a specific task (Perloff, 2016). Kiwanuka et al. (2020) defined attitude towards mathematics as the emotion that students associate with mathematics, their opinions concerning mathematics, and the way they behave toward the subject whereas Kibrislouglu (2015) stated that attitudes toward mathematics indicate a love or dislike of the subject of mathematics, a proclivity to participate in or reject mathematical tasks, a view that an individual is either good or poor at mathematics, and an assertion that mathematics is beneficial or not. Students tend to act as well as behave in ways which reflect their attitudes (Hwang & Son, 2021). A positive disposition toward the subject encourages learners to learn the subject much better, whereas a negative attitude causes learners to dislike mathematics, perceive it as an irrelevant one, and be afraid of participating in it (Wigfield et al., 2016; Guo et al., 2015).

Classroom climate has also been identified by a number of authors as a factor that influence learners' academic performance (Haugan, Frostad, & Mjaavatn, 2021; Meyer & Eklund, 2020; Haji Vosoogh, Tavakolizadeh & Pakdaman, 2021; Ruiz-Robledillo et al., 2022; Ma & Wei, 2022). A classroom climate is an environment created for students in the classroom by the peers, teachers and the school (Akanbi, 2014) which may be conducive to learning or not. A conducive

classroom environment allows learners to feel comfortable and likely to receive a lot of information; on the other hand, an unfavorable classroom environment may discourage students by rendering them less eager to learn, decreasing their overall interest in learning processes and setting (Zedan, 2021; Ezike, 2018; Suleman, Aslam, & Hussain, 2014). Positive classroom atmosphere corresponds to one that ensures learners feel safe, nurtured, as well as being intellectually stimulated whereas a poor classroom atmosphere constitutes a situation in which learners are academically, psychologically and physically uneasy for whatever cause (Akanbi, 2014).

In the Ghanaian context, few attentions have been given to student's self-efficacy, classroom climate and students attitude towards the study of mathematics, meanwhile these factors influence learners' performance in mathematics as revealed in the background information, therefore, there was the need for a study to be undertaken in the Ghanaian context on the interplay between students' mathematics self-efficacy, the classroom climate, and students' attitudes towards mathematics, examining their collective influence on students' academic performance in mathematics.

1.1 Statement of the problem

Mathematics is among the compulsory subjects that senior high school learners are expected to pass to pursue higher education. Hence, it is a prerequisite to different fields of study in tertiary institutions. But, among all the compulsory subjects, mathematics is deemed the most difficult. This perception has negatively impacted students' performance. According to WAEC (2022), 38.61% and 45.89% candidates failed core mathematics in 2022 and 2021 respectively. This

implied that at most half of the total number of graduates could not obtain admission to tertiary schools.

Liu et al. (2023) and Kamsurya et al. (2022) found that self-efficacy has significant effects on mathematics performance. Their findings indicated that if students have low self-efficacy, their mathematics performance is weakened. Similar study revealed that attitude towards mathematics also affects performance (Hwang & Son, 2021; Kiwanuka et al., 2020). Students who possess negative attitudes towards mathematics perform poorly. Furthermore, Ndidi and Effiong (2020) found that positive classroom climate ensures comprehensive mathematics learning and improves performance whilst poorly organized mathematics classroom discourages successful learning and understanding. Individually, the above studies investigated the effects of only self-efficacy, attitude, or classroom climate on students' mathematics performance. Therefore, there is no empirical evidence of the effects of the collective interplay of self-efficacy, attitude, and classroom climate on mathematics performance among senior high school students in Ghana. This study considered adding to literature the interplay between students' mathematics self-efficacy, the classroom climate, and students' attitudes towards mathematics, examining their collective influence on students' academic performance in mathematics.

1.2 Purpose of the Study

The purpose of the study was to investigate the interplay between students' mathematics self-efficacy, the classroom climate, and students' attitudes towards mathematics, examining their collective influence on students' academic performance in mathematics in senior high schools in Ghana.

1.3 Objectives of the Study

The study sought to accomplish the objectives below;

1. To determine the impact of student's mathematics self-efficacy on students' mathematics performance.
2. To find out the effect of classroom climate on students' mathematics performance.
3. To identify the mediation effect of student's attitude towards mathematics between student's self-efficacy and students' mathematics performance.

1. 4 Research Questions

The study answered the following research questions;

1. What is the impact of student's mathematics self-efficacy on students' mathematics performance?
2. What is the effect of classroom climate on students' mathematics performance?
3. What is the mediating effect of student attitude toward mathematics between student's mathematics self-efficacy and students' mathematics performance?

1.5 Significance of the Study

The research might inform the Ministry of Education and the Ghana Education Service on the extent to which students' self-efficacy, learners' mathematics attitude and classroom climate influence learners' performance. This might help to put measures in place to improve students' performance in mathematics. Stakeholders and policy makers might base on the findings of the study to formulate policies that might ensure the appointment of qualified and competent teachers at all levels of education as well as the adequate provision of academic facilities in all

schools, resulting in higher academic performance. This is because effective teachers always put measures in place to ensure student success. In addition, a negative classroom atmosphere might discourage students by rendering them reluctant to study and decreasing their participation in class activities. The research might contribute to the existing literature on variables that influence learners' mathematical performance and might inform mathematics educators and policymakers on how to implement measures that might help learners gain a positive mindset toward mathematics study. Finally, the research might assist future researchers who would carry out further study in this field and related areas.

1.6 Delimitation

The Ashanti area of Ghana has a large number of senior high schools. The research was undertaken in the two senior high schools in Atwima Nwabiagya Municipality, specifically Nkawie Senior High Technical School and Toase Senior High School. Also, the study focused on the interplay between students' mathematics self-efficacy, the classroom climate, and students' attitudes towards mathematics, examining their collective influence on students' academic performance in mathematics.

1.7 Limitations

The interference of unscheduled school activities was a disadvantage to the study. Also, the study's short duration was a constraint, and a longitudinal study would have yielded a more accurate finding.

1.8 Organization of the Study

The study was divided into five sections. The first chapter covered the introduction, which included the background to the study, statement of the problem, purpose of the study, objectives, research questions, significance of the study, delimitations, limitations, and organization of the study.

Chapter two was a review of relevant literature on factors influencing learners' academic performance, specifically students' mathematics self-efficacy, students' attitude toward mathematics, and classroom climate based on the objectives, and also the theoretical framework of the study and the conceptual framework. The third chapter covered the research methodology, including the research paradigm, the design to the research, as well as the population, including sample and sampling technique, research instrument, procedure for collecting data, analysis procedures, and ethical concerns. Chapter four looked at the analysis of data, results, and discussion. Finally, chapter five summarized the study's findings and provided conclusions and recommendations.

CHAPTER TWO

LITERATURE REVIEW

2.0 Overview

Several studies on factors influencing students' performance in mathematics had been conducted. This section provides an outline of review of some of the relevant literatures. This section consists of the conceptual review, the theoretical review, and empirical review on students' mathematics self-efficacy, students' attitude towards mathematics and classroom climate on mathematics performance as well as the conceptual framework.

2.1 Conceptual Review

2.1.1 Students Mathematics Self-efficacy

Social cognitive theory established by Albert Bandura in 1977 gave rise to the concept of self-efficacy (Bandura, 2012). It was a critical component of social cognitive theory; however, it has evolved into a theory of its own (Zakariya, 2021). In mathematics education, a number of factors have been accounted for as predictors of learners' performance. While many studies have shown that the cognitive aspect is quite strong in influencing learning outcomes, it can also be said that the affective aspect also plays important role in influencing learners' performance (Abin et al., 2020; Recber et al., 2018; Gafoor & Sarabi, 2017). Self-efficacy constitutes an element of the affective components.

Learners develop efficacy beliefs in most areas they study in school and in everyday life, but studies have shown that self-efficacy in mathematics is perhaps the most significant and practical avenue for self-efficacy (Sandilos et al., 2020; Regier & Savic, 2020; Zientek et al., 2019).

Burnham (2011) defines mathematics self-efficacy as learners' confidence in their abilities to solve mathematical problems or tasks. The amount of effort students put out, how long they persist when presented with challenges, and how resilient they are under difficult conditions are all influenced by their level of self-efficacy. Self-efficacy also affects learners' emotional reactions and thought habits (Phan, 2012).

Learners' self-efficacy in performing mathematical tasks may be high or low. When faced with complex and hard mathematics problems, a strong feeling of self-efficacy inspires confidence in students, empowering them to persist and achieve their goals (Zakariya, 2021). According to Putra et al. (2013), learners who have a strong sense of efficacy hold the opinion that they are always ready and alert in solving problems, regardless of their condition; they do not consider differences between themselves and others but believe that they are capable like others. Deep learning approaches, high levels of inspiration, and positive perceptions toward the study of mathematics have all been linked to great level of efficacy belief (Zakariya et al., 2022; Rozgonjuk et al., 2020). As a result, Toropova et al. (2019) noted that learners with a greater sense of efficacy were highly inclined to communicate positive attitudes toward academics compared to their colleagues. Yet, exceptionally recommended levels result in satisfaction, a state of relaxation from the relentless hard work to perform better (de Vera et al., 2022).

Contrary, students exhibiting poor efficacy beliefs struggle to deal with difficult situations, have low confidence in their abilities, and struggle academically. Low self-efficacy has been associated with the adoption of superficial strategies for learning, a substantial amount of mathematics anxiety, and a lack of enthusiasm for mathematics (Zakariya et al., 2022; Rozgonjuk et al., 2020).

According to Su et al. (2021), most learners with low self-efficacy believe that mathematics is only for those with deep roots in the field of mathematics and that mathematics is a “gift” that some people have that others do not (Boaler & Dweck, 2016). These students lack confidence in themselves and are unsure that they can answer any question posed by a teacher (Kasturi, Sulton, & Wedi, 2021). It does not matter the nature of question given by an instructor; these students just have the believe that they cannot perform any mathematical task to reach the desired outcome.

Liu et al. (2020) opined that, rather than analyzing the actual performance capability, students' mathematical self-efficacy may be established based on the level of difficulty that the mathematical task seems to present. In support, it has been discovered that variances in learners' mathematical self-efficacy are dependent on the task at hand (Krawitz & Schukajlow, 2018), which lends credence to the assertion of (Liu et al., 2020). Studies have also revealed that learners prefer activities that are neither too tough nor too easy but somehow moderate, which means that most learners prefer mathematical projects or works that are not too simple nor too complex (de Vera, 2022). As a result, instructional design explains students’ motivation and requires moderate assignments, which high self-efficacy learners might not believe that doing the task is meaningless, and as such low self-efficacy learners might not refuse because it appears not too tough. Borgonovi and Pokropek (2019) discovered that experience with challenging problems had a stronger effect on the self-efficacy of lower-achieving learners, whereas contact with easier tasks had a greater impact on the efficacy beliefs of higher-achieving learners. This means that very difficult tasks will always be a challenge for low self-efficacy learners, resulting in permanent low efficacy belief for the subject, whilst very easy tasks will not be appealing to learners with high self-efficacy, and will not bother themselves to answer such questions.

Ko, Choi, and Kaji (2021) postulated that low efficacy is the most significant indicator for students to give up on mathematics learning because students' consistent failure in the study of mathematics can make them believe that they can never do well and thus accept defeat (Cerbito, 2020). However, self-efficacy, according to Bandura (2001), is neither a fixed quality nor a natural trait. It is, however, the result of cognitive processes, implying that self-efficacy can be nurtured and developed. This means that self-efficacy beliefs are not stable; they fluctuate when learners examine fresh information on a regular basis; however, they are resistant to change once they have been developed for an extended period of time and are founded on prolonged exposure. As a result, learners who give up on mathematics and accept defeat do so as a result of repeated failure at mathematical tasks. Since self-efficacy is not stable, stakeholders must implement measures to assist learners with low self-efficacy so that they do not abandon or give up on mathematics learning. This will help to break down the fixed mindset that most learners have about studying mathematics. A fixed mindset holds that intelligence is fixed, limited, and unchangeable (Su et al., 2021).

Studies (Lent et al., 2016; Raelin et al., 2015; Goldman & Penner, 2016) have revealed that self-efficacy has a great impact on learners' decisions about whether to choose mathematics as a major or not or to pursue a profession in a math-related sector. Czocher, Melhuish, and Kandasamy (2020) discovered that learner's evaluation of their own capability of completing mathematical problems plays a crucial role in choosing a profession and endurance in mathematics. Raelin et al. (2015) also noted a connection between self-efficacy and mathematics competency, which influences learners' perseverance in mathematics and hence in science related courses. In support, Luo et al. (2016) hypothesized that efficacy belief in mathematics is positively associated with STEM intentions and mathematics achievement. That

is, the greater one's proficiency and efficacy in mathematics, the greater one's interest in STEM, and vice versa. This is among the reasons most African countries have a low number of students pursuing mathematics and mathematics-related programs at the tertiary level. The basic level of efficacy learners develop has an impact on the decisions they take to pursue mathematics and its related courses, and the decision is influenced by their self-efficacy.

2.1.2 Students Attitude Towards Mathematics

A variety of research studies had been undertaken and published on learners' attitudes towards the study of mathematics, which are normally interpreted as liking and hating mathematics (Davadas & Lay, 2020; Arslan et al., 2014). To others, attitude towards mathematics is simply a favorable or negative emotional reaction to the discipline (Odogwu & Benedicta, 2015). Lin and Huang (2014) opined that attitude toward mathematics denotes a good, negative, or neutral temperament and sentiment toward mathematics.

According to Hwang and Son (2021), students' attitudes toward mathematics are multifaceted. From a multidimensional standpoint, attitude toward mathematics can be defined as the emotion that students associate with mathematics, as well as their beliefs about mathematics and their behavior toward mathematics. As a result, one's attitude toward mathematics includes cognitive, affective, and behavioral components (Kiwanuka et al., 2020).

Trends in International Mathematics and Science Study (TIMSS) researchers assessed students' attitudes about mathematics in three ways: value of mathematics, confidence in mathematics, and enjoyment of mathematics (Mullis et al., 2020). To them, the dimensions are mathematical enjoyment, mathematical value, and mathematical confidence.

Davadas and Lay (2017) proposed enjoyment, motivation, value, and self-confidence as elements that define mathematical attitude. While different researchers used different terms to define attitude toward mathematics, Hwang and Son (2021) found that three components of attitude toward mathematics are: liking mathematics, value of mathematics, and confidence in mathematics. Though the dimensions are phrased differently by several authors, the authors believed that they boil down to appreciating mathematics, having confidence in mathematics, and liking mathematics.

One of the aspects that contribute to the success of learners' mathematics understanding, according to Capuno et al. (2019), is their attitude. It can determine how much effort learners' put into comprehending and mastering mathematical principles and concepts, hence determining the level and mode of learning (Guinocor et al., 2020). Learners who have a favorable attitude concerning the study of mathematics have confidence (Makur, Prahmana, & Gunur, 2019) and prioritize mathematics over other subjects. Students with good attitudes about mathematics are more likely to participate in math-related tasks and learn the course compared to learners with a negative mindset (Mata, Monteiro & Peixoto, 2012; Asante, 2012). These students enjoy the discipline, recognize its significance, and exhibit confidence in it; consequently, they value mathematics study (Mullis et al., 2020; Kiwanuka et al., 2020), which is likely to result in outstanding performance (Wigfield, Tonks, & Klauda, 2016; Guo et al., 2015). They also have better problem-solving skills and can deal with unusual challenges (Marchiş, 2013). However, students who negatively perceive mathematics hate the subject and recognize it as useless, thereby feeling anxious (Wigfield et al., 2016; Guo et al., 2015; Yenilmez, 2007).

According to studies, students' attitudes toward mathematics and interest in it deteriorate as they progress through school (Rodriguez et al., 2020). Watt (2020) conducted a study primarily aimed

at understanding the correlation between mathematics attitudes and academic achievement, analyzing the extent to which students' age influenced their attitude toward mathematics. The findings revealed a shift in attitude as students progressed through school, with an increasing negative attitude toward mathematics learning and mathematics itself. Wakhata, Mutarutinya, and Balimuttajjo (2022) observed that students begin well in primary and secondary school but gradually grow to dislike mathematics, feeling uncomfortable and nervous, lacking self-confidence and motivation towards the subject. González-Pienda et al. (2007) also discovered that as students progressed from the basic level of education to the final year of senior high school, their interest waned, as did their perceptions of the subject's usefulness, as well as their perceived competence and confidence in their own mathematics skills. Blanco, Barona, and Carrasco (2013) proposed that as learners become older, their mathematics interest and attitudes shrinks, particularly at the secondary level. Mazana et al. (2019) noticed learners positive mathematics perceptions are negatively related to their age. They further observed an association between learners' mathematics attitudes and performance.

Early thoughts as well as ideas about mathematics have been recognized as strong indicators of future success and academic choices in mathematics and its related programs, and there is a need for measures to be put in place right at the start for learners to develop positive attitudes (Master & Meltzoff, 2020; Ceci et al., 2014; Gunderson et al., 2012). Meaning that a negative attitude toward mathematics study at an early stage affects learners' interest in mathematics and prevents them from following programs in science and its related disciplines at higher levels of the educational ladder.

Several studies have also revealed significant gender variations in students’ attitudes toward mathematics learning worldwide (Sarouphim & Chartouny, 2017; Pomeroy, 2016). According to

Bhowmik and Roy (2016), gender disparities in attitude toward the study of mathematics and academic performance exist. In a study conducted in Ghana at the senior high school level on gender disparities in mathematics, Asante (2010) discovered that "girls lacked confidence, had debilitating causal attribution patterns, perceived mathematics as a male domain, and were anxious about mathematics" when compared to boys. The findings revealed a considerable disparity between genders in terms of attitudes and mathematical ability.

Based on a meta-analysis of 96 publications, Etsey and Snetzler (2010) discovered that disparities among genders in attitudes toward the subject of mathematics exist, though modest. Males, according to the research, had a favorable attitude than females. Concerning research involving North American pupils, Sanchez et al. (2004) revealed substantial gender variations in eighth grade students' views about mathematics. While the findings revealed that boys were highly interested in mathematics in comparison to girls, they argued that girls viewed math as more significant than boys. Girls also outperformed boys when it came to math problems.

Morrisey et al. (2019) found age as a potential or causal component in mediating mathematics and gender inequality. The study focused on the hidden mathematic and gender preconceptions prevalent in adolescents as well as adults in Canada, employing both explicit and implicit language and mathematics sex stereotype assessments. Findings demonstrated that the elderly accepted more mathematics and gender stereotypes than teenagers (Junior High School students) engaged in the study. As a result, adults viewed mathematics to be a more gendered (favoring men) topic than teenagers (who reported fewer substantial math-gender stereotypes).

Despite this, research have revealed that gender has no influence on mathematical attitudes (Batool, Akhter, & Kalsoom, 2020; Dowker & Sheridan, 2022; Mato & De la Torre, 2010; Kogce, 2009; Georgiou, Stavrinides, & Kalavana, 2007). In addition, Simegn and Asfaw (2018)

did a study with grade 10 and 12 students in Ethiopia and observed no significant difference between gender in their attitudes about mathematics; nevertheless, female students exhibited a higher fall in views in terms of grade level. They concluded that increasing pupils' positive attitudes can help them do better in arithmetic, especially among female students. Georgiou, Stavrinides, and Kalavana (2007) found no difference in students' attitudes toward mathematics between boys and girls.

2.1.3 Classroom Climate

A classroom climate is a combination of elements that work together to facilitate learning in the classroom (Samrat, 2015). That is, a variety of factors or components combine to form the classroom environment. According to Samrat, the main variables that contribute to classroom climate are the physical climate (situation and facility) and physiological climate (teacher and teaching, use of teaching materials, learner and learning, teacher-student relationship, and classroom management). He further clarified that physical climate refers to the factors and forces that passively affect classroom phenomena, whereas physiological climate are the factors and forces that influence classroom phenomena' activities. According to Falsario, Muyong, and Neuvaespana (2014), essentially two types of classroom atmosphere exist, namely the social and the physical atmosphere. As a result, in the classroom setting, the physical climate is concerned with the layout of tables and chairs, as well as ventilation and lighting and painting, to mention but a few, whereas the social atmosphere is associated with the instructor's guidance as well as how learners participate and interact.

In argument, (Joulide, Faravani, & Boori, 2020; Wang et al., 2020; Wang & Degol, 2016; Kaplan Toren & Seginer, 2015) posited that classroom climate as a concept is multidimensional

since a variety of factors contribute to the overall construct. Classroom climate has three aspects, according to Kaplan Toren and Seginer (2015): interactions between teachers and students, as well as interactions between peers, and the educational environment (learning opportunities, classroom structure, instructional support, and behavior control techniques)

2.1.3.1 Teacher-student Relationship

Daud et al. (2020) discovered a beneficial or unfavorable connection between the two parties in the classroom, depending on the association between an instructor and a learner. Murray-Harvey (2010) also claimed that mathematics is perceived as a challenging subject, and that a beneficial connection among teachers and students may have a significant influence on student success. According to Wasike (2013) a strong connection between instructors and learners might constitute the basis that permits various perspectives to operate efficiently. When teachers and learners' have a positive relationship, it instills confidence in the students and makes them feel like they are a part of the class, with the teacher always available to help them in times of need. (Zhou et al., 2020; Kurdi & Archambault, 2018) asserted, a top-notch teacher-learner connection is marked by warmth and trust, which can effectively moderate students' negative self-perceptions of their academic abilities and influence their learning behaviors. In the opinion of Falsario, Muyong, and Nuevaespana (2014), the most essential feature of classroom atmosphere is the interaction between educators and learners, since there should be characteristics of compassion, credibility, and dignity in interactions among instructors and learners. Positive teacher-student relationships promote student learning by fostering a supportive environment in which students are encouraged to participate actively and appropriately in the classroom (McCormick et al., 2013), which influences students' self-perception, with possibly high self-

efficacy being an important indicator. Similarly, stronger teacher-student connections were linked to reduced levels of misbehavior in both high school and middle school, according to (Wang, Brinkworth, & Eccles, 2013).

A meta-analysis of 99 studies discovered that teacher-student relationship has a significant impact on students' learning, lending credence to the afore-mentioned relationship (Roorda et al., 2011). Other research has observed stronger positive correlations between supportive teacher-student relationships and mathematics performance (Ma et al., 2018; Hajovsky, Mason, & McCune, 2017; McCormick & O'Connor, 2015). According to (Wang, 2012; Jang et al., 2012), higher mathematics and reading grades among disadvantaged elementary school students were related with improved teacher-student relationships. Research studies involving students from high school and middle school showcased teachers' regard for and social assistance for their learners, which was correlated with academic performance and student intrinsic motivation.

According to Li et al. (2021b), effective teacher-learner interactions are connected with a substantial amount of fresh learners' sense of direction, which enhances their learning adjustment. Li (2022) also proposed that intimate, helpful, and gratifying teacher-student connections are crucial when it comes to the academic adjustment of fresh students. Most fresh students may be uninterested in mathematics and may wish to divert the course as time passes; however, with support, encouragement, and a positive teacher-student relationship, these students may change their minds and complete the course.

On the other hand, aggressiveness, truancy, lower academic achievement, and more instances of stressful circumstances, along with other unfavorable learner results (Fortin et al., 2013; Givens Rolland, 2012; Kong et al., 2013; Henry et al., 2011), have been linked to deteriorating teacher-student relationships (Rudasill et al., 2010). A bad teacher-student connection, according to

Lucas-Molina et al. (2015), can lead to increased levels of dispute and aggression in relationships among learners' and instructors, which predicts higher levels of student aggressiveness in the classroom.

2.1.3.2 Peer Relationship

Peer relationships have been found to aid in the achievement of both social and educational targets, along with emotional transformation. The absence of peer relationships or assistance, on the other hand, is associated with low self-esteem (Kaplan Toren & Seginer, 2015). Classrooms where students can discuss and share their problems with their peers help students improve their academic performance. For instance, learners may not understand what the teacher teaches in class, but when they approach their peers, they gain a better understanding than what the teacher teaches. Also, when students feel company in class, are supported, and have friends with whom they can always interact, they do not feel alone and are always proud to be a part of the class, which has a positive emotional impact on them.

According to Arslan (2009), support from peers is far more significant than that of teacher assistance in a conducive classroom atmosphere. While studies revealed that students who have favorable interactions with peers tend to be psychologically as well as behaviorally involved in school activities (Long et al., 2020) and have a sense of belonging in which they trust their peers and teachers (Bucholz & Sheffler, 2009), learners feel isolated in classrooms where they are not supported, have no one to interact with, or have no company, which has a negative impact on their emotions. These students may not participate in class activities and prefer to be alone. Furthermore, when there is miscommunication among students, it usually leads to conflict, making classrooms unsafe for learning. As a result of misunderstanding or disagreement,

students will always be disengaged in class. According to a study done by Thomas, Bierman, and Powers (2011), individual student hostility was greater in classrooms with more peer conflict, with students losing attention. Classes in which students assist one another as well as the instructor, on the other hand, promote the development of self-esteem, participation, and a sense of belonging (Hugerat, 2016). According to Haji Vosoogh, Tavakolizadeh, and Pakdaman (2021), recognizing and communicating with fellow students may additionally offer useful insight to instructors since it influences absenteeism, school dropout, absence of mutual respect between learners within the classroom, stress, depression, and sadness, opposition from learners towards the instructor, discomfort, and absence of engagement in the teaching and learning process.

2.1.3.3 Educational Atmosphere

Educational atmosphere which is also considered a dimension of classroom climate (Kaplan Toren & Seginer, 2015) encompasses learning opportunities, classroom organization, instructional support, and behavior management strategies. When it comes to the educational environment, classroom management is a very powerful tool. The ability of teachers to manage class well has a significant impact on academic achievement. There will be no meaningful learning in a classroom where there is no control. This classroom is distinguished by learners doing whatever they want without supervision, which has an impact on learning and peer interactions for all students (Haji Vosoogh, Tavakolizadeh, & Pakdaman, 2021). If such behavior continues for an extended period of time, it can even create a classroom climate in which disruption becomes the norm (Pas et al., 2015). The instructor's ability to control the class deteriorates.

Positive classroom climate, according to Joulide, Faravani, and Boori (2020), does not occur automatically; however, it is developed, which indicates that certain actions need to be instituted intentionally to actively mold the atmosphere and turn them into good learning settings. Several classroom management practices have been discovered to be beneficial in generating a healthy classroom atmosphere during the last few years, particularly in the area of behavior-based psychology in schools (Skiba et al., 2016). These management techniques include instructing and strengthening behavioral commitment and implementing an array of effective behavioral reaction techniques as well as procedures (Simonsen et al., 2008).

Creating a safe, supportive, and positive environment entails developing and reinforcing classroom rules and norms, as well as behavioral expectations. Setting, teaching, and reviewing expectations, as well as providing feedback, reduces disruptive behavior and increases academic engagement among students (Ingemarson et al., 2020). Apart from that, learners who obey rules become self-regulated, likewise, learners that are given the chance to exercise self-control might concentrate more on studying. Besides, students who follow rules control themselves and concentrate more on their studies since they exercise self-control (Joulide, Faravani, & Boori, 2020). It is suggested that pre-defined consequences be used in conjunction with behavioral expectations to reinforce desired behaviors (Ingemarson et al., 2020). Because students are already aware of the ramifications of breaking a rule, any necessary punishment will be easier to implement. Hochweber et al. (2013) observed that proper management of the classroom resulted in an improvement in secondary school learners' affective engagement and passion for mathematics. Also, the ability of instructors to regulate learners conduct plays an essential role in fostering student drive as well as involvement in school setting. In support, research on organizational climate and academic outcomes revealed that, teacher's ability to manage student

behavior is critical for learning motivation and engagement (Wang et al., 2020); therefore, classroom management needs to be given the maximum attention.

Classroom organization is also an important aspect of the educational environment. Classroom organization's role is centered on establishing an efficient and effective environment that satisfies learners' demands for proficiency and independence, allowing them to remain motivated to study (Miller & Wang, 2019; Hochweber, Hosenfeld, & Klieme, 2014; Downer et al., 2015). Classroom organization also talks about the arrangement of items in the classroom, particularly the seating arrangement of students. This is critical because it is necessary for the mathematics instructor to attend to each learner during the course of teaching to see how they are progressing; thus, seats should be arranged in such a way that there is enough space to pass through. Gaskins, Herres, and Kobak (2012) asserted that the setup of classrooms can influence student performance. Learners at the basic level that had a sense of structure and order in the classroom setting, for instance, tended to exhibit better math and literacy scores, as well as greater advancement concerning arithmetic and reading proficiency. Rimm-Kaufman et al. (2015) discovered that teachers in primary schools with higher management abilities and organizational skills had learners who exhibited more interest in their studies.

Instructional support is a type of assistance provided to students during the course of teaching and learning. Instructive assistance revolves around instructional characteristics that offer high academic expectations to students, apply critical thinking strategies, and deliver quality feedback (Danielson, 2011). Academic achievement is positively associated with a friendly, self-sufficient classroom setting. A learning-process-focused classroom environment is advantageous to learners' academic success, whereas a learning-results-focused classroom environment is deleterious to learners' success in school (Gutiérrez et al., 2019). In view of that, instructional

support focuses more on the learning process rather than the end of term or semester results. As a result, Fauth et al. (2014) opined that instructional assistance should foster more advanced thinking while encouraging intellectual development by means of meaning-driven discussions in class, assigning challenging activities, integrating previous and present knowledge, and including positive criticism, which broadens learners' understanding. To accomplish this, instructors must operate in more interactive settings centered on tasks that foster independence for learners and use instructional aids that have a significant beneficial correlation with student academic achievement (Fuqua et al., 2019; Lüftenegger et al., 2015). An instructor who is kind and helpful in addition to providing behavioral and learning assistance, according to Hamre et al. (2013), leads to a pleasant classroom environment. Students demonstrate improved mathematical skills and behavioral development in mathematics classrooms where instructional supports are provided (Horan & Carr, 2018; Luckner & Pianta, 2011). Fauth et al. (2014) proposed in support of this assertion that teacher support and successful teaching approaches help students acquire computational abilities, for instance, by applying multiple methodologies for completing mathematical problems and relating material to practical circumstances. Similarly, students reported greater engagement in school on the basis of their instructors being extremely supportive emotionally (Rimm-Kaufman et al., 2015). Furthermore, teachers foster a pleasant social environment in the classroom by responding positively and respecting learners' psychological and social requirements, learning about learners' passions and experiences beyond the educational setting, and integrating learners' views during instructional delivery (Quin, 2017).

Punitive techniques, ineffective instruction, and unattractive classrooms, including poor teacher-learner connections, on the contrary, constitute an atmosphere of inadequate support, which is

connected with defiant behavior (Pas et al., 2015), Falsario, Muyong, and Nuevaespana (2014) contended that a successful classroom atmosphere constitutes a situation where learners recognize the authority of instructors to create and control learning tasks, there is a sense of respect for each other and strong rapport, and the environment is characterized by trust and meaning.

When discussing the educational atmosphere, the physical environment cannot be overlooked. The physical environment includes the layout of items in the classroom, which encompasses tables, chairs, and cupboards, as well as ventilation and lighting, painting, etc. Fisher (2008) defines the physical climate as the actual room whereby the instructor and learners are primary components, involving space-related components such as the walls, windows, doors and also equipment in the classroom. The physical climate is very essential in classroom environment and may be the first to consider when it comes to the classroom climate. Classroom environment where materials comprising the physical environment are provided, teaching and learning become easy. However, classrooms with lack or inadequate provision or availability of physical environment affect teaching and learning woefully. For instance, classrooms with inadequate furniture make teaching and learning difficult. Most learners do not get proper place to sit and end up perching their colleagues. This affects the peace of mind of learners and is translated to the study of mathematics in a negative sense. Inadequate markers, chalks, poor ventilation, cannot escape mention when it comes to poor physical classroom environment.

2.2 Theoretical framework

The study was founded on Walberg's notion of educational production. Herbert J. Walberg propounded the theory in 1981. Walberg's educational productivity theory sought to explain

learner performance with the primary goal of determining what factors influence students' academic performance. Individual students' psychological qualities, as well as their surrounding psychological contexts, impact learners' emotional and cognitive learning outcomes, according to the theory (Ancheta & Napil, 2022). Walberg's theory of educational productivity recognizes that learning accomplishment cannot be attained through one element and therefore proposes that academic success is only achievable if multiple variables are united as a single entity (Walberg, 1984; Fraser et al., 1987).

Walberg identified nine factors that influence students' learning and academic performance. These factors include “ability or previous achievement, age or development level, motivation or self-concept, quantity of instruction, quality of instructional experience, home environment, classroom or school environment, peer group environment, and mass media” (Mazana, Montero, & Casmir, 2019; Bruinsma & Jansen, 2007; DiPerna, Volpe & Elliot, 2002). The nine factors were categorized further into student aptitude factors, instructional variables, and psychological environment variables (Everist et al., 2023; Mazana, Montero, & Casmir, 2019). Student aptitude factors include previous accomplishments, development level, as well as motivation. The instructional factors include the instructional quantity (comprising, time of instruction, material covered, and hours of interaction) as well as the instructional quality experience. Instructional pace, clarity of language, and content, which consist of instructors’ subject-matter competence, the standard of reference materials and their sources, instructional techniques, as well as standard evaluation, are all components of instructional quality.

Educationally stimulating psychological environments encompass the "school or classroom environment, peer group environment, home environment, and mass media", notably time spent

by learners' watching television in their leisure time (Şahinoğlu, 2022; Mazana et al., 2020), which influence learners' academic performance.

The study was backed by Walberg's theory based on the fact that individual students' psychological characteristics are associated with the study's variables; self-efficacy and students' attitude toward mathematics. Since the study intended to determine the effect of these variables on academic performance of learners, it is underpinned by Walberg's notion of educational productivity. Similarly, classroom climate is included in the surrounding psychological environment that affects the cognitive and affective learning outcomes of learners. The theory also takes into consideration the direct and mediating effects on learners' performance (Halala & Seni, 2022); therefore, it is related to the study's objectives.

2.3 Empirical Review

2.3.1 Self-efficacy and Mathematics Performance

Numerous evidence-based studies have been conducted in recent years in mathematics education, examining the connection between self-efficacy and academic success (Kamsurya et al., 2022; Muhtadi, Assagaf, & Hukom, 2022; Arifin, Wahyudin, & Herman, 2021; Liu et al., 2020; Dowker et al., 2019; Drago et al., 2018; Chen et al., 2018a).

Almost all nations that study mathematics aspire for the majority of learners to be proficient at problem solving and to excel in the discipline. In studies on self-efficacy perception in mathematics and problem-solving abilities (Kohen et al., 2022), self-efficacy is a variable that predicts problem solving as well as performance. Lee and Cho (2018) discovered learners' having greater degrees of efficacy displaying pronounced levels of proficiency in mathematics

problem solving as well as high performance in mathematics, whereas learners' exhibiting lower levels of efficacy being less able in solving more complicated mathematical tasks.

Kamsurya et al. (2022) investigated how self-efficacy affects students' mathematical abilities. A meta-analysis was utilized to analyze 16 research papers consisting of 73,935 learners as a sample size. The study observed that self-efficacy had a significant positive impact on students' mathematical abilities. Muhtadi, Assagaf, and Hukom (2022) conducted a similar study on the association between self-efficacy and learning abilities of students in mathematics using meta-analysis design on forty (40) published papers. According to the findings, there was both substantial and positive association between mathematics self-efficacy and learners' abilities.

Self-efficacy shown a favorable and substantial relationship with student mathematical outcomes, based on the findings of studies (Honicke & Broadbent, 2016; Stevens et al., 2016). Stevens et al. (2016) discovered a significant positive link between prior mathematics achievement and self-efficacy, whereas taking into consideration moderating and mediating influences, Honicke and Broadbent (2016) identified a mild association between self-efficacy perception and academic outcome in 59 university-based research studies.

Arifin, Wahyudin, and Herman (2021) used a survey design to look into the connection between learners' self-efficacy in mathematics and mathematical comprehension in Indonesia. 44 fourth-grade learners participated in the study. Students' mathematical self-efficacy, according to the findings, was positively connected to and had a substantial effect on students' mathematical understanding. The study further stated that students' mathematical efficacy may be the most reliable indication of future accomplishment.

Ugwuanyi, Okeke, and Ageda (2020) studied the association between motivation, learner efficacy, and academic achievement. A relational survey design was employed with 375 respondents from high school. The study noticed that self-efficacy as well as motivation were significantly and positively connected to learner achievement. Grigg et al. (2018) investigated the association between mathematics interest, self-efficacy, aspirations, and academic achievement of learners' using an integrated approach. The study sampled 400 learners, and the data was analyzed using structural equation modeling. According to the findings, self-efficacy in the study of mathematics is positively related to mathematics performance. In addition, Odiri (2020) researched learners' mathematics efficacy and their performance. The study found a substantial positive association between learner's mathematics efficacy and performance.

Roick and Ringeisen (2018) published the result of long-term research that looked into the influence of mathematics self-efficacy on learners' mathematics achievement. The authors discovered that self-efficacy predicts student performance based on the analysis of the study with 206 respondents. Okafor-Agbala and Okigbo (2021) studied the association between self-efficacy and the mathematics academic performance of senior high school students in Nigeria. The study made use of a correlation survey design. Stratified and simple random techniques were utilized to sample 5,096 respondents from a population of 18,352. The instruments used for data collection were a questionnaire on mathematics self-efficacy and students' performance. Simple regression analysis, t-test, and Pearson correlation were used for the data analysis. Based on the findings, the study discovered a moderately significant positive connection between students' self-efficacy, and mathematics performance.

In Nigeria, Ugwuanyi, Okeke, and Asomugha (2020) studied how self-efficacy, self-esteem, and emotional intelligence influence learners' mathematics academic performance. With a population

of 2937, a sample of 400 learners was selected as participants, and the design was a relational survey. The study instrument was a scale for measuring learner' self-efficacy, self-esteem, emotional intelligence, and academic success. Analysis through simple linear regression revealed that self-efficacy, self-esteem and emotional intelligence, had substantial predictive effects on learners' mathematics performance. The findings suggested that self-efficacy, self-esteem, and emotional intelligence, are major determinants of learners' performance in mathematics.

Ozkal (2019) researched high school students' self-efficacy beliefs, disaffection, and engagement in mathematics lessons, as well as their academic performance concerning mathematics learning and achievement. 651 high school learners participated voluntarily in the study, and the instruments utilized for data collection were the "engagement and disaffection scale", the "self-efficacy sub dimension" of the "Motivation Scale" which was connected to achievement and learning as well as the learners' grade for the semester. The study observed that mathematics performance was positively and substantially predicted by learners' mathematical efficacy beliefs.

Tossavainen, Rensaa, and Johansson (2021) investigated engineering students in Sweden, consisting of a sample of 88 students, on their self-efficacy, motivation, and beliefs about the nature of mathematics and how these relate to their task performance in mathematics. The study revealed that students with high self-efficacy and intrinsic motivation in mathematics performed better in mathematical task as compared to learners with low self-efficacy. The study further suggested that task performance of learners was relatively modest in connection with their claimed efficacy and motivating ideals.

Hiller et al. (2022) undertook a study on mathematics self-efficacy and anxiety as determinants of literacy in mathematics. The results showed that self-efficacy and anxiety in mathematics

were significantly connected with performance, and both explained 34% of the variation in mathematics performance, which indicated that when learners' efficacy in mathematics is high, their performance increases by roughly 34%. Nisa and Arliani (2023), in the same vein, conducted a study on the impact of learners' self-efficacy on mathematical literacy in junior secondary schools and discovered that learners with higher self-efficacy had high mathematical literacy, medium efficacy learners doubted their capabilities when confronted with challenging mathematical literacy task, and low efficacy learners were not confident in their abilities since they believe they are mathematically challenged. In a study on the effect of mathematics self-efficacy, enjoyment, and anxiety on mathematics achievement, Živković et al. (2023) observed a positive and significant relationship between mathematics self-efficacy, enjoyment, and academic performance.

In Kuwait, Hammad et al. (2022) examined the impacts of a conducive mathematics classroom setting on learners' motivation, mathematical self-efficacy, and performance. The study employed a case study design with a sample of 130 students from a university. The findings revealed a significant positive relationship between learners' self-efficacy and performance and learners' motivation and performance.

Bohrnstedt et al. (2020) conducted a longitudinal study on self-efficacy, mathematics identity, and mathematics interest as well as their association with mathematics performance in secondary schools, grade 9 to grade 12, to be specific. With a sample of 3500 learners, SEM was used for the data analysis, and the following results were identified: Mathematics self-efficacy as well as mathematics interest of grade 11 students revealed a direct impact on mathematics performance in grade 12 students. However, grade 9 mathematics self-efficacy revealed indirect impact on the performance of grade 12.

Kaburi (2019) looked at the connection between senior high school learners' self-efficacy and mathematics and English language academic achievement in Kenya. The study utilized a mixed study, and a sample of 240 participants was selected using stratified, purposive and simple random techniques. The analysis of the data was performed using inferential as well as descriptive statistics. The study discovered a substantial relationship between students' mathematics self-efficacy and mathematics performance, according to the findings.

Usher et al. (2019) investigated middle and elementary school learners of United States grit and self-efficacy and their predictive relationship with achievement in one academic year (a sample size of 2,430). Using SEM as a data analysis tool, self-efficacy was revealed to be positively related to mathematics outcomes. Zakariya et al. (2022) analyzed the connection between self-efficacy, attitude towards mathematics, previous knowledge, and learners' performance with 115 participants. Questionnaires and tests were used as the instrument and analysis was done using SEM. Based on the findings, self-efficacy and anticipated results were discovered to significantly impact learners' performance.

Studies (Oyuga, Raburu, & Aloka, 2019; Nwaukwa, Onyemechara, & Ndubuisi, 2019; Hüseyin, Yıldız, & Mehmet, 2018; Osenweugwor, 2018; Hammed & Toyin, 2015; Bushra & Lubna, 2014) also discovered a substantial and positive association between students' academic performance and self-efficacy. However, Talsma et al. (2018) and Sakellariou (2022) discovered a reciprocal connection between self-efficacy in mathematics and academic achievement, in which the efficacy of learners influences their academic achievement and vice versa.

June and Eamoraphan (2019) researched the association of mathematics self-efficacy and attitudes toward mathematics with the mathematics performance of tenth grade students in senior high school in Myanmar. The research included 200 respondents, and the research instruments

were scales on the mathematics self-efficacy, mathematics attitude, and mathematics test scores of the respondents. Based on the findings, no significant connection was discovered between mathematics self-efficacy, mathematics attitude, and mathematics performance.

Tus (2020) examined secondary school learners' self-concept, self-efficacy, self-esteem, and academic achievement. The study adopted a descriptive survey design with a sample of 190 twelve-grade students. A structured questionnaire and participant average performance for the academic year were used as the instruments. Analysis from multiple regression pointed out no significant relationship between students' self-efficacy, self-concept, self-esteem, and performance. In 2019, Tus conducted a similar study on the influence of self-efficacy on high school students' academic performance. The findings also demonstrated no significant effect on the academic performance of learners, which indicated that learners' performance is not influenced by their efficacy beliefs, as proposed by the author. Also, in research on the impact of reflection and feedback on student self-efficacy and academic achievement, Lamb (2019) identified no significant correlation between students' efficacy beliefs and mathematical achievement. In the same vein, Balami (2015) investigated the association between self-efficacy and learners' mathematics achievement, and the study discovered no substantial association between them. Baanu et al.'s (2016) study also discovered no substantial connection between the efficacy beliefs of learners' and their performance.

Pendon (2022) investigated the degree of self-efficacy as well as mathematical achievement among college students in the Philippines. The study's design was descriptive-correlational research, and the participants were 150 students chosen at random. The study revealed both substantial and adverse relationships between students' self-efficacy and their mathematical performance.

2.3.2. Students Attitude Towards Mathematics and Mathematics Performance

In recent decades, mathematics education researchers have conducted studies to investigate the association among learners' attitudes toward the study of mathematics and learner academic achievement (de Vera et al., 2022; Kartowagiran & Manaf, 2021; Hwang & Son, 2021; Gao, 2020; Kiwanuka et al., 2020; Foster, 2016). According to studies (Maamin et al., 2022; Davadas & Lay, 2020; Hwang & Son, 2021; Berger et al., 2020; Chen et al., 2018; Mazana et al., 2019), a positive correlation exists between attitude toward the study of mathematics and mathematics achievement.

Hwang and Son (2021) conducted research in Korea on the link between mathematics attitude and mathematics achievement. A survey design was utilized on 4,858 fourth and eighth grade students from 153 different schools. The Trends in International Mathematics and Science Study measurement scale was used as a data collection tool. The study discovered that learners' math attitudes are linked to academic performance. The authors further suggested that students that enjoy studying mathematics participate in activities related to mathematics, believe that understanding mathematics would benefit them, and those who trust their skills and abilities have a greater chance of higher performance.

Kartowagiran and Manaf (2021) explored the influence of student attitude on mathematics learning success in Indonesia. The study employed a quantitative meta-analysis design, with twenty-two research publications selected from online databases (Google Scholar, national and international journals) from various research results in Indonesia from 2010 to 2019 based on predefined eligibility criteria. The findings revealed both a substantial and positive influence of learners' attitudes toward mathematics on learning success.

In Nigeria, Adedayo (2020) undertook a study in senior high schools, investigating the attitudes and performance of learners. Descriptive research design was used in the study, which included 30,120 participants from 217 different schools. The instrument was the mathematics attitude scale and students' mathematics results from the 2018/2019 academic year. The collected data were analyzed using linear regression. Based on the findings of the study, attitude towards the study of mathematics had a positive and substantial influence on learners' academic achievement.

Wen and Dubé (2022) conducted a meta-analysis of 95 studies on high school learners' attitudes and their connection with academic performance in mathematics. The review investigated the relationships between the attitude subdimension and mathematical performance. Anxiety and gender roles were negatively connected to mathematical achievement, while confidence, motivation, perceived value, enjoyment, and behavioral goals were significantly and positively connected with mathematical performance, based on the findings.

Peteros et al. (2019) studied Filipino learners from secondary schools on mathematics attitudes along with their mathematics achievement. With 112 respondents, the authors utilized a descriptive survey approach and found a substantial positive association in terms of self-confidence, enjoyment, motivation, and value between learners' attitudes as well as their academic performance. Furthermore, the four components were revealed to have a substantial association with the students' academic progress.

In Uganda, Kiwanuka et al. (2020) studied the correlation between learners' attitudes toward the study of mathematics and academic performance among 4,244 senior high school learners. Based on the results and analysis from SEM via student questionnaires and mathematics tests, there was

a statistically significant positive association between mathematics attitude and the academic achievement of learners.

Capuno et al. (2019) investigated the influence of students' attitudes and their learning habits toward mathematics achievement. A quantitative survey design was employed with a sample of 177 learners offering mathematics as part of their subjects. As part of the data collection instrument, participant grades were utilized to evaluate their mathematical academic achievement. The research found that students showed a favorable attitude toward mathematics concerning worth. In terms of motivation, self-confidence, and enjoyment, learners showed an insignificant math attitude. Findings also revealed a minor positive connection concerning attitudes and mathematics achievement.

Ghimire (2021) conducted a study intended to discover the connection between the attitude of learners toward the study of mathematics and their mathematics performance. The survey research design was employed with 154 tenth grade learners. In addition to the survey, the performance of learners was measured using their grades. It was concluded that learners' mathematics attitudes were positively and significantly associated with their performance.

Michelli (2013) investigated the relationship between fifth-grade students' attitudes and mathematical performance. A questionnaire with a Likert scale survey and a mathematics test was used to collect data. Results from the study demonstrated a significant positive connection between learners' attitudes and academic success.

Mazana, Montero, and Casmir (2019) examined the impact of learners' attitudes towards mathematics on learners' performance in Tanzania. Data were collected from 419, 318 and 132 primary, high school, and college students, respectively, using the mixed method and survey

design. Analysis was performed using descriptives, regression, ANOVA, correlation, and thematic analysis. The results demonstrated a significantly weak and positive relationship between students' attitudes and mathematics performance.

Dan'inna (2017) explored the relationship between learners' mathematics attitudes and their mathematics performance in Nigeria. From a population of 114,504 high school learners in eight schools, the researcher sampled 383 learners for the study using cluster as well as simple random techniques, and a descriptive relational survey design was adopted. An adapted structured questionnaire was utilized as the data collection tool, and both inferential and descriptive analysis were employed. The study discovered a substantial connection between mathematics attitude and performance. Recber, Isiksal, and Koç (2018) conducted a similar study investigating attitude, anxiety, self-efficacy, and mathematics performance concerning school type and sex. The study noticed that attitude, anxiety, self-efficacy, school type, and gender substantially influenced the performance of learners.

Substantial outcomes of studies have also shown in terms of attitude, excellent routines of study, and mathematics performance that mathematics achievement is predicted by students' attitude as well as excellent learning habits. This assertion was seconded by studies undertaken by the authors Kumar and Nagaraju (2015) and Mendezabal (2013), which reported excellent habits of learning along with positive attitudes impacting positively and significantly with learners' mathematics achievement.

Zakariya et al. (2022) examined the relationship between attitude towards mathematics, previous knowledge, self-efficacy, anticipated results, and students' mathematics performance. The study sampled 115 participants using questionnaires and tests as the data collection tools. The data were analyzed using SEM, and the findings revealed no statistically substantial relationship

between mathematics attitude and students' performance. Studies (Mubeen, Saeed, & Arif, 2013; Mohamed & Waheed, 2011; Papanastasiou, 2000), similarly, found no significant correlation between learners' attitudes toward mathematics and mathematics performance. However, Fernández-Cézar, Solano-Pinto, & Garrido (2021) looked at how self-concept, learning strategies, learning attitude towards mathematics and science, educational setting, and past grades influence performance in mathematics and found negative and relatively small link between mathematics attitude and achievement.

2.3.3 Classroom Climate and Mathematics Performance

Increasingly, countries such as the USA, England, France, China, Singapore, Israel, Germany, Canada, etc. have highlighted the enhancement of learning atmosphere as a primary objective in their educational reform campaigns, proving a global consensus on the vital role of classroom atmosphere in fostering quality education and students' educational and emotional wellness (Wang, Hofkens, & Ye, 2020; Wang & Degol, 2016). Several studies relating to classroom climate and its influence on student academic performance have also been conducted in recent years.

Wang et al. (2020) looked at how the classroom environment affects students' academic performance and psychological well-being. A meta-analytic technique was utilized to integrate previous data in order to assess classroom atmosphere as a multifaceted concept and its relation to the behavioral, socio-emotional and educational consequences of learners. 61 studies published between 2000 and 2016 (73,824 individuals with 679 effect sizes) were considered. Overall, favorable relationships with engagement, motivation, social competence and performance were discovered, as well as minor negative connections with socioemotional discomfort and externalizing behaviors.

Ndidi and Effiong (2020) undertook a study involving senior high school learners in Nigeria on the impact of the classroom climate on performance. Two dimensions of the classroom climate, specifically learning resources and class size, and their impact on learners' performance, were considered. A sample of 700 students was utilized, data was obtained using questionnaires, and the academic performance of the learners was measured using tests. According to the study's findings, the existence of teaching and learning resources as well as class size positively and significantly influence mathematics achievement.

Malik and Rizvi (2018) researched learners' views concerning classroom atmosphere and their mathematics performance at the high school level in Pakistan. The sample consisted of 516 students, and the instrument for the study was the classroom environment measurement scale and scores from the yearly mathematics examination. According to the study's findings, "teacher support, involvement, focus on understanding, and personal relevance" were strongly associated with learners' progress, while "investigation, autonomy, and equity" were adversely related.

Falsario, Muyong, and Nuevaespana (2014) studied the classroom climate and academic performance of learners. The study consisted of 123 students and utilized a descriptive survey design. The study used the grade of the respondents and an adapted classroom climate questionnaire as the instrument, and the data were analyzed using descriptive statistics and Pearson correlation. The findings revealed that classroom atmosphere had a significant impact on the academic achievement of learners to some extent.

Wang, Hofkens, and Ye (2020) undertook a longitudinal study on classroom quality, learner engagement, and mathematics achievement. The study observed that teacher-student interaction and peer interaction in the classroom setting were moderately related to learners' academic performance. Yin et al. (2020) likewise investigated the connection between mathematics

classroom climate and academic performance in China with the mediation role of mathematics belief. 1443 students from university level were sampled, and according to the findings, classroom climate was significantly and positively associated with learners' mathematics performance.

Samrat (2015) researched the classroom setting and students' academic achievement at the high school level. The study employed a survey design with a sample of 400 students. Using inferential and descriptive analysis, the study discovered that classroom climate moderately influenced learners' performance. Murugan and Rajoo (2013) studied the perceptions of students about classroom climate and mathematics performance in Malaysia. A descriptive survey design and 235 participants were utilized. Structured questionnaire as well as test scores of the participants were the measurement tools. Descriptive and inferential analysis revealed significant and weak relationships between classroom atmosphere and mathematics performance.

Ahmed et al. (2018) explored the association between the learning climate and the academic achievement of Sudanese learners. Descriptive cross-sectional research of 638 learners was conducted. One-way ANOVA and descriptive statistics were used for the data analysis and the finding demonstrated a positive and significant association between the learning setting and students' performance. Suleman, Aslam, and Hussain (2014) observed a positive and substantial relationship between a conducive classroom atmosphere and academic performance in their study on the impact of the physical classroom climate on the academic performance of senior high school learners in Pakistan.

Tosto et al. (2016) looked at the relationship between classroom atmosphere and mathematics performance, taking into consideration the mediating effects of course interest and individual-perceived ability. The study noticed that classroom climate insignificantly influenced learners'

performance. However, classroom climate indirectly influenced learners' performance in the presence of the mediators' self-concepts and interest.

Ranđelović and Dimić (2019) examined the relationship between academic performance and specific learning environment dimensions ("teacher-student interaction, social climate, fear of failure, and emotional climate") and also the association between learning atmosphere dimensions and social demographic factors. 180 learners from Leskovac schools participated in the study. The data collection tool used for the study was the classroom environment scale. According to the findings from the analysis, classroom atmosphere dimensions did not significantly influence learners' mathematics achievement.

Akanbi (2014) explored the connection between classroom climate and female learners' performance in Nigeria. Six schools in two districts were chosen for the study, which consisted of a sample of 249 learners from secondary schools. A survey design was employed, and a questionnaire and performance test were utilized as research instruments. The researcher discovered no significant relationship between female learners' assessments of classroom atmosphere and students' achievement. Additionally, no substantial age variation existed between female learners' assessment of the classroom environment and their achievement.

Barksdale, Peters, and Corrales (2021) investigated the association between classroom atmosphere and learners' performance using a mixed approach. The study sampled 428 respondents, and questionnaires were administered to learners in order to examine their impressions of their classroom setting with respect to coherence, formality, material surroundings, and degree of fulfillment. Focus groups and state evaluations were also used to collect data. The quantitative results revealed no significant association between the classroom environment and learners' performance. Establishing connections, keeping instructional

materials available and structured, setting classroom norms, and holding learners accountable were all found to have an impact on learners' performance, according to the qualitative findings.

Gentova and Madrigal (2020) conducted a study to determine the impact of classroom environments on junior high school learners' performance in Antique, Philippines. With 358 students, descriptive-comparative and correlational approaches were utilized. The Alliance for the Study of School Climate's Standardized Classroom Climate Inventory was used for data collection. Secondary data, on the other hand, were used to assess students' academic performance during the first and second quarters of 2019/2020. No substantial association was found between classroom atmosphere and academic performance, according to the research.

Peters (2013) researched the connection between self-efficacy, classroom climate, and mathematics performance among undergraduate students. The research included 326 undergraduate students with a questionnaire and an end of semester examination as the data collection tools. According to the findings of the study, mathematics performance was not substantially predicted by classroom climate.

2.3 Conceptual Framework

Al-hassan (2015) defined a conceptual framework as "a model that allows the researcher to explore the relationship among variables in a logical and prescribed fashion" (p. 33). A conceptual framework provides a pictorial view of the interrelationship between the constructs. Students' mathematics self-efficacy (MS), classroom climate (CC), and students' attitude toward mathematics (SATM) were the three independent variables for study, whereas students' mathematics performance (MP) was the dependent variable. The mediator (Students' Attitude Towards Mathematics (SATM)) was utilized to determine whether students'

mathematics self-efficacy (MS) and students' mathematics performance (MP) are related and whether the influence on one variable influences the other. The conceptual framework for the study is shown below.

MS = Mathematics Self-efficacy, SATM = Students Attitude Towards Mathematics, CC = Classroom Climate, MP = Mathematics Performance

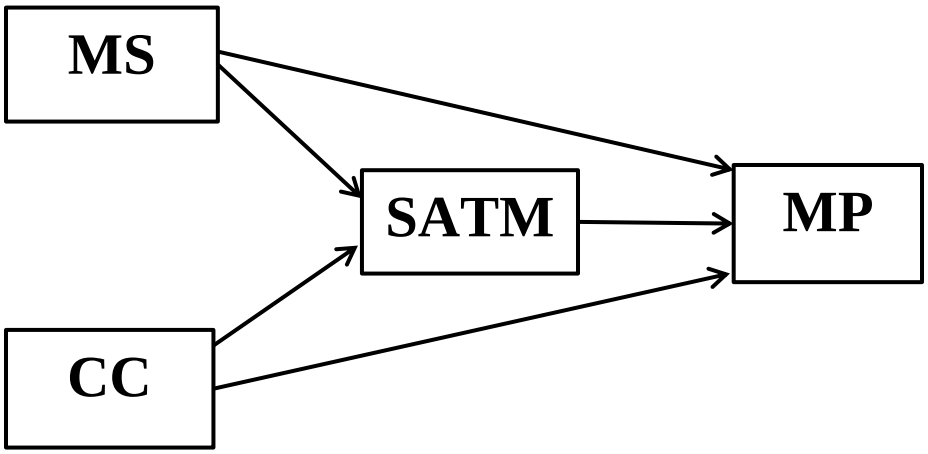

Figure 1: ***Conceptual Framework***

(Source: Author's Construct, 2023)

CHAPTER THREE

METHODOLOGY

3.0 Overview

This section provides an outline of the methodology the study adopted. The section highlights the research paradigm, research approach, research design, population, sample and sampling technique, research instrument, data collection procedure, data analysis, and ethical consideration.

3.1 Research Paradigm

A research paradigm is simply a philosophical framework or foundation that a study is based on. Khatri (2020) defined research paradigm as the lens the researcher looks into to examine the study as well as the methodology to be adopted. The study was based on the positivist philosophical framework. Taking an ontological stance, Park, Konge, and Artino (2020) posited that the positivist paradigm assumes that there exists a single reality that can be measured. Concerning epistemology, positivism refers to realities that can be observed as well as measured as the basis of knowledge (Junjie & Yingxin, 2022). Meaning that positivists are interested in discovering realities which are observable and quantifiable (Alharahsheh & Pius, 2020). In terms of axiology, the positivist prioritizes objectivity and, as a result, dismisses the importance of personal views, experiences, biases, and principles in the conduct of a study (Park, Konge, & Artino, 2020).

The positivist paradigm is the philosophical framework that the study was founded on in that it sought to identify a single reality, the study involved variables and responses that could be

observed, measured, or quantified, and the researcher's bias, values, and experiences were not incorporated into the study.

3.3 Research Approach

The research method that the study adopted is the quantitative approach. The quantitative approach is primarily concerned with theory testing by establishing various hypotheses that are tested statistically using statistical techniques to either approve or refine a theory (Neuman, 2011;, Wahyuni, 2012). Quantitative methodology generates knowledge by investigating phenomena that can be quantified in some way (Alharahsheh & Pius, 2020). The quantitative method was used because the study involved variables and responses that could be quantified, utilize a statistical analysis to test statistically to either confirm or disprove a theory.

3.4 Research Design

According to Leedy and Ormrod (2015), the objective of a study influences the selection of a research design. The research design was a relational survey. A survey design is a type of research in which a selected group of people are provided with questionnaires to examine their opinions, attitudes, perceptions, attributes, or traits at a specific moment (Creswell, 2005). A survey allows for the gathering and analysis of quantitative data employing inferential and descriptive statistics (Saunders et al., 2012). The relationship or correlation between constructs is determined through a relational survey (Phillips, Phillips, & Aaron, 2013). The relational survey was significant because the association between mathematics self-efficacy, students' attitude toward mathematics, classroom climate, and students' mathematics performance was explored.

3.5 Population

In research, the term population refers to every member of a clearly established group of people, events, or things (Ary et al., 2002). Senior High Schools in Ashanti region of Ghana were targeted for the research. However, the research was accessible to students in Atwima Nwabiagya Municipal. Currently, the number of SHS in the municipality is two, namely; Nkawie Senior High School and Toase Senior High School; therefore, the study was accessible to students in these two schools. Both schools have a population of 8,619, with Nkawie SHTS consisting of 3,019 and Toase SHS comprising 5,600.

3.6 Sample and Sampling Technique

A sample is termed as a lesser number of data or group of people chosen or selected as a representative of the population via a pre-defined technique. The researcher can reliably generalize the results when the sample is sufficiently typical of the population (Ary et al., 2002). The researcher sampled 382 students for the study. The sample size was calculated using Miller and Brewer (2003) method. The formula is given by:

$$n = \frac{N}{1 + N(\alpha^2)},$$

N indicates the population (8,619), n denotes the sample size, α represents the significance level (0.05). The study relied on human respondents, whose replies might be skewed; therefore, the number of samples was determined using a 95% level of confidence and a 5% error margin. This implies;

$$n = \frac{8{,}619}{1 + 86{,}19(0.05^2)}$$

$$n = \frac{8{,}619}{22.5475} = 382.2597$$

$$\approx 382$$

The methods, procedures, or tactics for gathering facts or proof for assessment in order to discover new information or gain more experience in a subject are referred to as research techniques (Haviz et al., 2020). The study used simple random sampling technique to select sample from the population. 134 respondents were selected from Nkawie SHS ($\frac{3{,}019}{8{,}619} \times 382$), and 248 samples were selected from Toase SHS ($\frac{5{,}600}{8{,}619} \times 382$) using the lottery method. In each school, the population was numbered and written on paper slips of equal sizes. The papers were folded and put in a box, mixed thoroughly each time before a sample was drawn. Samples were selected randomly until the number of samples needed was achieved; therefore, samples were chosen at random rather than based on prejudice, and each student had an equal chance of being selected.

3.7 Research Instrument

A closed-ended questionnaire on a Likert scale was utilized to collect data. The questionnaire consisted of five-level Likert scale items ranging from 1 to 5, with 1 being "strongly disagree" and 5 being "strongly agree". There were two sections to the questionnaire. The first component gathered background information on the participants. Background characteristics included age, form, course, and gender. The second section included four sections of items to assess the four constructs of the study, specifically, mathematics self-efficacy, classroom climate, attitude toward the study of mathematics, as well as mathematics performance.

There were 40 measurement items in the survey. Ten (10) mathematics self-efficacy measurement items were adapted from Negara et al. (2021). They were (MS1) “I am motivated to solve difficult mathematic problem”, (MS2) “I believe I can score very well in mathematics task”, (MS3) “I am confident that I can complete an assigned task”, (MS4) “I am sure I can learn important mathematics concepts taught by my mathematics teacher”, (MS5) “I believe I can understand the most difficult concepts in mathematics”, (MS6) “I am able to use different strategies to complete mathematical tasks”, (MS7) “Even though mathematics is difficult, I believe I can do very well”, (MS8) “I am confident about my mathematical skills”, (MS9) “I communicate with friends to find the best solution of a mathematical problem at hand”, and (MS10) “I can use examples or similar problems to solve mathematics problem”.

Ten (10) attitudes toward mathematics measurement items were adapted from TIMSS (2019): (SATM1) “Mathematics is a subject I enjoy learning”, (SATM2) “Mathematics is one of my favorite subjects”, (SATM3) “I usually wish to study mathematics”, (SATM4) “I like solving mathematics problems”, (SATM5) “For me, mathematics is not difficult than any other subject”, (SATM6) “Mathematics makes me confuse”, (SATM7) “I usually look forward to mathematics lessons”, (SATM8) “Mathematics is one of my strengths”, (SATM9) “I need mathematics to learn other school subjects”, (SATM10) “I think learning mathematics will help me in my daily life”.

Ten (10) classroom climate scale items were adapted from Lyons, Brown, and Bourke-Taylor (2018), Walker and Baepler (2017) and PISA (2014): (CC1) “My mathematics teacher shows interest in my mathematics learning”, (CC2) “My mathematics teacher treats me fairly in class”, (CC3) “Enough desks and teaching materials are provided in my classroom for effective teaching and learning”, (CC4) “The layout of the classroom creates safe environment for students during

teaching and learning", (CC5) "My peers support me in the classroom in appropriate ways", (CC6) "I feel comfortable asking for help from my peers", (CC7) "My mathematics teacher has clear and consistent sanctions for students who misbehave or do not follow classroom rules", (CC8) "My teacher gives students opportunity to express their opinion during mathematics lessons", (CC9) "My mathematics teacher gives extra help when I need it", (CC10) "I often have a chance to discuss materials with my peers".

Finally, ten (10) mathematics performance questions were adopted from Arthur et al. (2021) and Zhou et al. (2020): (MP1) "I perform well in mathematics examinations", (MP2) "I contribute and answer questions in mathematics class", (MP3) "I actively participate in mathematics group studies", (MP4) "I am able to study and understand mathematical concepts on my own", (MP5) "Learning mathematics improves my decision making ability", (MP6) "Learning mathematics improves my thinking ability", (MP7) "Learning mathematics strengthens my analytical ability", (MP8) "Learning mathematics enhances my knowledge in profession and concepts", (MP9) "Learning mathematics improves my problem-solving ability", (MP10) "I have adequate background for mathematical concepts I have studied". Although the measuring items were derived from prior research, they were changed to match the demands of the investigation.

3.7.1 Reliability and Validity Measures of the Instrument

The number of questionnaire items loading on their right construct and the interrelationship between the whole set of data as well as the number of components to be retrieved were analyzed using Exploratory Factor Analysis (EFA) through principal component analysis from SPSS (v.23). Suhr (2012) define EFA as "a variable reduction technique that identifies the number of latent constructs and the underlying factor structure of a set of variables" (p.1). Seven (7)

measurement items loaded under the first component (SATM1, SATM2, SATM3, SATM4, SATM5, SATM7, SATM8), six (6) measurement items under the second component (MP5, MP6, MP7, MP8, MP9, MP10), five (5) measurement items under the third component (MS2, MS3, MS4, MS5, MS7) and three (3) measurement items under the fourth component (CC1, CC2, CC8). Therefore, the items were loaded under four components after items whose factor loadings were not up to 0.5 and items under multiple constructs were deleted. These extracted factors were used for further analysis.

The consistency and stability of a measuring device in delivering accurate and consistent measurements over time and even when used by different researchers is referred to as its reliability. Cronbach's Alpha (CA) analysis on the retained items was used to establish the instrument's internal consistency, and this was performed using SPSS (v.23) software. Cronbach's alpha measures the internal consistency of an instrument, or how well measurement items in a construct correlate with one another. The observed variables are regarded as reliable if they have a CA score greater than or equal to 0.7 (De Veilis, 1991).

Validity refers to how well an instrument measures exactly the variable it is supposed to measure and generates meaningful and dependable results. To test for convergent validity, Average Variance Extracted (AVE) and Composite Reliability (CR) were calculated utilizing the retained items factor loadings. Convergent validity is defined by Trochim and Donnelly (2001) as the degree to which observed variables on the same construct are connected with each other. To attain convergent validity, Fornell and Larcker (1981) proposed AVE and Composite Reliability (CR) scores of not less than 0.5 and 0.7 respectively.

The study also tested discriminant validity by comparing the square-root of the AVEs (√AVEs) to the inter-correlation coefficients of the main variables, as employed in prior studies like Bamfo et al. (2018). Discriminant validity assesses the degree to which observed variables in a construct are unrelated to that of other constructs (Trochim & Donnelly, 2001). According to Arthur et al. (2021), discriminant validity is attained when the greatest coefficient of correlation between the constructs is lesser than the smallest √AVE.

3.8 Data Collection Procedure

Before the commencement of data collection, authorization was obtained from the headmasters and heads of mathematics departments at both Nkawie SHTS and Toase SHS via an introduction letter to the schools, and the appropriate date and time were agreed upon with the school officials. The researcher also sought the permission of teachers in charge of the various classes in which the participants were enrolled. The researcher introduced himself to the participants before the session. The researcher also outlined the study's goal, time range, and also the respondents' rights and obligations in participating in the study A total of four hundred (400) questionnaires were administered to students in the two schools. Three hundred and eighty-two (382) questionnaires were returned, which represented 95.5% $(\frac{382}{400} \times 100)\%$. The participants' anonymity was respected to ensure data protection and confidentiality. The researcher self-administered the questionnaire while under his supervision.

3.9 Data Analysis

The first method for ensuring the accuracy of data analysis findings involved assessing the psychometric properties of the instrument. Cronbach Alpha for all latent variables was attained, demonstrating internal consistency.

The study performed Confirmatory Factor Analysis (CFA) using Amos (v. 23) to determine the fitness of the hypothesized model (Zaid, 2015). Various goodness-of-fit indicators, such as chi-square statistic, Tucker-Lewis Index (TLI), Comparative Fit Index (CFI), Root Mean Square Error of Approximation (RMSEA), Root Mean Square Residual (RMR), etc., are employed to evaluate the fitness of a model. CFA additionally presents statistical details regarding the extent as well as the cause of model inconsistency, that may be used to refine the model (Lahey et al., 2012).

Structural equation modeling was used to determine the empirical relationships between students' self-efficacy, classroom climate, students' attitude toward mathematics, and students' mathematics performance. In studies with multiple constructs and larger sample sizes, structural equation modeling proved helpful (Arthur, 2019).

3.10 Ethical Consideration

Ethics, in the opinion of Ubi, Orji, and Osang (2020), are the rules or guidelines for behavior that help to discern between right and wrong and between acceptable and inappropriate behaviors. Thus, one way to conceptualize research ethics is as a collection of broad moral rules controlling how participants and other study materials should be treated during the course of conducting research (Salifu, 2017).

When the data were being collected, the researcher asked and gained consent from the headmasters of the schools, as well as the instructors in the various classes where the surveys were administered, via an introduction letter. The study's goal, data collection method, along with participants' expectations were all communicated to the participants. The respondents also provided informed agreement to the researcher, and no one was coerced to participate in the study.

According to Ubi, Orji, and Osang (2020), being anonymous necessitates that researchers conceal the names of their respondents. Participants' privacy and identities were maintained.

CHAPTER FOUR

ANALYSIS, RESULTS AND DISCUSSION

4.0 Overview

This chapter is entailed with the analyses, presentation and interpretation of the results of the study. The findings obtained were reported under the research questions which guided the study and path analysis using Structural Equation Modelling from Amos (v.23) was employed to answer the study's questions:

1. What is the impact of student's mathematics self-efficacy on students' mathematics performance?
2. What is the effect of classroom climate on students' mathematics performance?
3. What is the mediating effect of student attitude toward mathematics between student's mathematics self-efficacy and students' mathematics performance?

4.1 Analysis and Results

4.1.1 Demographics of Respondents

Table 1 summarizes the findings based on the respondents' background information. According to the findings, 382 students completed the questionnaire. From the total of 382 that participated, 194 comprised males (50.8%) and 188 were females (49.2%). The age ranges of 11-15 years were represented by 15 respondents (3.9%), 16-20 years by 366 respondents (95.8%), and 21-25 years by 1 respondent (0.3%). The respondents were 99 form 1 students which represented 25.9%, 157 form 2 students representing 41.1% and 126 form 3 students representing 33.0% from Nkawie SHTS and Toase SHS. In accordance with the results of the respondents' courses,

55 were General Science students representing 14.4%, 40 were Business students representing 10.5%, 88 were General Arts students representing 23.0%, 48 Visual Arts students representing 12.6%, 56 respondents were Technical students representing 14.7%, Home Science was 60 respondents representing 15.7%, and Agric. Science consisted of 35 students which represented 9.2%.

Table 1: Demographics of Respondents

Demographics	Frequency (N)	Percentages (%)
Gender	***382***	***100.0***
Male	194	50.8
Female	188	49.2
Age	***382***	***100.0***
11-15 years	15	3.9
16-20 years	366	95.8
21-25 years	1	0.3
Form	***382***	***100.0***
Form 1	99	25.9
Form 2	157	41.1
Form 3	126	33.0
Courses	***382***	***100.0***
Business	40	10.5
Home Science	60	15.7
General Science	55	14.4
Agric. Science	35	9.2
General Arts	88	23.0
Technical	56	14.7
Visual Arts	48	12.6

Source: Field Data (2023)

4.1.2 Descriptive Statistics

The descriptive analysis for the items on Students Mathematics Self-efficacy, Students Attitude Towards Mathematics, Classroom Climate, and Students Mathematics Performance was assessed using SPSS version 23. From the table below, the highest mean of 4.167 was scored by classroom climate whereas students' attitude towards mathematics scored 3.419, which was the

least of the means. The constructs were evaluated on a Likert scale with five levels, that spans "Strongly Disagree" to "Strongly Agree" with maximum potential mean being 5.

Based on the descriptive analysis, student's mathematics self-efficacy measure had an average score of 4.008 with 0.952 as the standard deviation. The average score varied from 3.82 to 4.16. Item 5 ("I believe I can understand the most difficult concepts in mathematics") attained the minimum average of 3.82 and a standard deviation of 1.031. Item 7, "Even though mathematics is difficult, I believe I can do very well," obtained the greatest average of 4.16, and 0.901 as the standard deviation.

The student attitude toward mathematics scale reported 3.419 and 1.249 as the average and standard deviation, respectively. Average score ranged from 3.21 to 3.66. The item with the lowest mean score was item 5, "For me, mathematics is not difficult than any other subject" (Mean = 3.21, Standard deviation = 1.330). "I usually wish to study mathematics" (M = 3.66, SD = 1.188), the third item received the greatest average.

The classroom climate scale obtained an average value and standard deviation of 4.167 and 0.998, accordingly. The average score varied from 4.07 to 4.29. "My mathematics teacher shows interest in my mathematics learning" had the lowest mean of 4.07 and 1.041 standard deviation. The eighth item (8), "My mathematics teacher gives students the opportunity to express their opinions during mathematics lessons" (Mean = 4.29, Standard Deviation = 0.936), reported the greatest average.

The mathematics performance scales gave an average score of 3.923, with 0.983 being the standard deviation. The average score varied from 3.77 to 4.06. Item 7, "Learning mathematics strengthens my analytical ability" received the lowest mean score of 3.77 with a standard

deviation of 1.068. "Learning mathematics enhances my knowledge of profession and concepts" (Mean = 4.06, Standard Deviation = 0.919) recorded the greatest average (the eighth item)

All four variables studied had a favorable average score greater than three, indicating that the average scores were high.

Table 2: Descriptive Statistics

Variables	**Mean**	**Std. Dev.**
Mathematics Self-efficacy (MS)	***4.008***	***0.952***
(MS2): I believe I can score very well in mathematics task	4.01	0.905
(MS3): I am confident that I can complete an assigned task	3.94	0.966
(MS4): I am sure I can learn important mathematics concepts taught by my mathematics teacher	4.11	0.956
(MS5): I believe I can understand the most difficult concepts in mathematics	3.82	1.031
(MS7): Even though mathematics is difficult, I believe I can do very well	4.16	0.901
Students Attitude Towards Mathematics (SATM)	***3.419***	***1.249***
(SATM1): Mathematics is a subject I enjoy learning	3.36	1.320
(SATM2): Mathematics is one of my favorite subjects	3.30	1.354
(SATM3): I usually wish to study mathematics	3.66	1.188
(SATM4): I like solving mathematics problems	3.41	1.226
(SATM5): For me, mathematics is not difficult than any other subject	3.21	1.330
(SATM7): I usually look forward to mathematics lessons	3.62	1.134
(SATM8): Mathematics is one of my strengths	3.37	1.192
Classroom Climate (CC)	***4.167***	***0.993***
(CC1): My mathematics teacher shows interest in my mathematics learning	4.07	1.041
(CC2): My mathematics teacher treats me fairly in class	4.14	1.002
(CC8): My mathematics teacher gives students opportunity to express their opinions during mathematics lessons	4.29	0.936
Mathematics Performance (MP)	***3.923***	***0.983***
(MP5): Learning mathematics improves my decision-making ability	3.90	0.971
(MP6): Learning mathematics improves my thinking ability	4.03	0.933
(MP7): Learning mathematics strengthens my analytical ability	3.77	1.068
(MP8): Learning mathematics enhances my knowledge in profession and concepts	4.06	0.919
(MP9): Learning mathematics improves my problem-solving ability	3.91	0.974
(MP10): I have adequate background for mathematical concepts I have studied	3.87	1.030

Source: Field Data (2023)

4.1.3 Test of Normality

One of the important factors to consider before main data analysis is for a study to check for normality. For multiple variables, all variables are said to be univariately normally distributed (Appiah et al., 2022). Using SPSS (v.23), the study assessed the skewness as well as the kurtosis indices of each item. According to Kline (2011), for a measurement item to pass skewness and for that matter kurtosis tests, the skewness index should be "less than |4|" and that of the kurtosis should be "less than |8|". From the estimates reported in table 3, it appears that each item was normally distributed since the benchmark as proposed by Kline was met.

Table 3: Test of Normality

Measurement items	**Skewness**		**Kurtosis**	
	Statistic	**SE**	**Statistic**	**SE**
(MS2): I believe I can score very well in mathematics task	-1.014	0.125	1.151	0.249
(MS3): I am confident that I can complete an assigned task	-1.126	0.125	1.251	0.249
(MS4): I am sure I can learn important mathematics concepts taught by my mathematics teacher	-1.405	0.125	2.251	0.249
(MS5): I believe I can understand the most difficult concepts in mathematics	-1.144	0.125	1.181	0.249
(MS7): Even though mathematics is difficult, I believe I can do very well	-1.251	0.125	1.836	0.249
(SATM1): Mathematics is a subject I enjoy learning	-0.442	0.125	-0.924	0.249
(SATM2): Mathematics is one of my favorite subjects	-0.322	0.125	-1.127	0.249
(SATM3): I usually wish to study mathematics	-0.759	0.125	-0.240	0.249
(SATM4): I like solving mathematics problems	-0.483	0.125	-0.737	0.249
(SATM5): For me, mathematics is not difficult than any other subject	-0.278	0.125	-1.126	0.249
(SATM7): I usually look forward to mathematics lessons	-0.728	0.125	-0.130	0.249
(SATM8): Mathematics is one of my strengths	-0.379	0.125	-0.787	0.249
(CC1): My mathematics teacher shows interest in my mathematics learning	-1.236	0.125	1.114	0.249
(CC2): My mathematics teacher treats me fairly in class	-1.294	0.125	1.294	0.249

(CC8): My mathematics teacher gives students opportunity to express their opinions during mathematics lessons	-1.581	0.125	2.491	0.249
(MP5): Learning mathematics improves my decision-making ability	-1.213	0.125	1.663	0.249
(MP6): Learning mathematics improves my thinking ability	-1.299	0.125	2.085	0.249
(MP7): Learning mathematics strengthens my analytical ability	-0.957	0.125	0.580	0.249
(MP8): Learning mathematics enhances my knowledge in profession and concepts	-1.079	0.125	1.363	0.249
(MP9): Learning mathematics improves my problem-solving ability	-1.081	0.125	1.210	0.249
(MP10): I have adequate background for mathematical concepts I have studied	-0.976	0.125	0.691	0.249

SE: Standard Error.
Source: Field Data (2023)

4.1.4 Preliminary Analyses

A preliminary study was performed to assess the model's fitness for the data analysis. Using Exploratory Factor Analysis (EFA), the study determined the observed variables that loaded on the respective component. The descriptive statistics and normality test were also examined, as shown in Tables 2 and 3. Hypothesized model fitness was also evaluated using Confirmatory Factor Analysis (CFA) as well as discriminant validity.

4.1.5 Exploratory Factor Analysis (EFA)

A statistical approach or variable reduction technique that investigates the interrelationships between observed variables and uncovers latent factors that explain patterns of correlation or covariance among them is termed as Exploratory Factor Analysis (EFA). The purpose of EFA is basically to study the patterns of correlation among observed variables and to determine the lesser number of observed variables that correlate highly to measure each construct. SPSS (v. 23) was used to estimate the EFA by uncovering a measure's factor structure, providing direct insight

into patterns or structures, and interrelationships across variables via its data summarizing perspective, and analyzing its internal reliability.

The KMO coefficient was discovered to be 0.903 being higher than the required value of 0.5. According to Hair et al. (2010), this demonstrates a strong relationship among the observed variables. A p-value of 0.000 was also discovered from the Bartlett's test of sphericity which paved the way for factor analysis since the test proved to be substantial. Factor analysis was done purposely to reveal the extracted factors to be considered. The study extracted as well as rotated four factors based on the results. The varimax approach was employed for the rotation due to the fact of decreasing factors with poor loadings. These factors were eliminated repeatedly; with the fit indices being evaluated the numbers of instances the items were removed.

Table 4: Exploratory Factor Analysis (EFA)

KMO and Bartlett's Test		
Kaiser-Meyer-Olkin Measure of Sampling Adequacy		.903
Bartlett's Test of Sphericity	Approximate Chi-Square	3838.904
	Degree of Freedom	210
	P-value	.000
Total Variance Explained		62.617%

	Components			
Measurement items	**1**	**2**	**3**	**4**
SATM1	.755			
SATM2	.804			
SATM3	.718			
SATM4	.707			
SATM5	.704			
SATM7	.710			
SATM8	.732			
MP5		.717		
MP6		.730		
MP7		.795		
MP8		.788		
MP9		.733		
MP10		.731		
MS2			.665	
MS3			.773	
MS4			.692	
MS5			.743	
MS7			.779	
CC1				.818
CC2				.818
CC8				.755

Extraction Method: Principal Component Analysis.
Rotation Method: Varimax with Kaiser Normalization.
Rotation converged in 6 iterations.
Source: Field Data (2023)

4.1.6 Reliability and Validity Analysis

Research instruments that are utilized in studies that are quantitative are evaluated thoroughly and statistically to establish their validity and reliability (Boadu et al., 2023). Since the study was quantitative and used an established tool, the researcher must give evidence of the tool's validity and reliability. The consistency and stability of a measuring device in delivering accurate and

consistent measurements over time and even when used by different researchers is referred to as its reliability. It reflects how well the instrument performs when used regularly under similar settings. Reliability ensures that the instrument can be relied on to produce consistent and reliable results, enabling meaningful data analysis and interpretation. The correlation coefficient is used to assess an instrument's consistency.

The accuracy with which a measuring instrument measures or assesses the specific concept or variable it is designed to measure is referred to as its validity. The importance of validity in guaranteeing the correctness and trustworthiness of research findings or assessment outcomes cannot be overlooked.

The items were adapted, which means they were chosen from prior research but adjusted to meet the objectives of this investigation. Adapting measuring scales in research has the considerable benefit of having been thoroughly evaluated in the past, boosting its dependability. When the study setting is related to that of a validated instrument setting, it is advisable for a researcher to adapt or adopt, according to (Hyman et al., 2006). The use of validity metrics also relieves researchers of the task of generating benchmarks. Using validated measurement scales also relieves researchers the task of developing and validating research instruments.

Cronbach Alpha (CA) analysis was done on the maintained items after eliminating observed variables with inadequate loading (that is, below 0.5) and items loaded under multiple constructs in order to evaluate the constructs' reliability. Reliability is said to be attained with a Cronbach Alpha value less than or equal to 0.7 (De Veilis, 1991). Using SPSS (version 23), the estimated Cronbach Alpha values were 0.834, 0.892, 0.757, and 0.878 for Students Mathematics Self-efficacy, Students Attitude Toward Mathematics, Classroom Climate and Mathematics Performance, respectively. Cronbach alpha for the constructs exceeded 0.7, signifying that the

internal consistency coefficient for the four constructs employed in this study met the 0.7 minimal requirement.

Table 5: Reliability Analysis

Construct	Cronbach Alpha	Number of Items
Mathematics Self-efficacy (MS)	0.834	5
Student Attitude Towards Mathematics (SATM)	0.892	7
Classroom Climate (CC)	0.757	3
Mathematics Performance (MP)	0.878	6

Source: Field Data (2023)

Convergent and discriminant validity of the study instrument were assessed using the observed variables factor loadings from the confirmatory factor analysis, which are presented in the following section.

4.1.7 Confirmatory Factor Analysis (CFA)

A statistical approach employed by researchers to determine whether or not there is a relationship between the variables studied through the testing of hypotheses is termed as confirmatory factor analysis. Two types of relationships exist in a hypothesized model. The connection between the measurement items and their main variable, referred to as the measurement model. The link between the main variables, also termed the structural model. The structural equation model is formed by the combination of the measurement model and the structural model. Theoretical knowledge, empirical study, or both are used by researchers to propose the relationship pattern, which is then statistically tested. Amos software (version 23) was utilized to perform the confirmatory factor analysis.

The Confirmatory Factor Analysis technique was chosen by the researcher because of its advantage of allowing for testing of several features of hypothesized models. Also, it gives information in relation to the sources of inaccurate models that may be utilized in fine-tuning the

model (Lahey et al., 2012). Table (6) displays the CFA findings. Items that had factor loadings below 0.5 in the confirmatory factor analysis approach were eliminated from further analysis. Initially, there were ten measurement items for each of the constructs. Following the CFA process, three (3) of the observed variables in students' attitude towards mathematics were deleted, four (4) were eliminated from mathematics performance measurement items, five (5) items were removed from mathematics self-efficacy, and seven (7) items were deleted from classroom climate measurement items. Therefore, twenty-one (21) measurement items were used for further analysis.

Confirmatory factor analysis, in addition, evaluates how well the data fits into the hypothesized model. To ensure the overall model's fitness, Hair et al. (2010) proposed that the ratio of the chi-square statistic to the degree of freedom (CMIN / DF) must be less than 3, Tucker-Lewis Index (TLI), Goodness-of-Fit Index (GFI), Comparative Fit Index (CFI), should be at least 0.9, Root Mean Square Error of Approximation (RMSEA), Root Mean Square Residual (RMR) must be less than 0.08, and P-close must exceed 0.05. CMIN denotes the model's minimal inconsistency; Root Mean Square Error of Approximation and Root Mean Square Residual measure the divergence of the hypothesized model from the ideal model; The RMSEA is a measure of the difference in covariance structure between the hypothesized model and the population, whereas RMR assesses the average difference in observed and projected covariance or correlations. According to Xia and Yang (2019), Tucker-Lewis Index and Comparative Fit Index compare the fitness of hypothesized model to that of the baseline model, such as the null or independence model (determining the poorest fit). Tucker-Lewis and Comparative Fit Indices span from 0 to 1, with values approaching 1 suggesting better fit. GFI calculates proportion of variance and covariance that the hypothesized model accounts for. P-close is the p-value for evaluating the

population's null hypothesis. At 5%, P-close is said to be statistically insignificant (Hair et al., 2010).

CFI produced an estimate of 0.941, which was larger than 0.90; 0.910 for GFI; 0.049 and 0.056 were estimated values for RMR and RMSEA accordingly, both less than 0.08. TLI was 0.932, which was greater than 0.9; 2.204 was CMIN / DF (> 3); and 0.083 was P-Close, which was greater than 0.05 and indicates that p-close was significant (Hair et al., 2010). As a result, all the thresholds for the overall fitness of the model were met, as shown in Table 6.

Table 6: Confirmatory Factor Analysis

Model Fit Indices: *CMIN = 403.303; DF = 183; CMIN/DF = 2.204; CFI = .941; TLI = .932; RMR = .049; RMSEA = .056; PClose = .083; GFI=.910; AGFI=.886*	**Std. Factor Loading**
STUDENTS ATTITUDE TOWARDS MATHEMATICS(SATM): CA=0.892; CR=0.891; AVE=0.542	
(SATM1): Mathematics is a subject I enjoy learning	0.83
(SATM2): Mathematics is one of my favorite subjects	0.84
(SATM3): I usually wish to study mathematics	0.71
(SATM4): I like solving mathematics problems	0.70
(SATM5): For me, mathematics is not difficult than any other subjects	0.71
(SATM7): I usually look forward to mathematics lessons	0.63
(SATM8): Mathematics is one of my strengths	0.71
MATHEMATICS PERFORMANCE (MP): CA=0.878; CR=0.879; AVE=0.549	
(MP5): Learning mathematics improves my decision-making ability	0.72
(MP6): Learning mathematics improves my thinking ability	0.73
(MP7): Learning mathematics strengthens my analytical ability	0.81
(MP8): Learning mathematics enhances my knowledge in profession and concepts	0.73
(MP9): Learning mathematics improves my problem-solving ability	0.73
(MP10): I have adequate background for mathematical concepts I have studied	0.72
MATHEMATICS SELF-EFFICACY (MS): CA=0.834; CR=0.836; AVE=0.506	
(MS2): I believe I can score very well in mathematics task	0.68
(MS3): I am confident that I can complete an assigned mathematical task	0.70
(MS4): I am sure I can learn important mathematical concepts taught by my mathematics teacher	0.74
(MS5): I believe I can understand the most difficult concepts in mathematics	0.65
(MS7): Even though mathematics is difficult, I believe I can do very well	0.78
CLASSROOM CLIMATE (CC): CA=0.757; CR=0.761; AVE=0.517	
(CC1): My mathematics teacher shows interest in my mathematics learning	0.76
(CC2): My mathematics teacher treats me fairly in class	0.75
(CC8): My teacher gives students opportunity to express their opinions during mathematics lessons	0.64

$AVE = \frac{\sum \lambda^2}{n}$, $CR = \frac{(\sum \lambda)^2}{[(\sum \lambda)^2 + \sum(1-\lambda^2)]}$, $\lambda \sim Factor\ Loadings$

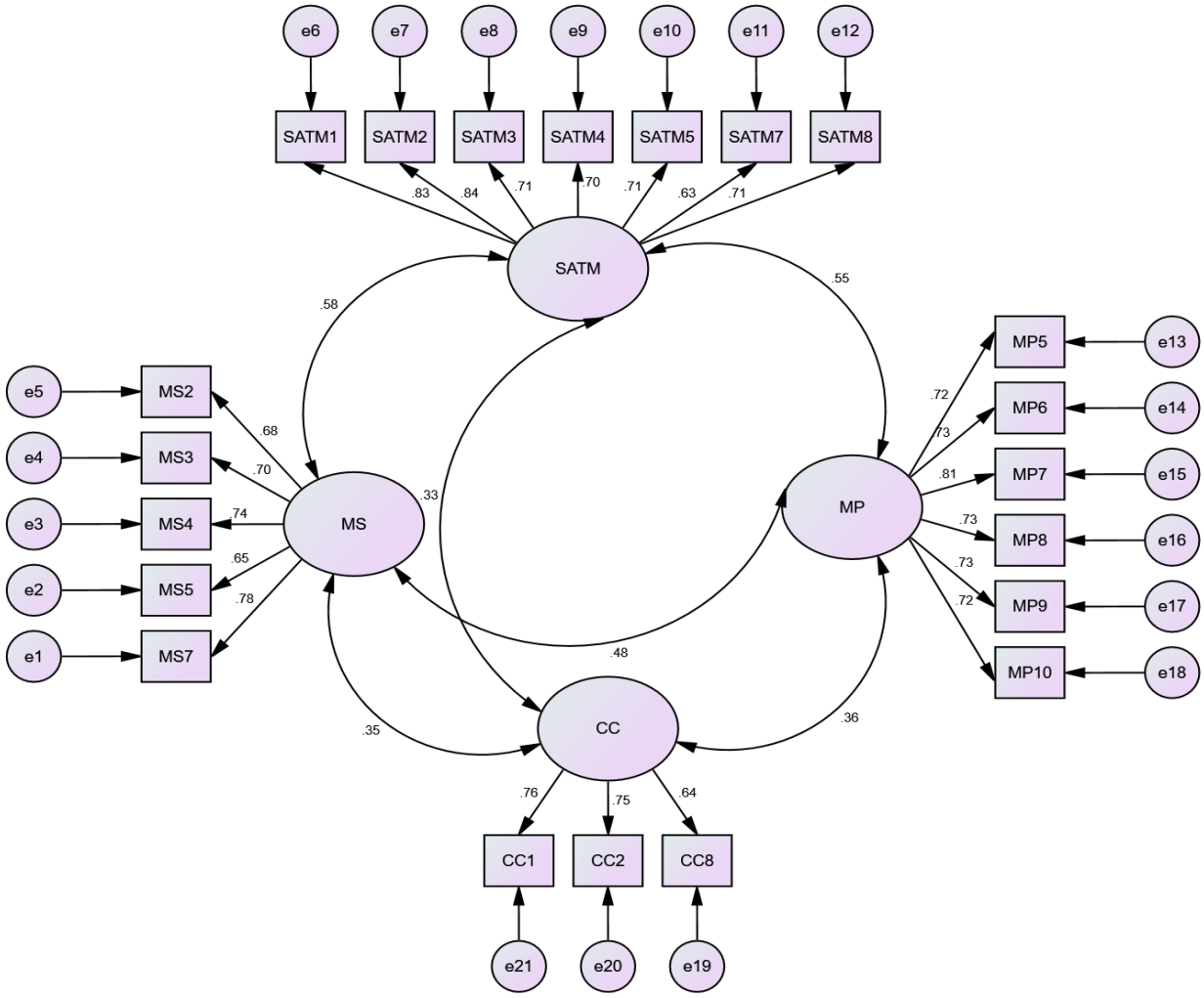

Figure 2*: Diagrammatic Presentation of Confirmatory Factor Analysis*
Source: Field Survey (2023)

4.1.8 Convergent Validity

The degree to which observed variables on the same construct associate with one another is called convergent validity, according to (Trochim & Donnelly, 2001). Average Variance Extracted (AVE) and Composite Reliability (CR) were determined using the factor loadings from CFA to investigate the observed variables convergent validity. To attain convergent

validity, Fornell and Larcker (1981) proposed AVE and Composite Reliability (CR) scores of not less than 0.5 and 0.7, respectively. According to the reported data in Table 6, the lowest AVE was 0.506 (Mathematics Self-Efficacy), and the lowest CR was 0.761 (Classroom Climate), showing that this study attained convergent validity.

4.1.9 Discriminant Validity

Other ways for measuring discriminant validity exist; however, this study compared the square root of the Average Variance Extracted from the observed variables of each construct to the correlation coefficients between the constructs, the same way Bamfo et al. (2018) did. Trochim and Donnelly (2001) define discriminant validity as the extent to which observed variables are unrelated to observed variables in different constructs. Arthur et al. (2021) suggested that discriminant validity is attained when the greatest coefficient of correlation between the constructs is less than the smallest √AVE. 0.711 was the minimum √AVE, and 0.58 was the greatest coefficient between the constructs, according to the results presented in table seven. As a result, discriminant validity was attained on the dataset.

Table 7: Discriminant Validity

Variables	MS	SATM	CC	MP
MS	**0.711**			
SATM	0.58**	**0.736**		
CC	0.35**	0.33**	**0.719**	
MP	0.48**	0.55**	0.36**	**0.741**

** *~ P-value significant at 1% (0.01)*
√AVE are bold and underlined
Source: Field Data (2023)

4.1.10 Path Estimates

Path estimates are the estimated coefficients in a hypothesized model which quantify the relationships between the main variables. The direction as well as the strength of the causal or predictive paths between variables in the model are indicated by these estimates.

Path estimates can be read as regression coefficients, reflecting a variation in the dependent variable that corresponds to a unit variation in the independent variable, which confirms previous studies by other researchers.

To investigate every possible path presented in the study, Amos (version 23) was utilized to perform structural equation modeling. The structural model satisfied the different fit indicators presented by Hair et al. (2010), as displayed in Table 8.

4.1.11 Analysis of Direct Effects

What is the impact of student's mathematics self-efficacy on students' mathematics performance?

The first question was to determine the impact of students' mathematics self-efficacy on students' mathematics performance. Result from the hypothesized path of the direct effect analysis (MS→MP) shown that mathematics self-efficacy had a direct positive influence on mathematics performance ($\beta = 0.201$; C.R. /t = 2.975) as an indicator with a p-value < 0.01. The p-value for the impact was significant at 1% statistically, with p-value = 0.003. The finding suggested that when learner's efficacy in mathematics is high, their mathematics performance improves by roughly 20%. The result is shown in table 8.

What is the effect of classroom climate on students' mathematics performance?

The second question looked at the relationship between the classroom climate and students' mathematics performance. Direct effect analysis (CC→MP) discovered that classroom climate had a direct positive effect on students' mathematics performance (β =0.188; C.R. /t =2.677). The p-value was 0.007, which indicated significant at 1%. Finding indicated that, when classroom climate is conducive for teaching and learning, it improves students' mathematics performance by about 19%. The finding is shown in table 8.

Table 8: Direct Path Estimates

Direct Paths	UnStd. Estimate	C.R./t	S.E.	p-value
MS → MP	0.20	2.975	0.068	0.003***
CC → MP	0.188	2.677	0.070	0.007***
SATM → MP	0.239	5.527	0.043	***
Model Fit Indices: ***CMIN = 403.303; DF = 183; CMIN/DF = 2.204; CFI = .941; TLI = .932; RMR = .049; RMSEA = .056; PClose = .083***				

*** ~ *P-value significant at 1% (0.01)*

Source: Field Data (2023)

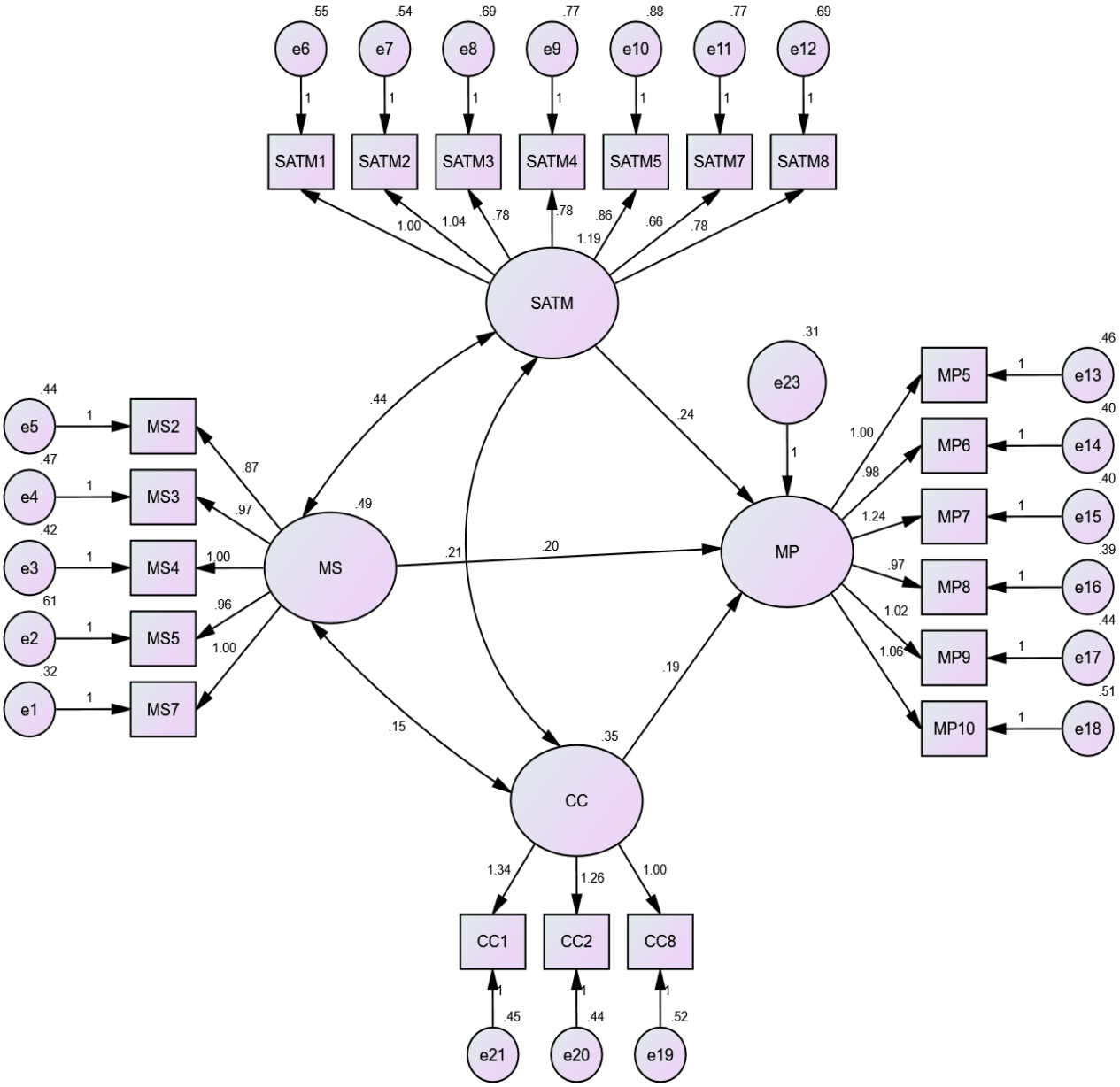

Figure 3*: Diagrammatic Presentation of Direct Paths*
Source: Field Data (2023)

4.1.12 Mediation Effects Analysis

What is the mediating effect of student attitude toward mathematics between student's mathematics self-efficacy and students' mathematics performance?

The last research question sought to identify the mediating effect of students' attitudes toward mathematics between students' mathematics self-efficacy and mathematics performance. Structural Equation Modelling (SEM) was employed to measure the various paths proposed in the study. The structural model fulfilled all-indices Hair et al. (2010) reported. The estimated coefficient for the indirect effect (MS → SATM → MP) was 0.230 ($a \times b = 0.928 \times 0.248$). To check for the significance of the indirect effect, a 95% confidence interval as well as Bias-Corrected (BC) percentile method with bootstrap samples of 5,000 was employed. The coefficient of the indirect effect was statistically significant (both the upper and lower BCs were positive). It indicates that the confidence interval did not cross zero (0.149, 0.345). The results showed that student's attitude towards mathematics partially mediated the relationship between students' math self-efficacy and math performance, since math self- efficacy had a direct positive impact on math performance in the presence of the mediator ($\beta = 0.242, p < 0.01$)

Table 9: Mediating Effect

			95% Confidence Interval		
Relationship	**Direct Effect**	**Indirect Effect**	**Lower BC**	**Upper BC**	**P-value**
MS→SATM→MP	0.242***	0.230	0.149	0.345	***

Model Fit Indices: ***CMIN=282.855; DF=131; CMIN/DF=2.159; CFI=.955; TLI=.947; RMR=.048; RMSEA=.055; PClose=.163***

Bias-corrected (BC) percentile method; 5,000 Bootstrap samples; 95% Confidence level
**** ~ p-value significant at 1% (0.01)*
Source: Field Data (2023)

Figure 4*: Diagrammatic Presentation of Direct Paths*
Source: Field Data (2023)

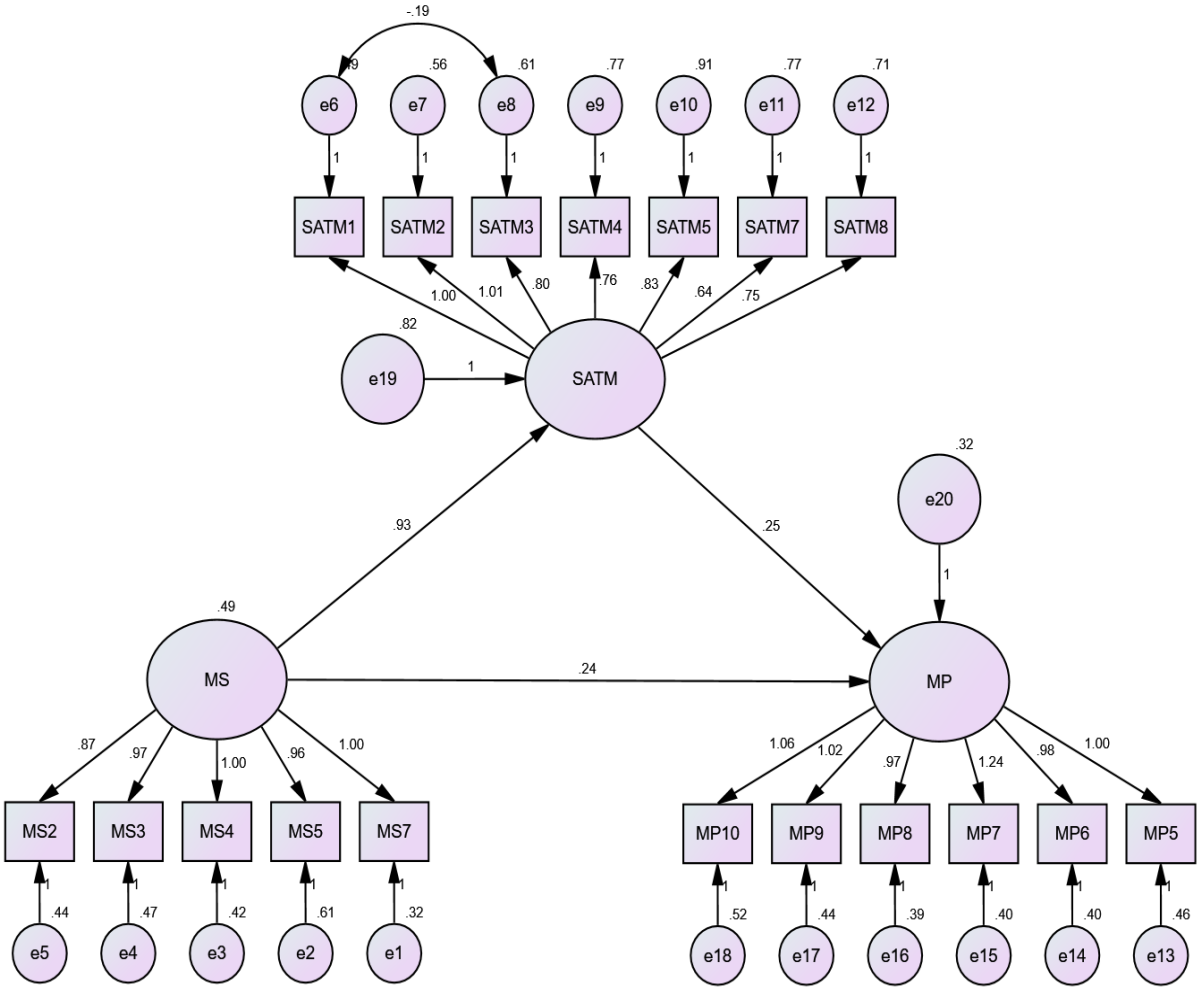

Figure 4*: Diagram of Mediation Effects*
Source: Field Data (2023)

4.2 Presentations and Discussion of Results

This section provides discussion of the research findings in light of past studies. The discussion was presented under the study's objectives as follows:

1. The impact of student's mathematics self-efficacy on students' mathematics performance.

2. The effect of classroom climate on students' mathematics performance.
3. The mediating effect of student's attitude towards mathematics between student's mathematics self-efficacy and students' mathematics performance.

4.2.1 Impact of Students Mathematics Self-efficacy on Mathematics Performance.

The connection between learners' math self-efficacy and their performance has been the subject of several empirical studies. Majority of these studies had found a positive and significant impact of mathematics self-efficacy on academic performance, suggesting that learners with greater sense of efficacy outperform in the discipline. These results align with the findings of this study and that of present studies. For instance, studies such as Kamsurya et al. (2022) and Muhtadi, Assagaf, and Hukom (2022) conducted meta-analyses and discovered that self-efficacy positively and significantly correlate with students' mathematical abilities and learning abilities, respectively. These findings were supported by other studies such as Arifin, Wahyudin, and Herman (2021), which investigated the association between learners' self-efficacy and mathematical comprehension and observed that students' mathematical self-efficacy was positively associated with and had substantial effect on students' mathematical comprehension and further noticed that students' mathematical efficacy may be the most reliable indication of future accomplishment. Odiri (2020) found a substantial positive association between learner's mathematics efficacy and performance. Also, Okafor-Agbala and Okigbo (2021) investigated the relationship between self-efficacy and secondary school two (SS2) students' academic performance in mathematics, and the findings revealed a moderately positive relationship between mathematics self-efficacy and students' performance. Ugwuanyi, Okeke, and Ageda (2020) highlighted a significant positive connection between self-efficacy, motivation, and

learner achievement, suggesting that beyond just mathematics, achievement in academic is greatly influenced by self-efficacy. Grigg et al. (2018) investigated the association between mathematics interest, self-efficacy, aspirations, and academic achievement of learners' using an integrated approach and observed positive relationship between learners' self-efficacy and mathematics performance. Similarly, Ugwuanyi, Okeke, and Asomugha (2020) studied how self-efficacy, self-esteem, and emotional intelligence influence learners' mathematics academic performance in Nigeria and discovered substantial positive effects between self-efficacy, self-esteem, and emotional intelligence and mathematics performance. Furthermore, Ozkal (2019) researched high school students self-efficacy beliefs, disaffection, and engagement in mathematics lessons, as well as their academic performance concerning mathematics learning, and the findings revealed academic performance being positively and substantially predicted by the learner's mathematical efficacy beliefs. Hiller et al. (2022) looked at mathematics self-efficacy and anxiety as determinants of literacy in mathematics, and the results indicated a significant positive connection among self-efficacy, anxiety and academic performance, with both self-efficacy and anxiety explaining 34% of the variation in mathematics performance. Nisa and Arliani (2023) likewise conducted a study on the impact of learners' self-efficacy on mathematical literacy in junior secondary schools and discovered a substantial relationship between them. Investigating the association between self-efficacy, classroom climate, and mathematics performance, Peters (2013) discovered learners with greater mathematical self-efficacy performing greatly in the subject, which lends credence to the positive and significant relation between self-efficacy and mathematics performance. Zakariya et al. (2022) analyzed the association among self-efficacy, attitude towards mathematics, previous knowledge, and

learners' academic performance in mathematics, and according to the findings, self-efficacy and anticipated results were discovered to significantly impact learners' performance.

In addition, studies (Tossavainen, Rensaa, & Johansson, 2021; Bohrnstedt et al., 2020; Kaburi, 2019; Usher et al., 2019; Oyuga, Raburu, & Aloka, 2019; Nwaukwa, Onyemechara, & Ndubuisi, 2019; Hüseyin, Yıldız, & Mehmet, 2018; Osenweugwor, 2018; Hammed & Toyin, 2015; Bushra & Lubna, 2014; Akomolate et al., 2013) reported positive correlations between learners' self-efficacy and performance or mathematical understanding.

On the other hand, the findings contradict that of the following studies: Lamb (2019), who found no significant correlation between students' mathematics self-efficacy as well as academic achievement in mathematics, focused on the impacts of reflection and feedback. June and Eamoraphan (2019) researched the association of mathematics self-efficacy and attitudes toward mathematics with mathematics performance and noticed no significant connection between mathematics self-efficacy, mathematics attitude and mathematics performance. Tus (2020) examined secondary school learners' self-concept, self-efficacy, self-esteem, and academic achievement and discovered no substantial relationship between students' self-efficacy, self-concept, self-esteem, and performance. Similarly, a study by Tus (2019) on the influence of self-efficacy on high school students' academic performance observed no significant effect on the performance of learners by their self-efficacy. Baanu et al.'s (2016) study also discovered no substantial connection between the efficacy beliefs of learners' and their performance. Balami (2015) investigated the association between self-efficacy and the mathematics achievement of learners, and the study discovered no substantial association between them. Furthermore, Pendon's (2022) study among Filipino college students, revealed both substantial and adverse

connections between learners' efficacy and mathematical achievement, which contrasted majority of studies being reviewed.

4.2.2 Effect of Classroom Climate on Students Mathematics Performance.

The findings of the study indicated a direct positive impact of classroom climate on students' mathematics performance, which was statistically significant. This finding aligns that of Wang et al. (2020), who carried out meta-analysis on the effects of classroom atmosphere on students' achievement and psychological well-being. Their study found that entirely classroom atmosphere showed small to moderate favorable relationship with engagement, motivation, social competence and performance.

Ndidi and Effiong (2020) also explored the relationship between classroom setting and learners' mathematics achievement in Nigeria. The findings demonstrated that access to learning resources and the size of a class substantially impacted learners' mathematics achievement. Similarly, Malik and Rizvi (2018) investigated learners' views concerning classroom atmosphere and their mathematics performance at the high school level in Pakistan and noticed that certain dimensions of classroom climate "teacher support, involvement, focus on understanding, and personal relevance", to be specific, were strongly connected with learners' performance. Falsario, Muyong, and Nuevaespana (2014) found that the classroom atmosphere substantially impacted learners' academic achievement to some extent. A longitudinal study on classroom quality, learner engagement, and academic achievement in mathematics undertaken by Wang, Hofkens, and Ye (2020) discovered teacher-student interaction and peer interaction in the classroom setting to be positively and moderately connected with learners' academic performance. Similarly, Yin et al. (2020) found a significant and positive association between classroom

atmosphere and learners' mathematics performance. Also, Tosto et al. (2016) looked at the relationship between classroom atmosphere and mathematics performance, taking the mediating effects of course interest and individual-perceived ability into consideration and noticed insignificant influence of classroom climate on learners' performance. Murugan and Rajoo (2013) explored the perceptions of students on classroom climate and mathematics performance in Malaysia, the analysis revealed significant and weak relationships between classroom atmosphere and mathematics performance. Ahmed et al. (2018) observed a positive connection between the learning setting and the academic achievement of learners. Samrat (2015) discovered that classroom climate moderately influence learners' performance in his study on classroom climate and academic performance of higher secondary students.

On the other hand, some studies presented inconsistent findings. For example, Ranđelović and Dimić (2019) examined the relationship between specific dimensions of classroom atmosphere and learning achievement, but their results did not reveal a statistically substantial relationship. Akanbi (2014) also found no significant relationship between the assessments of classroom atmosphere and learners' achievement among female learners in Nigeria. Barksdale, Peters, and Corrales (2021) undertook a mixed-method study, and while quantitative analysis did not find an association between classroom atmosphere and the academic performance of learners, qualitative analysis highlighted the importance of building relationships, providing resources, establishing guidelines, and promoting accountability in influencing student learning. Furthermore, Gentova and Madrigal (2020) discovered no significant association between classroom atmosphere and academic performance among Philippine junior high school pupils. Peters (2013) studied the connection between self-efficacy, classroom climate, and mathematics performance of

undergraduate students' and noticed no substantial connection between classroom climate and mathematics performance

4.2.3 Mediation Effect of Students Attitude Towards Mathematics between Mathematics Self-efficacy and Mathematics Performance.

The indirect effect of mathematics self-efficacy on mathematics performance through students' attitudes towards mathematics was explored. Findings revealed a direct beneficial effect between self-efficacy in mathematics and performance, and in addition a partially mediated impact via students' attitudes toward mathematics. The mediation effect had a significant coefficient, indicating that students' attitudes toward mathematics are instrumental in mediating the impacts of self-efficacy on performance.

The results of this study correspond with earlier researches which have explored students' attitudes towards mathematics and mathematics performance. Colomeischi and Colomeischi (2015) discovered, for example, that learners who had high self-efficacy and good emotional intelligence developed positive mathematics learning attitude, which resulted in improved academic performance. Chen, Lee, and Hsu (2015) also noticed that learners who showed a stronger sense of efficacy exhibited good learning attitudes, leading to better performance in pattern reasoning.

Similarly, Özdemir, Karaşan, and Şahal (2021) reported a substantial positive association between students' judgments of self-efficacy and mathematics attitudes. The findings suggest that when students have belief in their abilities and a positive perception of mathematics, their attitudes towards the subject are more favorable, leading to better performance.

Several other studies also support the mediation of attitudes. Hwang and Son (2021) found that students who believed in positive outcomes, had confidence in their abilities, and enjoyed studying mathematics were more likely to achieve higher levels of performance. Kartowagiran and Manaf (2021) observed a positive influence of student attitudes on mathematical learning success, while Olonade et al. (2022) reported a significant positive impact of attitudes on high school learners' mathematics performance. These findings were realized due to the fact that learners had confidence in themselves and in the study of the subject, which led to positive attitude and high performance. de la Hera et al. (2023) examined the relationship between learners' mathematics attitude, self-efficacy, anxiety, and mathematics achievement and observed positive association between self-efficacy and attitude towards mathematics which impacted positively learners' mathematics performance. Also, Živković et al. (2023) explored the effect of mathematics enjoyment, anxiety, and self-efficacy on mathematics achievement and discovered a positive and significant relationship between mathematics self-efficacy, enjoyment, and academic performance, indicating that learners with high efficacy enjoy the study of mathematics, which is translated positively to their performance.

Wen and Dubé (2022) conducted a systematic review that revealed positive relationships between various subdimensions of attitude, such as confidence, behavioral intentions, motivation, enjoyment, perceived value, and academic achievement in mathematics. This suggests that learners with high confidence tend to have high goals, value themselves and the subject of study, and are motivated towards the study of mathematics, which leads to higher academic success. Likewise, Peteros et al. (2019) found that students with self-confidence value, enjoy, and feel motivated toward the study of mathematics, which were positively related to academic performance. Furthermore, Recber, Isiksal, and Koç (2018) investigated self-efficacy,

attitude, anxiety, and mathematics performance concerning school type and sex and observed that students' self-efficacy and attitude positively and substantially predicted learners' performance, which implies that learners with higher self-efficacy usually have a positive attitude towards mathematics, which consequently leads to higher academic performance.

CHAPTER FIVE

SUMMARY OF FINDINGS, CONCLUSIONS AND RECOMMENDATIONS

5.0 Overview

This section is concerned with the summary, conclusion, and recommendation of the findings of the study.

5.1 Summary of the Study

The study explored the interplay between students' mathematics self-efficacy, the classroom climate, and students' attitudes towards mathematics, examining their collective influence on students' academic performance in mathematics. Atwima Nwabiagya Municipality in the Ashanti region of Ghana was the area for the study, and a descriptive survey design was utilized as the study's design. The participants were from Nkawie Senior High Technical School and Toase Senior High School, which had a combined enrollment of 8,619 students offering visual arts, home economics, technical, general science, agric. science, business, and general arts.

The study included 382 respondents. For data collection, the study made use of a structured questionnaire which were adapted from previous studies, and was scaled based on the study's variables, which included students' mathematics self-efficacy, students' attitude toward mathematics, classroom climate, and mathematics performance. Amos (v. 23) Structural Equation Model (SEM) was used for data analysis. The study first undertook preliminary analysis, which included descriptive statistics, test of normality, exploratory factor analysis, reliability analysis, convergent and discriminant validity, and confirmatory factor analysis, to determine the fitness of the model for data analysis. The main analysis consisted of direct path effect and indirect effect analysis.

5.2 Major Findings

The study discovered the following findings based on data analysis:

1. The direct impact of student's mathematics self-efficacy on mathematics performance was positive and significant.
2. The direct effect of classroom climate on mathematics performance was revealed as positive and significant.
3. The mediating effect of student's attitude toward mathematics on student's mathematics self-efficacy and performance was significant with partial mediation.

5.2 Conclusions

The study explored the interplay between students' mathematics self-efficacy, the classroom climate, and students' attitudes towards mathematics, examining their collective influence on students' academic performance in mathematics in senior high school in Ghana. The study concluded that students' mathematics self-efficacy had a significant positive impact on mathematics performance, indicating that students with higher mathematics self-efficacy tend to perform higher in mathematics than their colleagues with lower self-efficacy. The study also revealed that classroom climate had a significant positive effect on students' mathematics performance, which signifies that a classroom atmosphere conducive to teaching and learning creates a platform for learners to perform well in the subject of mathematics. Finally, the relationship between students' mathematics self-efficacy and mathematics performance was partially mediated by students' attitudes towards mathematics. Therefore, attitude toward the study of mathematics plays an important role in mediating the relationship between self-efficacy and learners' mathematics performance.

5.3 Recommendations

Based on the findings, the study pointed out the recommendations below:

1. Mathematics self-efficacy is extremely important to students' mathematics learning. It is an emotional aspect, and once low efficacy belief is developed, the amount of effort a teacher will put in to help learners understand mathematical concepts will not yield results. Therefore, mathematics instructors should encourage learners to appreciate the study of mathematics and avoid using derogatory comments for wrong answers in mathematics class.
2. Ghana Education Service should appoint well-trained and well-equipped mathematics teachers at the basic level because they comprehend mathematical concepts better and would naturally foster interest and high efficacy in learners right from the basic level. If high efficacy and interest are developed at the basic level, it will result in a higher number of learners pursuing mathematics and its related courses at the higher level of education since the foundation would be strong.
3. The Ghana Education Service should ensure that adequate teaching and learning materials are provided in every classroom at all levels of education to facilitate teaching and learning. Teaching and learning materials form an integral part of learners understanding of mathematical concepts and should be easily accessible in mathematics classrooms.
4. Classroom atmosphere is critical to learners' performance; consequently, the Government of Ghana should put measures in place to eradicate schools under trees and provide enough desks to all schools with inadequate desks because these impair learners' peace of mind.

5. Most learners regard mathematics as abstract, boring, and a subject of formulas; therefore, mathematics instructors should relate mathematics to real-life situations in order to help learners develop positive attitude towards mathematics.

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APPENDIX A

QUESTIONNAIRE

A survey information on "the impact of student's mathematics self-efficacy, classroom climate and students' attitude towards mathematics on students' performance".

Dear participant, this survey is purely for academic purposes only. Your response will be treated with extreme confidentiality.

Background Information

Please tick [√] where appropriate.

1. Gender: Male [ ] Female [ ]
2. Age: 11-15 [ ] 16-20 [ ] 21-25 [ ] Above 25 [ ]
3. Course: General science [ ] Business [ ] General arts [ ]
   Visual arts [ ] Technical [ ] Home science [ ] Agric. Science [ ]
4. Which form are you? Form 1 [ ] Form 2 [ ] Form 3 [ ]

Please rank the following statements to indicate the extent to which you agree or disagree on Mathematics Self-efficacy

Key**: SD=Strongly disagree; D=Disagree; N=Neutral; A= Agree; SA=Strongly agree**

SN	Mathematics self-efficacy	SD	D	N	A	SA
1	I am motivated to solve difficult mathematics problem					
2	I believe I can score very well in mathematics task					
3	I am confident that I can complete an assigned task					
4	I am sure I can learn important mathematics concepts taught by my mathematics teacher					
5	I believe I can understand the most difficult concepts in mathematics					
6	I am able to use different strategies to complete mathematical tasks					
7	Even though mathematics is difficult, I believe I can do very well					

8	I am confident about my mathematical skills					
9	I communicate with friends to find the best solution of a mathematical problem at hand					
10	I can use examples or similar problems to solve mathematics problem					

Please rank the following statements to indicate the extent to which you agree or disagree on Attitude Towards Mathematics

SN	Students attitude towards mathematics	SD	D	N	A	SA
1	Mathematics is a subject I enjoy learning					
2	Mathematics is one of my favorite subjects					
3	I usually wish to study mathematics					
4	I like solving mathematics problems					
5	For me, mathematics is not difficult than any other subject					
6	Mathematics makes me confuse					
7	I usually look forward to mathematics lessons					
8	Mathematics is one of my strengths					
9	I need mathematics to learn other school subjects					
10	I think learning mathematics will help me in my daily life					

Please rank the following statements to indicate the extent to which you agree or disagree on Classroom climate

SN	Classroom climate	SD	D	N	A	SA
1	My mathematics teacher shows interest in my mathematics learning					
2	My mathematics teacher treats me fairly in class					
3	Enough desks and teaching materials are provided in my classroom for effective teaching and learning					
4	The layout of the classroom creates a safe environment for students during teaching and learning					
5	My peers support me in the classroom in appropriate ways					
6	I feel comfortable asking for help from my peers					
7	My mathematics teacher has clear and consistent sanctions for students who misbehave or do not follow classroom rules					
8	My teacher gives students opportunity to express their opinions during mathematics lessons					

9	My mathematics teacher gives extra help when I need it					
10	I often have a chance to discuss materials with my peers					

Please rank the following statements to indicate the extent to which you agree or disagree on Mathematics Performance

SN	Mathematics Performance	SD	D	N	A	SA
1	I perform well in mathematics examination					
2	I make contributions and answer questions in mathematics class					
3	I participate actively in mathematics group studies					
4	I am able to study and understand mathematical concepts on my own					
5	Learning mathematics improves my decision-making ability					
6	Learning mathematics improves my thinking ability					
7	Learning mathematics strengthens my analytical ability					
8	Learning mathematics enhances my knowledge in profession and concepts					
9	Learning mathematics improves my problem-solving ability					
10	I have adequate background for mathematical concepts I have studied					

APPENDIX B

Statistics

		Gender	Age	Course	Form
N	Valid	382	382	382	382
	Missing	0	0	0	0

Gender

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Male	194	50.8	50.8	50.8
	Female	188	49.2	49.2	100.0
	Total	382	100.0	100.0	

Age

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	11-15	15	3.9	3.9	3.9
	16-20	366	95.8	95.8	99.7
	21-25	1	.3	.3	100.0
	Total	382	100.0	100.0	

Course

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	General Science	55	14.4	14.4	14.4
	Business	40	10.5	10.5	24.9
	General Arts	88	23.0	23.0	47.9
	Visual Arts	48	12.6	12.6	60.5
	Technical	56	14.7	14.7	75.1
	Home Science	60	15.7	15.7	90.8
	Agric. Science	35	9.2	9.2	100.0
	Total	382	100.0	100.0	

Form

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Form 1	99	25.9	25.9	25.9
	Form 2	157	41.1	41.1	67.0
	Form 3	126	33.0	33.0	100.0
	Total	382	100.0	100.0	

KMO and Bartlett's Test

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.903
Bartlett's Test of Sphericity	Approx. Chi-Square	3838.904
	Df	210
	Sig.	.000

Total Variance Explained

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	7.496	35.694	35.694	7.496	35.694	35.694	4.241	20.193	20.193
2	2.155	10.263	45.957	2.155	10.263	45.957	3.769	17.948	38.142
3	1.865	8.879	54.836	1.865	8.879	54.836	3.050	14.524	52.666
4	1.634	7.780	62.617	1.634	7.780	62.617	2.090	9.951	62.617
5	.792	3.773	66.390						
6	.748	3.561	69.950						
7	.652	3.103	73.053						
8	.589	2.804	75.858						
9	.558	2.655	78.513						
10	.527	2.508	81.021						
11	.513	2.444	83.465						
12	.454	2.160	85.626						
13	.429	2.045	87.671						
14	.398	1.896	89.567						
15	.389	1.852	91.419						
16	.360	1.715	93.134						
17	.345	1.644	94.778						
18	.313	1.491	96.268						
19	.305	1.452	97.721						
20	.269	1.282	99.003						
21	.209	.997	100.000						

Extraction Method: Principal Component Analysis.

Rotated Component Matrix[a]

	Component			
	1	2	3	4
SATM2	.804			
SATM1	.755			
SATM8	.732			
SATM3	.718			
SATM7	.710			
SATM4	.707			
SATM5	.704			
MP7		.795		
MP8		.788		
MP9		.733		
MP10		.731		
MP6		.730		
MP5		.717		
MS7			.779	
MS3			.773	
MS5			.743	
MS4			.692	
MS2			.665	
CC1				.818
CC2				.818
CC8				.755

Extraction Method: Principal Component Analysis.

Rotation Method: Varimax with Kaiser Normalization.[a]

a. Rotation converged in 6 iterations.

Students Attitude Towards Mathematics

Reliability Statistics

Cronbach's Alpha	N of Items
.892	7

Classroom Climate

Reliability Statistics

Cronbach's Alpha	N of Items
.757	3

Mathematics Performance

Reliability Statistics

Cronbach's Alpha	N of Items
.878	6

Mathematics Self-efficacy

Reliability Statistics

Cronbach's Alpha	N of Items
.834	5