UNIVERSITY OF CAPE COAST

INFLUENCE OF TEACHING APPROACHES ON SENIOR HIGH SCHOOL STUDENTS' MATHEMATICAL MINDSET AND THEIR ACHIEVEMENT IN CORE MATHEMATICS

BRIGHT ASANTE BRITWUM

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BY

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Thesis submitted to the Department of Mathematics and I.C.T Education Psychology of the Faculty of Science and Technology Education, College of Education Studies, University of Cape Coast, in partial fulfilment of the requirements for the award of Master of Philosophy degree in Mathematics Education

JUNE 2022

DECLARATION

Candidate's Declaration

I hereby declare that this thesis is the result of my own original research and that no part of it has been presented for another degree at this university or elsewhere.

Candidate's Signature……..…… Date……

Name: ……..……..……

Supervisors' Declaration

I hereby declare that the preparation and presentation of the thesis were supervised in accordance with the guidelines on supervision of thesis laid down by the University of Cape Coast.

Supervisor's Signature ……..… Date ……

Name: ……..……..……

ABSTRACT

The study examined the influence of teaching approaches on students' mathematical mindsets and their achievement in Core Mathematics among public Senior High Schools in the Kumasi Metropolis of the Ashanti Region. A co-relational ex post facto research design was used for this study. A total sample of 384 respondents was involved in this study. Two sets of questionnaires were employed for the study. Students' and teachers' perceptions of teaching approaches and mathematical mindset questionnaires were used for this study. In addition, students' achievement scores for Core Mathematics were also used for this study. The data for this study was analysed by using mean, standard deviation, frequencies, and multiple regression analysis. The results revealed possible influences between the teaching approaches and students' mathematical mindsets. That is, students taught with a more student-centred approach were found to generally possess a growth mindset while those identified to possess a more fixed mindset were mostly students taught using a more teacher-centred approach. Also, a significant relationship was found between students' mathematical mindsets and their academic achievement in learning Core Mathematics among some of the schools. The study recommends that teachers should adopt the student-centred approach to teaching since it has the potential to shape students' learning towards a strong growth mindset.

KEY WORDS

Achievement

Mathematical mindset

Perception

Senior High Schools

Teaching approaches

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DEDICATION

To my family: Kate Britwum, Francis Britwum, Isaac Kwabena Britwum, Nana Agyei Britwum, and Kwadwo Akuoko Britwum

TABLE OF CONTENTS

DECLARATION ii

ABSTRACT iii

KEY WORDS iv

ACKNOWLEDGMENTS v

DEDICATION vi

TABLE OF CONTENTS vii

LIST OF TABLES xi

LIST OF FIGURES xiii

CHAPTER ONE: INTRODUCTION 1

Background to the Study 1

Statement of the Problem 7

Purpose of the Study 12

Objectives 12

Research Questions 12

Hypothesis 13

Significance of the Study 13

Delimitation 13

Limitations 14

Organisation of the Study 14

CHAPTER TWO: LITERATURE REVIEW 16

Overview 16

Theoretical Framework 16

Implicit Theory of Intelligence 17

The fixed mindset or an entity theory of intelligence 18

The growth mindset or an incremental theory of intelligence 19

Teaching Approaches 21

Student-centred approach 24

Teacher-centred approach 25

Students' Perception of Teachers' Teaching Approaches 27

Students' Mindset 30

Empirical Review 35

Perception of teaching approaches 35

Students' Mathematical Mindsets and their Achievement towards the Learning of Core Mathematics 36

Chapter Summary 38

CHAPTER THREE: RESEARCH METHODS 40

Overview 40

Research Design 40

Population 43

Sampling Procedures 45

Data Collection Instruments 47

Data Collection Procedures 53

Data Processing and Analysis 54

Chapter Summary 56

CHAPTER FOUR: RESULTS AND DISCUSSION 57

Overview 57

Background Characteristics of Senior High School Form Two Students 57

Background Characteristics of Senior High School Core Mathematics Teachers 58

Research Question One 60

Research Question Two 67

Research Question Three 76

Hypothesis One 82

Comparison of the Respective Schools 94

Chapter Summary 96

CHAPTER FIVE: SUMMARY, CONCLUSIONS AND RECOMMENDATIONS 98

Overview 98

Summary 98

Conclusions 100

Recommendations 100

Suggestions for Further Research 101

REFERENCE 102

APPENDICES 124

LIST OF TABLES

Table		Page
1	Population of SHS 2 students in the selected schools	45
2	Population and sample of SHS 2 students and mathematics teachers in the selected schools	47
3	Sex of SHS 2 student	57
4	How often do students learn Core Mathematics on their own after lessons	58
5	Sex of SHS Mathematics Teachers	59
6	Academic qualification of SHS Core Mathematics Teachers	59
7	Teaching experience of respondents at the SHS level	60
8	Teachers' perceptions of their Core Mathematics teaching approach	61
9	Students' perceptions of their Core Mathematics teacher's teaching approaches	68
10	Students' mathematical mindsets toward learning Core Mathematics for Group 1 schools	82
11	Students' mathematical mindsets toward learning Core Mathematics for Group 2 schools	83
12	Model summary and fit statistics of the relationship between sub-dimensions of student's mindset and their academic achievement	85
13	Coefficient of the prediction of student's mindset on academic achievement	86
14	Model summary and fit statistics of the relationship between sub-dimensions of student's mindset and their academic achievement	87

15 Coefficient of the prediction of student's mindset on academic achievement 87

16 Model summary and fit statistics of the relationship between sub-dimensions of student's mindset and their academic achievement 88

17 Coefficient of the prediction of student's mindset on academic achievement 89

18 Model summary and fit statistics of the relationship between sub-dimensions of student's mindset and their academic achievement 90

19 Coefficient of the prediction of student's mindset on academic achievement 90

20 Model summary and fit statistics of the relationship between sub-dimensions of student's mindset and their academic achievement 91

21 Coefficient of the prediction of student's mindset on academic achievement 92

22 Model summary and fit statistics of the relationship between sub-dimensions of student's mindset and their academic achievement 93

23 Coefficient of the prediction of student's mindset on academic achievement 93

LIST OF FIGURES

Figure		Page
1	Mindset of SHS students in Group 1	77
2	Mindset of SHS students in Group 2	79

CHAPTER ONE

INTRODUCTION

Background to the Study

Mathematics has always been one of the most fascinating disciplines in human lives. Mathematics is widely acknowledged as the foundation for technical and scientific progress which is applicable in other subjects like biology, engineering, geology, medicine, and physics (Roman, 2004; Wilmot & Otchey, 2012). Mathematics also forms an essential portion of industries, business, and social sciences. The significance of mathematics in our daily activities cannot be exaggerated. Mathematics is centred on a broad area but mainly comprises numbers and quantity, relationships and forms (Yadav, 2017). Nearly all facets of human life revolve around mathematics. Stressing on the significance of mathematics, mathematics is an important part of literacy that has an impact on students' academic performance as well as their future lives. Moreover, Kusmaryono (2014), emphasised that life deprived of mathematics is virtually not possible because living a regular life in other parts of the world would be difficult.

As established by Younn (2009), mathematics has become a precondition for educational access around the world; that is succeeding in mathematics has been one of the essential criteria for professional development and academic success in many fields. Mathematics tests, as an example, are used in Australia as a vital source for further education and future career paths, signalling the country's great importance to the subject (Collis, 1987). About the importance of mathematics, it becomes one of the key instruments fused into the curriculum. The mathematics

curriculum is planned, according to Ngussa and Mbuti (2017), to equip students with the necessary skills and experience required to succeed in the evolutional world of technology. Lawson (2003) acknowledges that mathematics educators and mathematicians around the world are expressing growing concern for teaching and studying mathematics in elementary and secondary institutions as mathematics is a mandatory study course for all students in several countries, from primary level to Senior High School. Mathematics is being recognised as an obligatory subject in some European countries like China and Russia (Marginson, Tytler, Freeman, & Roberts, 2013). Mazana, Montero, and Casmir (2019) also claimed that mathematics is among the main compulsory subjects for all elementary and secondary school students in Tanzania.

Similarly, in Nigeria, Sa'ad, Adamu, and Sadiq (2014) reported that emphasis is given to mathematics in the curriculum and all educational programmes from basic school levels to higher school levels. Mathematics also being a compulsory subject in Ghana starts right from the preschool to the college level. Mathematics is one of the subjects having the highest number of minutes (ten periods) of teaching per week in Ghana (National Council for Curriculum and Assessment [NaCCA], 2019). Clearly, this points out that in this modern world, students with a strong background in mathematics are well-equipped to fit into a variety of technological and scientific disciplines easily. Given this, mathematics is recognised as a fitting yardstick for evaluating student achievement (Bawuah, 2013). When a student fails in a mathematics paper at either the Junior High School or the Senior High School level, it denies the applicant advancement to the next

phase of the educational ladder (Ntow, 2009). As a consequence, Ghana's government and other educational partners have introduced various programmes to encourage the progressive instructional process of mathematics to make the subject exciting (Ampadu, 2012). This ignited the initiation of a revised mathematics curriculum in September 2010 in order to strengthen the educational system in terms of the teaching-learning process of mathematics.

As established by Clark (2009), most improvements in the design and quality of school mathematics curricula arose from evolving citizens' demands for successful engagement in the increasing technological environment and enhanced study information on learning and teaching. Another reason for the enrichment of the mathematics curriculum was the purpose of matching the industrial requirements or needs for various job positions in the country. The 2007 education reform in Ghana was focused on the demand for a system of education that focuses on the wants of the people, society, and the nation as a whole. Several foreign and local bodies or organisations have been involved in different activities at all stages to enhance mathematics teaching (Long, 2003). Annual seminars for mathematics teachers are conducted by the Mathematical Association of Ghana [MAG] to enlighten them on the significance of mathematics in the growth of the country's economy and to provide guidance on how to boost learning and teaching (Bawuah, 2013). Likewise, the Ministry of Education in Ghana, in cooperation with other foreign organizations such as the Department for International Development (DFID) and the United States Agency for International Development (USAID) showed a profound effort by undertaking mathematics and science programmes to

enhance the instructional process of mathematics at the primary, secondary institutions, training colleges, and tertiary level (Ampiah, Akwesi, Kutor, & Brown-Acquaye, 2000).

With all the attempts Ghana has made in providing students with a quality teaching-learning process in mathematics, from 2007 to 2020, there have been ups and downs in student performance in Core Mathematics. In the analysis of West African Senior School Certificate Examination (WASSCE) results based on the number of students who attained the grade of A1 to C6, there was a gradual improvement in Core Mathematics results from 2007 to 2012 (37.6%) excluding 2010 as WASSCE was not conducted that year. Then, there was a decline in the results from 2013 to 2015 (29.7%) which increased again in 2016 and 2017 (39.1%), the performance rate also declined in 2018 (38.3%), and had a final rise in 2019 and 2020 (65.51%) results. Recently, the 2021 WASSCE results displayed a decline in the result of Core Mathematics (54.11%). Following the trend in the past (2007-2020), it looks like the future is bleak because a number of 867,606 Senior High School students representing 49.1% attain the grade of A1 to C6 while 899,570 representing 50.9% also attained the grade of D7 to F9 (Abreh, Owusu, & Amedahe, 2018; WAEC, 2007-2020).

Specifically, in the Ashanti Region, the Educational Management Information Systems [EMIS] (2016) indicated that the performance of students in Core Mathematics was very low from 2012 to 2016 in the Kumasi Metropolis as matched to the other core subjects. Not only is the low performance of students in mathematics a challenge for certain countries, but over the years it has turned into

an international issue (Programme for International Student Assessment [PISA], 2003). From the above, one can see that if time is not taken to explore the problems concerning mathematics students, then the students' success may be devastating in the near future and that will not augur well for both personal and national growth.

Numerous researches have been undertaken lately that have established influences that are accountable for the impact on students' achievement in mathematics. Concerning the influence on students' achievement, (Clement, 2013; Hines, Cruickshank & Kennedy, 1985; Rice & Taylor, 2000), identified the methods of teaching, quality of teaching, home influences, school climate, characteristics of the pupils, teaching approach, and teaching strategies, as a major influence on students' achievement in mathematics. Similarly, students' families, the funding of the school's system, the methods of teaching, and students' mindsets have been identified by (Opara, Magnus-Arewa, & Nwaukwu, 2017; Zhang, Kuusisto, & Tirri, 2017) as the major problems affecting students' achievement in mathematics. Regarding achievement, Dweck (2000) emphasised that students' success is determined by their mindset. Also, according to Carroll, Houghton, Wood, Unsworth, Hattie, Gordon, and Bower (2009), students' academic journey, strength, perseverance, motivation, and efforts are influenced by the mindset they develop.

Dweck (2006) views mindset as a power that may affect the psychological component like thoughts, consciousness, attitudes, feelings, and others. Mindset was defined by Pyper (2018) as a style of thinking or arranging one's thoughts into a logical order. According to Boaler (2016), the mindsets that students acquire

regarding mathematics learning, mathematics intelligence, and their particular role as mathematics learners might determine whether or not they will be successful in mathematics. In particular, the effort one will require in partaking in a task, the failure, and the success of a student solely depend on the kind of mindset developed by the individual (Dweck, 2006). Students with a fixed mindset prove or demonstrate their intellect and see success as a test of talent and failure as an exposition of weakness. For people without natural skills, efforts are only needed from this point of view because those who are 'intelligent' in a field do not have to try it. In the face of problems, Dweck (2006) noted that people with fixed mindsets prefer to concede defeat, succumbing to lack of skill. Also, those with the growth mindset continue to face challenges but regard hard work as a pathway to achievement. People with the growth mindset learn by trying and failing at a task.

The perception students have about mathematics can be identified as the mental representation of ideas generally constructed through interactions with teachers and peers in the school (Mutodi & Ngirande, 2014). Although such perceptions are the creation of experiences that varies from student to student, the collective perceptions of students offer insight into the instructional process in the classroom (Black, 1996). The experience students gather from the teaching and learning process leads to the liking or disliking of mathematics. According to Campbell et al. (2001), students learning habit is influenced by the perceptions they have about mathematics. Ampadu (2012) also reported that how students perceive the approaches used in teaching provide the teachers with the necessary feedback

which helps them to make adjustment in the approaches they use in their instructional process.

As a result of the influence of teaching approaches on students' learning and their mindset toward mathematics, this present study seeks to examine the influence of teaching approaches on Senior High School (SHS) students' mathematical mindsets and their achievement.

Statement of the Problem

Studies and observations from reviewing bodies have shown that a high percentage of SHS students tend to underperform in mathematics examinations (Asamoah, 2018). This poor output continues to create much concern in the educational sector among parents, teachers, students, and other stakeholders. There are several studies at the SHS level that have sought to uncover the potential issues or obstacles around learning outcomes and teaching of mathematics. Research studies (Addae & Agyei, 2018; Etuk, Afangideh, & Uya, 2013; Dweck, 2006) have identified classroom management, communication skills, teaching methods, quality of instruction, home factors, and mindset as the prevailing issues or factors affecting students learning and achievement in mathematics. Furthermore, Dweck (2006) demonstrated that there exists a link between students' mindsets and learning mathematics, as the mindset developed by students affects their mathematics achievement (Su, Wan, He, & Dong, 2021).

Mathematical mindset has recently become pervasive in mathematics education as it has been discovered as having a significant influence on individual behaviours, goals, and beliefs as they learn. For instance, teaching approaches have

been discovered as a crucial component that influences the development of students' mindsets (Sun, 2018). Mostly, the mindset developed by students is the result of the various approaches used by mathematics teachers. In examining the data based on the relevant publications published between 1998 and 2017, it showed that mindset had an impact on most studies on academic success (Zhang, Kuusisto, & Tirri, 2017).

Studies that have been undertaken lately have also established influences that are responsible for the impact on students' learning in mathematics, and among these factors, teaching approaches used by teachers have been cited as a major factor impacting students' learning in mathematics (Beausaert, Segers & Wiltink, 2013; Grossman, Hammerness, & McDonald, 2009; Ireland, Watters, Lunn, Brownlee & Lupton, 2014). Normally, even though instructors feel they portray mathematics in an objective and context-based approach, but the manner in which mathematics is presented in the class and interpreted by instructors pushes students away from learning mathematics (Barton, 2000; Furinghetti & Pekhonen, 2002). Hence, it can be inferred from the foregoing discussions that students' learning in mathematics is greatly influenced by the teachers' teaching approaches.

About the types of teaching approaches, according to research, when students are taught using a student-centred approach, it has a positive influence on their learning (Polly, Margerison, & Piel, 2014). Similarly, students who learn by using the cooperative learning method reach greater levels of academic success, and comprehension of the content taught (Johnson & Johnson, 1999). Also, a study conducted by Emaliana (2017) established the fact that most students agree to the

use of the student-centred teaching approach (53%) at the tertiary school level in Indonesia as compared to the teacher-centred teaching approach (47%). In addition, a study conducted by Polly, Margerison, and Piel (2014) made it clear that the student-centred teaching approach was very instrumental in making kindergarten pupils understand the addition of numbers. Sharon (2008) also reported that students can be academically competitive when they receive positive feedback from instructors when a lecture method (teacher-centred approach) is used as an instructional process.

Chang (2003) compared two computer-assisted science teaching methods, finding that the teacher-centred approach was slightly more productive than the student-centred approach in terms of promoting science learning. Some studies conducted by researchers have yielded mixed results between teacher-centred approach and student-centred approach to teaching, for instance, Chung (2004) investigated students in the 3rd grade and discovered that the mean grades of students taught by each approach (student-centred and teacher-centred) were not significantly different.

In the Ghanaian context, the 2010 curriculum of Senior High School requires that teachers adopt the learner-centred approach to teaching but a research conducted by Ampadu (2012) at the Junior High School (JHS) level in Ghana on teachers indicated that teachers still make use of the teacher-centred teaching and learning approach as the 2007 and 2012 curriculum of the Junior High School is driven by a learner-centred approach of teaching. Also, a work conducted in Indonesia indicated that the reform in their 2013 curriculum was driven by a

student-centred approach but the research done in the investigation of teachers' teaching approaches indicates that teachers still adopt the teacher-centred approach (Kurniati & Surya, 2017).

The existing research on teaching approaches emphasises more on the self-reporting of teachers regarding their teaching approaches. Yarkwah (2020) indicated that teachers proclaim that they believe in constructivist beliefs or approaches but in actuality, they still practice the traditional approach of teaching and mastering mathematics. It is therefore important to assess the perceptions of students on their teachers' teaching approaches, rather than using self-reports from teachers' (Nijhuis, Segers, & Gijselaers, 2005; Struyven, Dochy, Janssens, & Gielen, 2006). It has proven to be accurate, objective, and one of the best means of evaluating the teacher's instructional activities by using ratings and feedback from students (Arthur, Tubre, Paul, & Edens, 2003; Cashin 1995; Centra, 1993).

Students' responses to their teachers' teaching approaches provide useful information about what teachers do since they are the only group that observes whatever happens in the mathematics classroom. In Ghana, Ampadu (2012) claimed that students are charged or tasked with assessing their teachers' instructions in most colleges of education and universities. But at the Senior High School and Junior High School level such an assessment process is not practiced, is only some specific schools that take it upon their selves in assessing their teaching staff. Maulana, Helms-Lorenz, and Van de Grift (2015) reported that assessing the perception of students on teaching and learning has been identified to be more predictive than other forms of assessing students learning outcomes.

Majority of studies concerning teachers teaching approaches have been conducted in the western world while in the Ghanaian context, a study conducted by Yarkwah (2020) in Cape Coast confirmed teachers' instructional practices as a major impact on the achievement of JHS students. In his work, he established the relationship between teachers' belief and practices regarding the academic achievement of students, and the instructional practices used in class was identified from the student's perspective. In addition, Ampadu (2012) reported that few studies have examined students' perception of teachers' teaching approaches in Senior High Schools and basic schools. Ampadu's work which was conducted on Cape Coast concentrated on the perception Junior High School students have on how teachers teach mathematics and how it impacts students learning but did not identify the extent to which these teaching approaches determine students' mathematical mindsets.

Among these works, little is known, if any, regarding the influence of teachers' teaching approaches on Senior High School year two students' mathematical mindsets in the Ghanaian settings. The situation in the Kumasi Metropolis by EMIS (2016) indicates that the performance of students in core mathematics has not been encouraging. From literature, the mindset students develop have a role to play in their performance because those who think they can learn hard gets to perform well as compared those who are not ready to learn. For that reason, the study seeks to find out the mindset students develop as a result of teaching approaches and its influence on their achievement in Core Mathematics in the Kumasi Metropolis of the Ashanti Region.

Purpose of the Study

This study aims to investigate the influence of teachers' teaching approaches on Senior High School (SHS) year two students' mathematical mindsets and their academic achievement in the learning of Core Mathematics from six selected Senior High Schools in the Kumasi Metropolis of the Ashanti Region of Ghana.

Objectives

i. To determine teachers' perceptions of their Core Mathematics teaching approaches.
ii. To determine students' perceptions of their Core Mathematics teachers' teaching approaches.
iii. To determine the mathematical mindset of students toward learning Core Mathematics.
iv. To examine the relationship, if any, that exists between students' mathematical mindsets and their academic achievement.

Research Questions

1. What are teachers' perceptions of their Core Mathematics teaching approaches?
2. What are students' perceptions of their Core Mathematics teachers' teaching approaches?
3. What are students' mathematical mindsets toward the learning of Core Mathematics?

Hypothesis

This null hypothesis was developed to guide the study.

1. H_o: There is no statistically significant relationship between students' mathematical mindsets and their academic achievement in Core Mathematics.

Significance of the Study

The study is assumed to be relevant to teachers in identifying the choice of approaches to teaching as the findings of the study unveil how teaching approaches affect the development of students' mathematical mindsets.

Also, the findings of the study would alert educational administrators and the departmental heads of the various schools on the types of approaches used by Core Mathematics teachers in their instructional process.

Lastly, the findings of this study would enrich the understanding of students' mindsets being growth and fixed and how differently these types of mindsets influence students' academic achievement in Core Mathematics.

Delimitation

Considering all Senior High School students in Ghana would have been laudable, but the research concentrated on only six Senior High Schools with regards to the approaches used by the teachers in these schools in the Kumasi Metropolis in the Ashanti region of Ghana due to limited time to write and present the report and financial constraints. The scope of this study concentrated only on all the public Senior High Schools, of which there were twenty-four (24) in the Kumasi Metropolis. Six schools were purposively selected based on the approaches

(student-centred and teacher-centred) used by the teachers in each selected school. Furthermore, the six selected Senior High Schools were delimited to only year two SHS students and teachers.

Limitations

The ability to generalise the findings of the study may be limited since the study was only done among some selected public Senior High Schools in the Kumasi Metropolis excluding private schools. This is due to the possibility of disparities in teacher qualifications and monitoring.

In the field of research, some schools were not willing to issue out students' end-of-term results (achievement) of Core Mathematics so the researcher had to go in for schools that were willing to give out students' results. These consequences delayed the process of collecting data since the researcher had to conduct another observational process at the schools which were later selected.

Organisation of the Study

This study was organised into five chapters. Chapter One covers the introduction aspect of the study. The introduction comprises the background to the study, statement of the problem, the purpose of the study, the research questions, and hypothesis, the significance of the study, delimitation, and limitation.

The Chapter Two discusses the theoretical framework, the various variables in the study, and empirical review in relation to the effect of teaching approaches on students' mathematical mindsets toward learning Core Mathematics from the students' perspective. Chapter Three describes the methodology of the study which includes; the population, sampling procedure, data collection instruments, data

collection procedures, and data processing and analysis. Chapter Four also discusses the results and findings of the study. The final chapter outlines the summary, conclusions, and recommendations from the study.

CHAPTER TWO

LITERATURE REVIEW

Overview

This chapter includes a review of related literature that highlights key points of knowledge about the research topic "influence of teaching approaches on Senior High school students' mathematical mindsets and their achievement in Core Mathematics". The review of literature has been written in terms of theoretical framework, teaching approaches, students' perception of teachers' teaching approaches, students' mindset, and lastly, the empirical evidence. The theoretical framework addresses the theory guiding this study while the conclusions of other researchers' investigations on teaching approaches and students' mathematical mindsets are also addressed in the empirical review.

Theoretical Framework

The beliefs students hold about themselves in terms of learning are the result of their own experiences and observations they gain either in school or in their immediate environment. These observations, experiences, and knowledge gained in the field of study by students are backed by some theories. The implicit theory of intelligence was used as the theoretical framework underpinning this study. This theory is deemed necessary for the study since it emphasises how students' mindsets or intelligence are developed in the cause of learning. Students are able to respond to either failure or success depending on the mindset they develop. This theory plays a vital role in determining how teaching approaches factor in the development of students' mindsets or intelligence. Therefore, this theory provides

perspectives, concepts, and other statements that influence students' mathematical mindsets toward learning Core Mathematics.

Implicit Theory of Intelligence

According to Sternberg, Conway, Ketron, and Bernstein (1980), the implicit theory of intelligence comes about as people make up informally in their heads about themselves, others, and world events. As a result of human behaviour and social organisational ideas, this knowledge structure is constructed (Reich & Arkin, 2006). Unbelievably, people interpret their perceptions and experiences based on these assumptions, which in turn drive their judgments about others and themselves (Heider, 1958).

According to Dweck and Leggett (1988), the root of the implicit theory of intelligence is the social cognitive theory of motivation and personality. Within this theory, there exist two models being the incremental theory (growth mindset) and an entity theory (fixed mindset) which an individual may espouse to one. Individuals have a greater knowledge of their own and others' intelligence as a result of this theory (Dweck, 2006). According to Dweck (1999), it is through them that individuals learn to respond to success and failure, praise, and difficulties, and it is through them that individuals gain or lose their self-confidence. In light of these diverse views, Dweck, Chiu, and Hong (1995) claim that individuals may see reality in different ways, resulting in the setting of different goals for themselves, and the adoption of various behavioural patterns to achieve those goals.

The fixed mindset or an entity theory of intelligence

The intelligence of people is seen as a rigid, uncontrolled trait with a fixed mindset (Dweck & Leggett, 1988) which could function as a limitation to the growth of skills and affect students' achievement negatively (Hochanadel & Finamore, 2015). Dweck (2006) and Dweck and Leggett (1988) made emphasis that it is considered as a fixed quantity within each individual that cannot be altered. Hence, intelligence is an important worry for people with a fixed mentality due to the fact that they do not know how much of it is left or when it will run out; thus, to avoid looking less intelligent, they are always trying to appear smart (Dweck, 2006). As a result, Elliott and Dweck (1988) claim that those with a fixed mindset are more prone to dodge difficult tasks, and people feel compelled to prove themselves over and over, regardless of the situation (Dweck, 2006).

Dweck and Leggett (1988) reported that individuals with a fixed mentality typically pursue achievement-oriented goals in order to get positive feedback on their capabilities, or at the very least to avoid bad feedback. The intelligence of individuals who have achievement objectives is always being measured, and they are constantly assessing whether that ability is acceptable or insufficient (Dweck & Leggett, 1988). Failure is seen as a sign of inferiority or weakness, which often leads to a helpless response as outcome and achievement is recognised as a primary goal for a person who has a fixed mentality (Dweck & Leggett, 1988; Elliott & Dweck, 1988).

A fixed-traits mindset assumes that success is found by proving one's talent or intelligence and seeking validation for it. In the world of a fixed-minded person,

failure serves as an indication that one is not intelligent. According to Dweck (2006), failure is the result of not reaching one's full potential. Students appearing to be intelligent may eventually deter them from searching out new learning options in the future; due to the possibility of making mistakes, students are less willing to try something new. A student will likely skip remedial work while in need of it; in spite of the fact that he or she wants to do well, he or she believes that effort is pointless. This claim was supported by Dweck (2000) as she mentioned that students will try their utmost to minimize the effort required because they view it as a sign of poor intelligence. To put out effort also implies that one lacks intellect or talent in the fixed-minded person because one would not need to put forth any effort if one had the necessary talent and competence (Dweck, 2006). Those students who have a fixed mindset on mathematics may become disheartened and put out minimal effort when faced with a difficult mathematics problem.

The growth mindset or an incremental theory of intelligence

The subscribers of the growth mindset think that intellect can be changed, controlled, and be improved (Dweck & Leggett, 1988). These people accept the fact that intelligence can be developed through exposure to new experiences and hard work (Dweck, 1999). Intelligence, according to many incremental theorists, is described as individual knowledge and skills, which can be developed through learning (Dweck, 2000). Because intelligence is regarded as a malleable quality, individuals with a growth mindset are not worried about proving their intelligence, but rather seek in learning more (Dweck, 2006). Hence, Elliott and Dweck (1988) established the fact that people with a growth mentality prefer to seek out difficult

chances and engage in creative thinking in order to create ways for completing increasingly complex tasks.

According to Boaler (2016) and Dweck (1999), not every person is born with the same skills or brain, but everybody can develop their intelligence with guidance and effort. Likewise, Dweck (2010) emphasised that no one is born with the same level of intelligence as Albert Einstein, but those with a growth mindset think that everyone's intellect has the potential to improve over time. Due to their belief that practice and instruction are the means through which they may enhance their intellectual talents (Dweck, 1999), growth-minded people typically set learning goals that require more work (Dweck & Leggett, 1988) as Dweck (2000) made it known that people with a growth mentality adopt to a masterly approach to learning. They are mostly motivated in learning new concepts. Learners are obsessed with expanding their knowledge and skills, and they are always assessing the best approach to improve their abilities or expertise (Dweck & Leggett, 1988). The more you exercise your brain, the stronger it gets as Dweck (2010) classified the brain as a muscle. Students that have a growth mentality think that every content or concept can be learned and that their brains can be strengthened through exercise (Dweck, 2006).

Achievement and outcomes are used as a yardstick to know whether the used approach in learning was either productive or not, as a result, efforts can be revised and redirected towards mastery (Elliott & Dweck, 1988). With a willingness to learn, it is possible to recover from failure, and then carry on with more difficult tasks (Dweck, 1999). In other words, students with a growth mentality do not

become suppressed by their mistakes and setbacks, but rather see them as chances to try again and improve their mathematical skills. Apparently, a growth mindset serves as a strong predictor of students' achievement in mathematics (Claro, Paunesku, & Dweck, 2016; Kismiantini, Pierewan, & Montesinos-López, 2021).

Individuals with a fixed mentality, on the other hand, are unable to monitor their selves and continue in actions in order to achieve their own goals (Dweck & Leggett, 1988). In most cases, students tend to favour one theory over the other, however, they may support both growth and fixed mindsets, depending on the context in which they are used (Hwang, Reyes, & Eccles, 2019; Murphy & Dweck, 2010). Boalor (2013) also made it known that students might have a combination of the two mentalities where a growth mentality is held by 40 per cent of students, a fixed mindset by 40 per cent, and a mixed mindset by 20 per cent of students. Hence, students can develop a mixture of growth and a fixed mindset for a particular subject but one may dominate over the other.

Teaching Approaches

Pratt (1992) defined teaching approaches as the dynamic association between the intentions, behaviours, and beliefs of the teacher. This indicates that the teaching approach includes the teachers' actual classroom activities, which are guided by their aims and beliefs. The application of a suitable teaching approach involves a well-ordered way to achieve an aim or perform a task. Teaching approaches is been identified by Adediwura and Tayo (2007) as a pattern used in teaching and learning to pursue a point. Effectiveness in teaching approaches makes learning concepts retainable whether in formal or informal education.

According to Obanya (1984), the degree to which a teaching approach is powerful depends very heavily on the instructor's successful utilization of it, and the impression left to the student is observable in their achievement. The teaching approaches used by the teachers are among the dominant variables which affect students' mathematics achievement (Organisation for Economic Co-operation Development [OECD], 2010). Castiglione (2019) made it known that for students to succeed in learning mathematics, teachers must practice different methods in their teaching process. This indicates that the approaches to teaching used in class by the teachers have a major influence on students learning. In my view, teachers still hold on to their approach to teaching based on their mathematical beliefs. Perkkila (2003) made mention that instructors' memories of their perceptions and beliefs have a significant impact on their instruction. To a larger extent, the beliefs of teachers affect the manner in which they teach and also affect students learning (Yarkwah, 2020). Perkkila (2003) added that the approaches used in class by the teacher can be traced back to how they were taught during their days in school.

A study by Umoren (2001) on teaching approaches showed that the teacher's ability to communicate knowledge heavily depends on the approach that they use during teaching. When the approach is flawed, the students will lose since they do not gain from the lessons. Wentzel (2002) emphasised that the approach an instructor chooses has a huge impact on the learning process, the beliefs of the students' concerning their skills, the academic achievement of the students, as well as on their emotions and sentiments in connection to the subject. Also, Rothrock (2019) indicated that teachers' approach to teaching, classroom environment, and

mathematical identity are some major factors that count in the development of mindset.

According to Hancock, Bray, and Nason (2003), teaching approaches are grouped into content-centred, teacher-centred, and student-centred. Similarly, Huitt (2006), made it known that cognitive, humanistic, behavioural, and constructivist are the main type of teaching approaches. But, Lord (1999) made it known that the most commonly used types of teaching approaches are the teacher-centred (behavioural) and the student-centred (constructivist) approaches. Adentunde (2007) indicated that in the Ghanaian classroom settings, these are the commonly used approaches; group work, discovery method, demonstration, lecture method, and problem-solving approach (activity) which can be grouped under student-centred approach (constructivism) and teacher-centred approach (behaviourism).

Uya (2008) indicated that teachers must possess the appropriate pedagogical abilities that must be systematic and methodical to ensure order and increase classroom learning. Umoh (2005) established the fact that teachers must research and use their know-how of educational abilities/strategies to determine whether the approach is a mass method or an individualised teaching approach. Esu (2003) was of the view that teaching involves a range of approaches by its nature to help assist students in learning to boost their knowledge and understanding level. Similarly, Umugiraneza, Bansilal, and North (2017) made it known that teachers involve different teaching approaches in teaching mathematics.

Student-centred approach

With a student-centred teaching approach, it throws much emphasis on students' experiences, backgrounds, views, abilities, interests, capacities, and desires. It fosters the utmost levels of learning and achievement by providing a learning environment that is favourable for learning for all students (Ahmed, 2013). A study conducted by Kang and Keinonen (2018) revealed that a student-centred approach to teaching positively impact students' academic achievement. Glasersfeld (1989) adds that the philosophy of a student-centred approach is centred on the notion of efficiently participating in social interactions in the instructional process to inspire students to explore, grow, and produce new knowledge. Students must engage in a series of exercises planned by a well-informed person to give each student a variety of chances for learning to grow and develop their knowledge. The ability of the student to use their prior experience in developing new knowledge depends on the concepts to be presented by the teacher in class.

The features of the student-centred teaching and learning approach as emphasised by Zhao (2003) include encouraging various explanations and forms of learning; motivating students to examine and pose their questions; encouraging students to work together; and using their colleagues as learning resources. Student-centred approaches are meant to facilitate learning through the discovery approach, group work approach, and problem-solving approach (Cohen, Manion, and Morrison, 2004). Group work as an approach to teaching is used as a method for teaching and as a research aid that offer teachers a sense of how students learn (Zakaria & Iksan, 2007). In order to build a sufficient comprehension of each topic

and proceed to a higher thinking level, students must be actively involved in the learning process (Abrams & Lockard, 2004). Students that engage in active learning seek meaning and knowledge of the information by developing and modifying it (Dart, Burnett, & Purdie, 2000). For a student to be an active learner, he or she needs to undergo the process of understanding the concepts of mathematics through a series of investigations, trial and error, and exercises, with little or no assistance from the teacher (Boaler, 2009).

Teacher-centred approach

Educators whose teaching and learning philosophy falls in line with this approach are believed to produce passive learners and students get to learn in a procedural and structured way (Ball & Kuhs, 1986). A teacher-centred approach is an instructional process in which teachers are the primary source of information. Apparently, Adentunde (2007) asserted that in this case, the teacher is regarded as the knowledge bank where students sit quietly and listen to what the teachers tell them of which they make their notes out of it. The instructional techniques and various modes of assessment to be used in class are all decided by teachers. According to Ellsworth and Buss (2000), teacher-centred teaching and learning approach focuses on students providing the right answers and encourages students to follow the exact processes that will result in the correct responses.

Regardless of these advantages, Ellsworth and Buss (2000) reported that the focus on laid down principles and rules only contributes to students engaging passively in lessons and influences their achievement adversely. Teacher-centred approach, according to Garrett (2008) hinders students' educational development.

In a teacher-centred classroom, the teachers get to control every activity of the students. Teachers commonly utilise instructional approaches (such as the dogmatic method, lecture method, demonstration, and guided discussion) that establish a focus on the instructor to assist them to keep control over their students. These instructional approaches allow the teacher to be the sole instructor of the class activities. This approach of teaching is an efficient method for teaching various topics in mathematics as well as the relationships that exist between them (Boaler & Greeno, 2000). Jenkins (2000) suggests that it is also an easy way to achieve curriculum targets and objectives within a strict time frame.

According to Lord (1999), with the teacher-centred approach, it is assumed that students share the same understanding level on the topic content to be covered and are capable of learning the content at the same rate. The teacher-centred strategies are defined as approaches that promote learning through reception and students are required to integrate new concepts into already existing ones (Cohen, Manion, & Morrison, 2004). A work conducted by Owusu, Monney, Appiah, and Wilmot (2010) emphasised that students prefer the use of traditional teaching and learning methods rather than the use of computer-assisted instruments as the conventional approach to learning helps in boosting the achievement of students. Similarly, a study embarked by Kurniati and Surya (2017) in Indonesia with a sample of 600 students indicated that teachers still used the teacher-centred teaching and learning approach. Teachers align themselves to this approach of teaching because, during their secondary and training college education, they were trained using the same approach (Chapman, 2007).

Students' Perception of Teachers' Teaching Approaches

Perception is defined by Allport (1968) as to how others are judged by people they come into contact with. While it was also described by Eggen and Kauchak (2001) as the process where one adds meaning to whatever he or she comes into contact with. This can be further clarified that the processing of one's perception occurs when the person comes into contact with anything that may have an influence or impact on the mind. So, perception becomes very important since it affects whatever the mind comes into contact with. According to Adediwura and Tayo (2007), past and current experience, individual mood, and the person's interests can strengthen the perception of the student.

The perception of students toward teachers' teaching approaches, the teacher's classroom interaction skills, and teaching styles are completely reliant on the fact that they were taught and are familiar with the teachers, thus, they have memories of what happens in their learning environment. According to research, students who believe in excellent teaching and learning have a higher likelihood of using constructivist learning strategies in their classrooms (Parpala, Lindblom-Ylänne, Komulainen, Litmanen, & Hirsto, 2010). Studies conducted recently at universities showed that when learning objectives are clearly defined, the ability to better comprehend and put theory into practice is provided; classes are engaging and relevant; teachers engage with students and give constructive feedback, and courses of instruction are matched positively (Hailikari & Parpala, 2014).

Students learning outcomes can be better predicted by using the perception of students rather than any external observation. As it was also made clear by

Akram (2019) that the approaches used by teachers in class can be measured by students' ratings or perceptions. The perceptions of students toward the characteristics of teachers may lead to the development of students' mathematical mindsets which intend can affect their mathematics achievement.

Research by Kashefi et al., (2017) stressed on the theories of teaching and learning in the classroom of mathematics teachers at the primary school level. The study was conducted in Malaysia and made use of a qualitative design. Seventy-two mathematics teachers answered open-ended questions which were categorised into the encounters and guidance needed to improve the instructional process and the teaching approaches used in the classroom. Majority of the teachers representing 61.1% aligned themselves to the teacher-centred approach to teaching as they are much into the drill and practice during their class periods while 1.4% of the respondents claimed that they used the cooperative aspect of teaching and learning. In all, teachers agreed to the use of a teacher-centred approach to teaching as they believe that rewarding and punishing students aid in the effectiveness of teaching and learning mathematics.

Another study conducted by Govender (2015) focused on the perceptions of students on methods of teaching at the university level in South Africa. A sample size of two hundred respondents of level 300 undergraduate students were selected randomly from the Education faculty. The researcher made use of a descriptive survey design. A closed-ended questionnaire was administrated to elicit responses and information on the teaching methods teachers mostly used. The various method on the questionnaire was; lecture method, group discussion, individual

presentation, individual assignments, group assignments, brainstorming, role play, workshops, seminars, and case study. The results indicated that lecture method had been frequently used for their three years stay on campus with a rating of 91% as compared with other teaching methods. Govender (2015) concluded by emphasizing that alternative teaching methods that involve active participation were perceived to be less commonly used by teachers. Hence teachers were much into the teacher-centred teaching approach as compared to the student-centred teaching approach.

In addition, a study conducted by Briede (2016) on mathematics teaching approaches and mathematics self of students in grade nine in Latvia. The study focused on teaching approaches (student-centred and teacher-centred) and mathematical self (self-conception, mathematical anxiety, and self-efficacy). A mixed-method research design was used for this study. Students and teachers were the target population for this study. The study was comprised of 3,478 participants of which 3,083 students were sampled by using cluster sampling. The rest of the sample were the teachers. Descriptive statistics were used in analysing data on self-efficacy, anxiety, and self-conception. The students were put into two clusters (develop indicators of self-efficacy, anxiety, and self-conception and undeveloped indicators of self-efficacy, anxiety, and self-conception) while teachers were also put into three clusters (student-centred, teacher-centred, and student-centred and teacher-centred combined). Correlation analysis was conducted to investigate the relationship between teaching approaches and mathematical self-efficacy, anxiety, and self-conception of grade 9 students.

The study findings found that the traditional teaching approach is less effective than the constructivist teaching approach in impacting students' mathematical selves. Students also prefer to be taught by the constructivist teaching approach. The teachers also confirm that the student-centred approach is the best way of teaching but is a very complex process as it is mostly controlled by external and internal factors. The current study by Briede (2016) outlines some factors existing in the literature; teaching approaches (student-centred and teacher-centred) which makes it related to this study.

Students' Mindset

A mathematical mindset occurs when students perceive mathematics as a collection of ideas and relationships, and their function as one who thinks about and makes sense of those concepts (Boaler, 2016). Since mathematics is recognised as a conceptual domain, there is no need for rote procedures, facts, or skills to be memorised. Unfortunately, pupils are taught procedural algorithms at a very young age, which undermines the subject's flexibility. They learn multiplication facts, for example, without looking at the variety of patterns found in multiplication tables, which may lead to a better mathematical grasp of multiplication characteristics. Alternatively, students may learn the long division algorithm without comprehending the significance of place value and its part in the process.

As Boaler (2016) points out, at this age, students are more inclined to adopt a procedural or fixed mindset toward mathematics. In all subjects and aspects of their lives, students' mindsets are not the same. According to McCutchen, Jones, Carbonneau, and Mueller (2016), depending on the subject, students are able to

adopt a different mindset. Meaning that the student's mindset on their history subject may differ from their mindset towards their mathematical abilities. The mindset of a student about one topic, however, can impact their mindset toward other subjects (Allen & Schnell, 2016). But, Stohlmann (2022, p. 159) claims that "students may have a general growth mindset, but for a specific subject such as mathematics or science they may hold more fixed mindset beliefs". A student's mathematical mindset may influence their perception of their general intelligence or their confidence in their ability to master other disciplines. Also, the learning environment can alter students' mindsets, at least temporarily, by conveying an implicit message about who is and is not capable of doing high-level work (Good, Rattan, & Dweck, 2012; Murphy & Dweck, 2010).

When students with a growth mindset are confronted with academic difficulties, they perceive them as chances to learn. For instance, when people with a growth mentality are given negative feedback, they are more likely to ascribe lower achievement due to lack of effort and are willing to take remedial action to enhance their achievement as compared to people with a fixed mentality (Hong, Chui, Dweck, Lin, & Wan, 1999). As a result, students who have a growth mindset are more likely to succeed in school and beyond (Yeager & Dweck, 2012). Similarly, Grant and Dweck (2003) stated that students with a growth mindset mentality produce higher grades as compared to students with a fixed mindset mentality. As Hwang, Reyes, and Eccles (2019) reported that a fixed mindset predicted lower academic achievement in mathematics.

Students' progress and development can be greatly impacted by the differences between these two mental models. Students with a fixed mentality can be taught to acquire a growth mindset, according to Dweck (2010). In the same way, students can be identified with a growth mindset with some fixed ideas (Adhitya & Prabawanto, 2018; Madden, 2015). The shift from a fixed to growth or growth to a fixed mentality has a substantial impact on the academic achievement of these students. Dweck (2014) found a statistically significant relationship between students' mindset and their achievements. The work emphasises that the mindset of students predicts their mathematics achievement over time and a change in the student mindset increases mathematics achievement. When asked about their views on intelligence, students in kindergarten through first grade to third grade answered a survey conducted by Ricci (2013). According to Ricci (2013), a growth mindset was present in all kindergarten students, and also present in 90% of first graders, 82% of second graders, and 58% of third graders. According to these findings, current teaching approaches contribute to students' changing perceptions of their skills and capabilities.

When students have a growth mindset, they believe in their ability to learn. Despite the fact that they may be facing difficulties in the classroom, they are driven to succeed despite these obstacles. Regardless of their academic standing, these students may appear more assured or enthused in the classroom. Teachers may notice the students' growing self-confidence and urge them to keep growing as well. Students with a fixed mindset, on the other hand, may feel fearful in class because they are concerned about seeming intelligent or avoiding making errors (Dweck,

2010). Because of this timidity, teachers may assume that a student is unable to produce challenging work. However, students' success depends a lot on their mindset, and teachers are in charge of making sure that all students have an equal opportunity to succeed.

The message that errors are an important component of mathematics learning is conveyed when teachers go beyond just appreciating them and engage students in investigating their mistakes (Sun, 2018). New synapses are produced in the brain whenever a learner makes a mistake in mathematics, according to Dweck (2012). A teacher's response to students' mistakes in the classroom is an essential and effective part of their practice (Boaler, 2013). To prevent pupils from developing a fixed mindset, teachers should encourage them to think about why they made a mistake and how they may have avoided it (Hall, 2016). As a result of a student's mistake, the brain is given an opportunity to develop (Boaler, 2013). When students learn from their mistakes, students are better equipped to deal with similar situations in the future (Boaler, 2013). As a result, learning is impossible without making mistakes. When teachers and students have a growth mindset, they encourage pupils to embrace failure and learn from it. If some students are not being pushed to reach their full potential, this can lead to more serious issues of equity in the classroom.

Working with small groups of students allow teachers with a growth mindset to differentiate their teaching. These groups must be adaptable to meet the learning needs, understandings, and misunderstandings of students. According to Darling-Hammond (2010) and Boaler (2013), ability grouping harms students in low and

middle ability groups and does not improve the achievement of high-achieving students if groups remain static. Low-ability groups, for example, are told that they are incapable of completing increasingly difficult tasks through ability grouping (Sun, 2018). A self-fulfilling prophecy, according to Strauss (2013), was used to describe the practice of putting low-level students in the same class. Students are well-aware of their academic standing and the implications it has on their self-perception. This does not encourage students to progress, but rather gives them the option to remain static without any challenge or advancement in their lives (Strauss, 2013). For a teacher to impact successful, he or she must go through a proper application of planning, pedagogy, and assessment (Beyranevand, 2017).

In planning a lesson, the teacher must consider the method or approach to use while the pedagogy also talks about how to employ these methods or approaches in teaching. On the approaches to teaching and learning, a work conducted by O'Brien, Makar, Fielding-Wells, and Hillman (2015) made it known that students possess a growth mindset when they are taught with an inquiry approach to teaching and learning in the mathematics classroom. The inquiry approach can be classified under the student-centred teaching and learning approach as this approach to learning allow students to investigate on their own which serves as one of the key constructs of the student-centred teaching and learning approach.

Similarly, Sun (2015) embarked on a study relating to teaching mathematics for a growth mindset in the south and northern part of California. The researcher made use of the mixed-method design with a sample of 3,400 students and 40 mathematics teachers from six middle schools in California. A five-point Likert

scale questionnaire was used in soliciting information in the quantitative phase and classroom observations and interviews were done in the qualitative part. The study revealed that the teaching of mathematics in a student-centred approach that exceeds algorithm and procedural works aids in the development of a growth mindset on the part of students. Sun (2015) also made it known that exposing students to triggering questions helps them develop a growth mentality.

It has been identified that mindsets are also impacted by the subject and classroom atmosphere, as well as by pedagogical methods and epistemological views (Jonsson, Beach, Korp, & Erlandson, 2012; Rattan, Good, & Dweck, 2012; Yeager & Dweck, 2012). With regards to the findings of the various study above, a growth mentality among students, as well as diverse classrooms and dynamic student groupings, seems to be an effective approach to assist all learners to achieve their full potential.

Empirical Review

This part of the literature takes into account prior studies that have been performed and which have some relationship with the present study.

Perception of Teaching Approaches

Ampadu (2012) investigated the teaching and learning of mathematics of Junior High School students in Ghana. The researcher adopted a mixed-method approach with a sample size of 482 participants comprising 358 Junior High School students from 12 schools and 24 mathematics teachers. In the quantitative phase, structured questionnaires were used to solicit information concerning the perception of teachers and students towards teaching and learning mathematics

where the data was analysed by using descriptive statistics. In the qualitative phase, interviews and classroom observation were used to obtain in-depth information on the approaches used by teachers and how they impact students learning. From the analysis of the data, it revealed that teachers proclaim to use the constructivist approach to teaching and learning but from the student's perspective, the teachers use the behaviourist approach to teaching especially the didactic approach to teaching and learning. Because of this, students' perceptions cannot be ruled out when talking about the learning process. Therefore, the present study is in line with the work of Ampadu (2012) in the sense that both admit to the perception of students and teachers on teaching approaches towards learning mathematics.

Students' Mathematical Mindsets and their Achievement towards the Learning of Core Mathematics

Zhang, Kuusisto, and Tirri (2017) embarked on a study concerning how the mindset of students and teachers in learning has been studied over time. The research complied twenty-two (22) articles from 1998 and 2017 in identifying the relationship between student's mindset and their academic achievement. The participants or respondents in the various articles included elementary school students, middle school students, and university or college students. The data collection instruments considered in the various works are as follows; interview, observation, questionnaire, survey, standard process matrices, and test. The empirical review only concentrated on articles from these countries; Britain, USA, Chile, France, Greece, China, Sweden, and Finland. The findings of the work revealed that the cause and mediator of students' academic achievement is their

mindset. Out of the 22 publications, it was revealed that 13 articles confirm this fact. The research also reviewed that a teacher's mindset also counts in the determination of students' academic achievements. Most of the articles were of the view that a growth mindset predicts higher achievement while a fixed mindset predicts lower achievement. This study is closely linked to the present study in the sense that both admit to the mathematical mindset and academic achievement of students.

Dupeyrat and Mariné (2005) investigated factors that affect students' achievement, by looking into the factors; implicit theory of intelligence, cognitive engagement, and goal orientation. The study was conducted in France for students who were enrolled in a diploma programme for one year reading these subjects; French, foreign language, mathematics, history, geography, and economics. The study involved 76 participants (31 men and 46 women) with an average age of 31. The only research instrument used for the data collection was a questionnaire and the data was analysed by using descriptive statistics. The data revealed that most students endorsed a growth mindset as compared to a fixed mindset with a mean of 2.93 and 1.68 respectively. The study revealed that cognitive engagement and goal orientation affects students' achievement but the mindset of students has no significant relationship with academic achievement. The relevance of this study is correlated to the present study as they both measure mindset and academic achievement.

Chapter Summary

Two key sub-headings, theoretical framework, and empirical studies were carried out in the literature review. Recent educational theories seek to understand more about how and why students form certain beliefs about their mathematical ability by examining students' mindsets. Students' performance and achievement may be linked to student mindset, according to recent research (Boaler, 2013; Soni & Kumari, 2015). Mathematical achievement, mentality, and its influential components are examined in just a few research (Liu et al., 2017). The study of how students' mathematical mindsets develop is a growing field of study. Their perspectives and experiences about these influencing factors are important in the educational process, which is why students are stakeholders in their education (Phelan, Davidson, & Cao, 1992).

Teaching approaches as one of the influencing factors affecting students learning was identified in the work of Rothrock (2019), as it was indicated that teachers' approach to teaching is one of the major factors that count in the development of mindset. On the approaches to teaching and learning, much research work has been conducted on the influence of student-centred teaching and learning approaches on students' mindsets but much is not known about the influence of teacher-centred teaching and learning approaches on students' mindsets. A deeper look into the consequences of teacher influence and past mathematics experiences is required (Boaler, 2013). The inclusion of student perspectives in this study enhanced our understanding of these themes and their effect on students' mindsets and achievement in mathematics.

The study objectives were also used to guide the empirical research along with some of the literature reviewed. Overall, the researcher observed that not much had been done in the Ghanaian context especially, Senior High Schools in the Kumasi Metropolis of the Ashanti Region. From a Ghanaian perspective, this research will be added to the literature.

CHAPTER THREE

RESEARCH METHODS

Overview

This research study explores the influence of teaching approaches on students' mathematical mindsets. The study design that was employed for the study, population, sample, techniques for sampling, instrument, and how the data was performed are discussed in this chapter.

Research Design

The purpose and goals of the study are decided by the researcher's type of research design to be used (Katunde, 1998). A study design for achieving the objectives of the study is compulsory for all research studies (Bless & Higson-Smith, 2000). The design of the research refers to a different strategy used in solving a research problem (Omari, 2011). Also, research design can be characterised as a research strategy, structure, and approaches to attain response to research questions and to be able to control variance (Creswell, 2003). A research design usually includes how data are compiled, what methods are used and how the obtained data are processed. Researchers align themselves to the use of different research designs based on their ideological backgrounds.

This study was found to be a good fit for an ex post facto research design. Ex post facto research design is therefore an approach for detecting potential histories of happenings that cannot be manipulated, programmed, or controlled by the researcher (Cooper & Schindler, 2001). On the other hand, it can help the researcher speculate on the possible causes of a previously observed effect.

According to Cohen, Manion, and Morrison (2007), researchers can only reveal what is happening or what has happened by always keeping variables in mind when sampling. The procedure through which the researcher examines the dependent variables only since the independent variable has already occurred is known as ex post facto research design (Kerlinger, 1986). Lammers and Badia (2005) established the fact that a non-experimental design that incorporates some features of a true experiment is known as ex post facto research design, particularly in terms of separation of groups and data analysis but in reality, is not a true experimental design. Again, Lammers and Badia (2005) added that an ex post facto design mimics a true experiment, which compares people from different groups with the same backgrounds and various predominant conditions which are directly related to their natural history. It is more effective in analysing a cause based on the outcome that is unlikely to happen in experimental research (Fraenkel & Wallen, 2003). In view of this, the study was found to be a good fit for an ex post facto research design as it aids the researcher in identifying the extent to which the teaching approaches of teachers influence students' mathematical mindsets toward the learning of Core Mathematics.

Ex post facto research design may be divided into three categories, according to Newman, Newman, Brown, and McNeely (2006). No hypothesis is used in the first design and generally is the weakest of the three. The test of hypotheses and a little more scientific value is been identified as the second type of ex post facto design. The third type of ex post facto research comprises testing hypotheses and

testing for alternative hypotheses that are significantly more effective in terms of their internal validity (Newman, Newman, Brown & McNeely, 2006).

An ex post facto research design as emphasised by Ary, Jacobs, and Sorensen (2010) is very useful in exploring the relationship between independent and dependent variables when the independent variables cannot be randomized or manipulated. Ex post facto can be recognised by the following characteristics; it is one of the designs that can be used to answer the "how and what" aspect of research questions and it also places much emphasis on the effect on variables as it helps the researcher identify the reasons behind the occurrence of an event (Fraenkel & Wallen, 2003).

According to Cohen, Manion, and Morrison (2007), co-relational study and criterion study are the main types of ex post facto research design. They further emphasised that co-relational study has to do with the collection of two sets of data to identify the relationship between them while in a criterion group study, the researcher compares the subjects in which the variable is present with comparable subjects in which it is missing in order to uncover plausible reasons for a phenomenon being examined. In this regard, in order to establish the effect and cause relationship between the variables, a co-relational ex post facto research design was used to establish, if there is any link or relationship between students' perception of teachers teaching approaches and their mathematical mindsets toward learning of Core Mathematics.

Population

Population is a whole collection of persons with specific identifiable features that are fascinated by the researcher (Creswell, 2003; Koul, 2003). Furthermore, a population, according to Fink (2001), is any group of specific people or non-human beings. In this regard, the population of the study needs to be established since no work is conducted in a vacuum. Furthermore, it is important to know the target population in other to decide on what sample size to use for the study.

The population is divided into the target and accessible populations by Gravetter and Forzano (2019). A target population is a demographic, identified by the common interests of the investigator, where individuals in a target population usually share the same traits, while an accessible population considers a portion of the target population made up of persons who can be recruited as research respondents (Gravetter & Forzano, 2019).

The target population comprises all public SHS students and mathematics teachers in year two in the Kumasi Metropolis of the Ashanti Region of Ghana. The schools in Ghana have been structured into categories, namely category A, category B, and category C. Among these categories, there are six (6) schools in category A (2 single-sex boys', 3 single-sex girls', and 1 mixed school), there are fourteen (14) schools in category B (1 single-sex boys', 3 single-sex girls', and 10 mixed schools), and lastly, there are also four (4) schools in category C (4 mixed schools) in the Kumasi Metropolis summing up to twenty-four (24) recognised public Senior High Schools (Computerized School Selection and Placement System [CSSPS], 2019). The private schools were not involved in this study because most of these

schools have been witnessing low enrollment due to the free SHS policy, so the private schools were not suitable for this study. Among the public schools, the accessible population that was used for this study was made up of year two students and Core Mathematics teachers of six selected Senior High Schools. The schools were chosen based on the approaches the teachers use in teaching mathematics. Through the use of an observational method, the researcher was able to associate each school with a certain teaching approach.

Year two students were regarded as suitable for this study as compared to the year one and year three students. It is due to their more than one year of familiarity with their teachers' teaching approaches used in Core Mathematics classroom and their developed mathematical mindset is best determined by their perceptions about Core Mathematics teachers' teaching approaches. Students in the first year were deemed too new to the high school programme. Nevertheless, the year three students had completed school when the data was collected. Since form two Core Mathematics teachers were observed while teaching, they were considered appropriate for this study as compared to form one and three Core Mathematics teachers.

The total population of SHS year 2 students in the six selected schools in the Kumasi Metropolis was 6,792 while at the time of the study, there were 150 mathematics teachers. This figure was based on available statistics obtained from the selected schools. Table 1 shows the total population of SHS year 2 students and mathematics teachers in the six selected schools.

Table 1: Population of SHS 2 students in the selected schools

Schools	Students Population	Teachers Population
School A	1,474	30
School B	946	22
School C	1,248	24
School D	1,013	21
School E	1,547	35
School F	564	18
Total	6,792	150

Source: Field Data (2022)

Sample and Sampling Procedures

A sample refers to a demographic sub-group analysed to generalise the target population (Creswell, 2013). Fowler (2009) pointed out that the need for sampling in a study is to pick the most representative portion of the population. The schools for the study were chosen using purposive sampling (non-probability sampling). In selecting the schools for this study, consent was sought from the administrators of the schools in the Kumasi Metropolis to conduct an observational method in their schools. The researcher observed each teacher from each school on two occasions by joining their class, upon observation, three schools were identified with a student-centred teaching and learning approach (e.g. teachers permitting students to make mistakes in order to discuss them), and three schools were also observed using the teacher-centred teaching and learning approach (e.g. teachers instructing students to strictly follow the procedures used in their notebooks).

In all, six Senior High Schools were purposively selected. It should be noted that all six selected schools read these academic courses; Business, General Arts, General Science, Home Economics, and Visual Arts. Upon choosing the schools and deciding on the sample size according to Krejcie and Morgan's (1970) sample size determination table, a sample size of 364 is recommended for a population of 7,000. The researcher saw it necessary to use a sample of 396 respondents which was made up of 378 SHS students and 18 mathematics teachers from a population 6,792 Senior High School students and 150 mathematics teachers. Depending on the research sample size which is 378 students and 18 mathematics teachers, a proportional sampling was then carried out in other to allocate the respondents according to the chosen schools. Proportional sampling is described as a form of sampling where a known population contains a significant number of subgroups.

The sample size of 378 and 18 was divided by the number of schools selected which is 6 giving a value of 63 and 3 representing the sample of students and mathematics teachers respectively. Hence, a sample of 63 students was selected randomly from each school to make a fair representation of each school selected in other to make a good generalisation of the study results. Also, 3 mathematics teachers were purposely selected from each sampled school. In each school, three classes were used by the researcher since a sample of 3 teachers was needed in each school. Hence, from the three classes, a sample of 21 was used which sums up to 63 students. The population and the sample size of students and mathematics teachers from the various selected Senior High Schools are documented in Table 2.

Table 2: Population and sample of SHS 2 students and mathematics teachers in the selected schools

Schools	Population of students	Population of teachers	Sample size (students)	Sample size (teachers)
School A	1,474	30	63	3
School B	946	22	63	3
School C	1,248	24	63	3
School D	1,013	21	63	3
School E	1,547	35	63	3
School F	564	18	63	3
Total	6,792	150	378	18

Source: Fieldwork (2022)

At the final stage of the sampling process, respondents were selected using simple random sampling as it assures that each respondent had an equal chance of being selected for this study. This influenced the researcher's decision on the sampling method. Microsoft Excel spreadsheet, 2016 was used in selecting students from the classrooms of the observed teachers in each school selected for this study. Before the use of the excel spreadsheet, the researcher used the class list or register. The names on the class register were given numbers to know the students that were sampled. In the other sampled schools, the same procedure was used in choosing respondents for this study.

Data Collection Instruments

Questionnaires and achievement scores were the main instruments used in gathering the data needed for this study.

Questionnaire

A questionnaire is one of the valuable and commonly used methods to gather data that offers standardised and sometimes numerical results in different measurement scales, such as nominal and ordinal. According to Cohen, Manion, and Marrison (2004), it is often useful for data processing without the intervention of the researcher and also easy to interpret. A questionnaire is a very powerful method to collect accurate knowledge on activities and circumstances that the respondents are expected to know. Paralov (2006) further explains a questionnaire as a useful measure in determining respondents' actions, choices, views, and purposes in comparatively large numbers, which is more appropriate than other approaches.

Questionnaires were distributed to respondents to elicit their views on the influence of teaching approaches on students' mathematical mindsets toward learning Core Mathematics. The findings of this study were obtained by using two sets of Likert scale type of questionnaires, which measures teachers' and students' perception of teaching approaches and students' mathematical mindsets toward learning Core Mathematics. According to Best and Kahn (1989), the Likert scale type aid respondents in expressing their level of convictions and sentiments about a certain cause or objective.

Teachers' and students' perception of the Core Mathematics teaching approaches questionnaire (TSPTAQ) was made up of two sections; Section A was used to collect the demographic characteristic of the respondents and Section B investigated how teachers and students perceive the teaching approaches used in

the Core Mathematics classroom. The perception of teachers and students on the instructional process was about student-centred and teacher-centred approaches.

The study adapted teachers' and students' perceptions of teaching approaches questionnaire (TSPTAQ) from Ampadu (2012). The questionnaire designed by Ampadu was divided into three sections, where Section A explored respondents' personal information with 8 items, 2 items in Section B were used to elicit information on teachers' priorities, and Section C which was comprised of 25 items explored the perceived classroom practices and teaching methods. The items in Section C were measured using a 4-point Likert scale with the format; strongly agree-1, agree-2, disagree-3, and strongly disagree-4 with the reliability coefficient of 0.75 and 0.74 for teachers and students respectively. The questionnaire was restructured into 18 items where 3 items elicited information on teachers' and students' backgrounds (Section A) and 15 items on teachers' and students' perceptions of teaching approaches (Section B) on a 4-point Likert scale.

Students' mathematical mindsets questionnaire (SMMQ) was used to seek information on the mathematical mindset of students toward learning Core Mathematics. The mathematical mindsets questionnaire as the second questionnaire measured the growth mindset and fixed mindset of SHS year two students. The mindset questionnaire was adapted from Dweck (2006). The questionnaire consists of 20 items measured on a 4-point Likert scale and 4 open-ended items. The scale was arranged as follows: Strongly Agree, Agree, Disagree, and Strongly Disagree.

One of the major drawbacks of employing a four-point scale is that it restricts respondents' options to disagreeing or agreeing with a statement, whereas Nworgu (1991) claims that a five-point scale allows for indecisive replies. Hence, a four-point Likert scale was chosen since it improves the strength and maximises efficiency in the data collection and analysis (Swan, 2006).

Achievement Scores

The end of second term examination results in Core Mathematics were used as the achievement scores to measure students' academic achievement for this study. The results were taken from each school selected for the study. The examination questions for these schools were set based on the various topics covered from form 1 to form 2. The examination test was designed by SHS 2 Core Mathematics teachers which were approved by the various Head of Department or Unit Heads of Mathematics from each school selected. In all, six examination results were gathered from the various schools. Some of these results were obtained from Core Mathematics teachers while others were gathered from the I.C.T department with the approval of the school administration.

The researcher sought in using these scores based on the fact that during examination periods, invigilation's are strictly conducted which reveals the true achievement of students. Hence, the examination results were deemed appropriate in determining students' academic achievement for the study.

Validity and Reliability of the Instruments

The instruments for the respondents were taken through face, content, and construct validity procedures. As Johnson and Christensen (2004) explained, the

importance of measuring validity in research tools cannot be overstated, thus, to guarantee the validity, make sure the test measures what it is supposed to assess, for the specific set of individuals and content. First of all, the instruments' face validity was determined by considering all of my supervisor's remarks as well as the opinions of certain specialists in the field of mathematics education. A measurement and evaluation specialist was provided with the initial instruments to verify the research instrument's structure, alignment, arrangement, and conformity to the study objectives and queries. Also, the views, comments, additions, and deletions that were raised were corrected. Expert judgement, according to Borg and Gall (1989), improves an instrument's content validity. My supervisor, on the other hand, assisted me in ensuring the content validity. To determine how effectively a research instrument measures what it is supposed to measure, my supervisor looked at it in relation to the study objectives and questions.

Pilot Testing

Pilot testing was carried out to verify the instrument, which is, to determine how valid and dependable it was for the primary data collection. The pilot study was done with ten mathematics teachers and forty SHS 2 students from a single school in Upper Denkyira East of the Central Region. Students from this school were selected since they share the same characteristics as the population under study. The pilot testing helped in checking appropriate wording, and items that yielded a small number of responses. Some of the items were needed to be refined and added to the list of items after the exercise. For example, on the item "How often do you learn Core Mathematics on your own after lessons". Some of the

respondents made it known that they do not learn Core Mathematics while others also did not respond to that item, so the option "None" was added to the responses. The purpose of the pilot testing was to assist update the instrument and to determine how long it would take respondents in the main research to complete all of the questionnaire items.

The establishment of reliability was complemented by a measurement of the instrument's internal consistency using a reliability coefficient calculated with Cronbach's alpha. An overall reliability coefficient of .73 and .75 was obtained for the Core Mathematics teacher's and Senior High School students' questionnaires respectively. The reliability coefficient for teachers' perception of their teaching approaches was .73 while a reliability coefficient of .76 was recorded for students' perception of their teachers' teaching approaches and .75 for students' mathematical mindsets. According to Pallant (2010), a reliability coefficient of .70 for an instrument is desirable for data collection.

Ethical Considerations

The right to privacy, voluntary involvement, no risk to the students, confidentiality, and anonymity were all highly valued in the pursuit of ethical consideration. It is important to note that students have the right to privacy, which was upheld at all times. In this light, the study's respondents were treated with respect, and no instruction was given to them without their knowledge or agreement. Furthermore, one of the most important aspects of ethical concerns in research is the individuals' willingness to participate. In a research of this sort, responding to questionnaires takes a lot of time and energy, which might cause the

respondents' normal activities to be disrupted. For this reason, the researcher presented the research's aims and importance to the respondents, allowing them to exercise their voluntary right to participate in the study.

Another ethical concern in educational research is that the activity should not cause damage to the persons under investigation, regardless of whether they volunteer or not. The term "damage" in this context might refer to physical, emotional, or psychological harm.

In addition, one of the most important ethical considerations in research is to preserve and defend the respondents' well-being, interests, and identities. In pursuance of this, I adopted confidentiality and anonymity techniques such as not disclosing the subjects' names in ensuring their protection.

Furthermore, unethical behaviour, such as plagiarism, is not tolerated in the field of research. This usually occurs when a researcher fabricates data, distorts data, or plagiarises someone else's work. To prevent plagiarism in this study, I completely followed the established norm of scientific behaviour. As a result, before writing the study report, I obtained information from the appropriate respondents and subjected it to thorough analysis. The University of Cape Coast's in-text and main referencing styles were used to properly acknowledge ideas, works, and publications.

Data Collection Procedures

A letter from the Department of Mathematics and ICT Education of the University of Cape Coast was sent to the headmasters and headmistresses of the schools which were selected for the study requesting permission to undertake the

study in their schools. Before the researcher arrived at the schools chosen for this study, the officials in these schools were informed about the research. This was done for the various school administrations in other for teachers and students to collaborate as much as possible. After gaining consent from the management of the various schools involved, teachers and students who were chosen to participate in the study were approached. Teachers and students were informed about the aim of the study. Questionnaires and achievement scores were administrated or used in different schools to complete the study in the course of their Core Mathematics period so that the teachers and students can react appropriately in the Core Mathematics setting.

Data Processing and Analysis

Bell (1999) stated that data collection comes in three phases, which include data codification, data entry, cleaning, and data analysis. The three stages of data collection were included in the analysis. In particular, the items on each questionnaire were labelled serially, immediately after data collection, to ensure simple detection, errors, and coding. Frequencies were performed to check all errors including missing values and outliers. The data from the study were examined for completeness, double responses, and non-response. The double responses and uncompleted questionnaire were taken out of the data collected and only a single response to items and completed questionnaire were used for the analysis. In all, the response rate of 366 (96.83%) was obtained from the sample of 378 students and a response rate of 18 (100%) from Core Mathematics teachers. In totality, 384 students and teachers were gathered for the study. Open-ended items

on the questionnaires were analysed using the quantitative approach where the responses from the respondents were put into themes. These themes were coded and analysed using frequencies and percentages. The data obtained were analysed using the Statistical Packages for Social Sciences (SPSS, version 22.0).

To answer research questions one to three on; teachers' perceptions of their Core Mathematics teaching approaches; students' perceptions of their Core Mathematics teachers' teaching approaches; and students' mathematical mindsets toward the learning of Core Mathematics, descriptive statistics such as mean, standard deviations, and frequencies were used to analyse the data.

Multiple regression analysis was used in analysing research hypothesis one which states that there is no statistically significant relationship between students' mathematical mindsets and their academic achievement in the learning of Core Mathematics.

The criterion means score (established mean cut-off point) for teachers' teaching approaches and students' perception of their Core Mathematics teaching approaches was 2.5. Responses on a four-point Likert scale were scored from 4 to 1 to achieve the test value as the criterion measure. That is $\left(\frac{1+2+3+4}{4} = \frac{10}{4} = 2.5\right)$. Therefore, the mean score of any teacher perception of teaching approaches (student-centred) which is above 2.5 depicts teachers making use of the student-centred approach, and a mean score of below 2.5 is a low practice of student-centred approach. On the other hand, mean scores of any teacher perception of teaching approaches (teacher-centred) which is above 2.5 depict teachers making use of the teacher-centred teaching and learning approach, and a mean score of below 2.5 is a

low practice of teacher-centred teaching and learning approach. The same meanings apply to the mean score for students' perception of their Core Mathematics teaching approaches.

Chapter Summary

Studying the influence of teaching approaches on students' mathematical mindsets requires an appropriate research method. This chapter discussed in detail the methodological underpinnings that guided this study. The research design, population, sample, and sample sampling techniques are extensively discussed. Also, data collection methods and the procedures that were followed with the analysis of data collected were described together with some ethical considerations that were adhered to.

CHAPTER FOUR

RESULTS AND DISCUSSION

Overview

The presentation and interpretation of the study's findings are presented in this section. The data were interpreted using the findings of the respondents' backgrounds and research questions as a guide. They included: the background characteristics of the respondents (sex, the highest qualification, number of years spent in teaching, how often do students learn mathematics), teachers' and students' perception of teaching approaches, and mathematical mindset of students.

Background Characteristics of Senior High School Form Two Students

Each responder was asked to provide information about his or her background characteristics, as these traits and features might impact their responses. They included: sex and how often they learn Core Mathematics on their own after lessons. The background characteristics of the respondents are presented in Table 3.

Table 3: Sex of SHS 2 student

Sex	Frequency	Percentage (%)
Male	208	56.8
Female	158	43.2
Total	366	100.0

Source: Field Data (2022)

Inferring from Table 3, it turned out that, the majority of the respondents were males. The next table presents the results on how students often learn Core Mathematics on their own after class sections.

Table 4: How often do students learn Core Mathematics on their own after lessons

Statements	Frequency	Percentage (%)
Everyday	52	14.2
Twice a week	116	31.7
Thrice a week	111	30.3
Four or more times a week	72	19.7
Not at all or None	15	4.1
Total	366	100.0

Source: Field Data (2022)

From Table 4, the majority of the students representing 116 (31.7%) showed that they learn mathematics twice a week while 15 (4.1%) out of 366 representing a minority of the respondents responded not to learning Core Mathematics at all.

Background Characteristics of SHS Core Mathematics Teachers

Each respondent was asked to provide information about his or her background characteristics, as these traits and features might impact their responses. These include sex, qualification, and the number of years spent in teaching. These background characteristics of respondents are presented in Table 5.

Table 5: Sex of SHS Mathematics Teachers

Sex	Frequency	Percentage (%)
Male	14	77.8
Female	4	22.2
Total	18	100.0

Source: Field Data (2022)

Inferring from Table 5, out of the 18 respondents who were involved in the study, it turned out that, the majority of the respondents were males. A clear indication of the number of male mathematics teachers in the Senior High School outnumbering the female mathematics teachers. The next table represents the results of Core Mathematics teachers' academic qualifications.

Table 6: Academic qualification of SHS Core Mathematics Teachers

Highest Qualification	Frequency	Percentage (%)
Bachelor's Degree	13	72.2
Master's Degree	5	27.8
PhD	0	0.0
Others	0	0.0
Total	18	100.0

Source: Field Data (2022)

The results displayed in Table 6 are the various academic qualifications that each mathematics teacher has obtained at the highest level. The findings showed that most of the mathematics teachers obtained the highest qualification of a Bachelor's Degree. The teaching experience of Core Mathematics teachers is represented in Table 7.

Table 7: Teaching experience of respondents at the SHS level

Teaching Experience	Frequency	Percentage (%)
Below 5 years	6	33.3
6 - 10 years	8	44.4
11 - 15 years	2	11.1
16 - 20 years	1	5.6
Above 20 years	1	5.6
Total	18	100.0

Source: Field Data (2022)

Table 7 presents the results of the teaching experiences of the mathematics teachers used in the study. It can be inferred from the table that the majority of Core Mathematics teachers has being in the teaching field for about six to ten years.

Research Question One: What are teachers' perceptions of their Core Mathematics teaching approaches?

The main goal of this research question was to ascertain how Core Mathematics teachers perceived their teaching approaches to student-centred approach and teacher-centred approach to teaching and learning. Teachers' perception of their teaching approaches questionnaires were scaled on a 4-point Likert scale format. The options on the Likert scale were scored as follows; Strongly Disagree-1, Disagree-2, Agree-3, and Strongly Agree-4 where a value of 1 indicates that the teachers' teaching approaches being measured hardly take place while 4 was interpreted as the teaching approaches that take place on a regular basis. The data obtained from the respondents were analysed by the use of mean and

standard deviation with the criterion mean score of 2.5 for teachers teaching approaches. Table 8 represents the results for how teachers perceive their teaching approaches.

Table 8: Teachers' perceptions of their Core Mathematics teaching approach

School Groupings	Group 1 (A, B, C)		Group 2 (D, E, F)	
Items	Mean	SD	Mean	SD
Student-centred approach				
I encourage my students to discuss their ideas with their colleagues.	2.89	0.78	3.22	2.22
I sometimes instruct my students to work in small groups.	3.67	0.50	2.22	1.09
I give my students time for discussion in their various groups during the core mathematics period.	2.89	0.93	2.56	1.23
I allow my students to create and implement their own methods.	3.00	1.00	1.67	0.71
I permit my students to make mistakes in order to discuss them.	2.56	1.01	2.00	1.12
I allow my students to compare and contrast various approaches to answering core mathematics questions.	3.00	0.87	2.89	0.78
I grade students' core mathematics assignments and meet with them to discuss the solutions.	3.22	0.67	2.78	1.20

Table 8 continued

I sometimes give my students group assignments which each group reports to the class during core mathematics period.	3.22	0.44	2.33	1.00
Mean of means	3.06		2.46	
Teacher-centred approach				
I tell my students the type of questions to solve in core mathematics class.	1.44	0.73	3.11	0.78
I allow my students to work alone in core mathematics class.	2.11	1.27	2.33	1.00
I demonstrate the type of method to use before instructing my students to do the same.	2.11	1.17	3.22	0.97
I carefully explain concepts to my students well in order for them not to make mistakes.	3.33	1.00	3.67	0.50
I sometimes restrict my students to following the procedures used in their notebooks.	2.33	0.87	2.33	0.87
I determine the type of questions to be solved in class.	2.78	1.20	3.11	1.05
My students listen and copy notes while I explain.	2.33	1.11	3.33	0.87
Mean of means	2.46		3.01	

Number of teachers in each group = 9, "SD" = Standard deviation.

Source: Field Data (2022).

Table 8 displays the results of Senior High School Core Mathematics teachers from two groups of schools. From Group 1 which comprises Schools A, B, and C, the findings indicated that the majority of mathematics teachers agreed

with the item "I sometimes instruct my students to work in small groups" (M = 3.67, SD = .50) and "I grade students' Core Mathematics assignments and meet with them to discuss the solutions" (M = 3.22, SD = .67). While a minority of the Core Mathematics teachers also responded to the statement "I give my students time for discussion in their various groups during the Core Mathematics period" (M = 2.89, SD = .93) and "I permit my students to make mistakes in order to discuss them" (M = 2.56, SD = 1.01) which all falls under the student-centred approach.

On the other hand, in responding to the items under the teacher-centred approach, the majority of the SHS Core Mathematics teachers agreed to the items "I carefully explain concepts to my students well in order for them not to make mistakes" (M = 3.33, SD = 1.00) and "I determine the type of questions to be solved in class" (M = 2.78, SD = 1.20) been the second-highest answered item. These items: "I demonstrate the type of method to use before instructing my students to do the same" (M = 2.11, SD = 1.17) and "I tell my students the type of questions to solve in Core Mathematics class" (M = 1.44, SD = .73) recorded the lowest mean.

In comparing the mean of means of the type of teaching approaches, it can be inferred from the results that the student-centred approach had the highest mean of 3.06 as compared with the teacher-centred teaching approach of mean 2.46. In referring to the criterion mean score of 2.5 for teachers teaching approaches, it can be then concluded that teachers in Group 1 align themselves with a student-centred approach to teaching and learning Core Mathematics.

In analysing the data of Group 2 which comprises Schools D, E, and F, most Core Mathematics teachers agreed to the statements "I encourage my students to

discuss their ideas with their colleagues" (M = 3.22, SD = 2.22) and "I allow my students to compare and contrast various approaches in answering Core Mathematics questions" (M = 2.89, SD = .78) while minority also agreed to the statement "I permit my students to make mistakes in order to discuss them" (M = 2.00, SD = 1.12) and "I allow my students to create and implement their own methods" (M = 1.67, SD = .71). These items fall under the subscale of the student-centred approach.

On the other hand, teachers answered items under the teacher-centred approach to teaching. These statements had the highest means: "I carefully explain concepts to my students well in order for them not to make mistakes" (M = 3.67, SD = .50) and "My students listen and copy notes while I explain" (M = 3.33, SD = .87). These items also had the lowest means: "I allow my students to work alone in Core Mathematics class" (M = 2.33, SD = 1.00) and "I sometimes restrict my students in following the procedures used in their notebooks" (M = 2.33, SD = .87).

In comparing the mean of means of the type of teaching approaches, as a consequence of the findings, it can be deduced that the teacher-centred approach had the highest mean of 3.01 as compared with the student-centred teaching approach of mean 2.46. In referring to the criterion mean score of 2.5 for teachers teaching approaches, it can be concluded that the responses of the teachers are indication that Senior High School teachers in Group 2 associate themselves with the teacher-centred approach to teaching and learning Core Mathematics.

In classifying schools into groups based on their teaching approaches, teachers' perceptions of their teaching approaches were used to check for

confirmation on the classification done by the researcher. The results showed that Schools A, B, and C belonging to Group 1 practice student-centred teaching and learning approach while Schools D, E, and F belonging to Group 2 also practice teacher-centred teaching and learning approach. Hence, these results of groupings conform to the findings obtained from the observational process.

The overall mean of means for Group 1 schools for teachers teaching approaches (M = 3.06) indicates that teachers associate themselves more with student-centred approaches to mathematics. This finding supports the assertion made by Briede (2016) that a student-centred approach is the best way of teaching but is a very complex process as it is mostly controlled by external and internal factors. The external factors relate to achievements while internal factors also relate to previous knowledge, beliefs, and mindset. This statement was backed by Kang and Keinonen (2018) as they revealed that a student-centred approach positively impacts students' academic achievements which were stated as an external factor by Briede (2016). Teachers in Group 1 schools made it known that they sometimes insist students work in small groups as emphasised by Zakaria and Iksan (2007) that group work as an approach to teaching is used as a method for teaching and as a research aid that offers teachers a sense of how students learn. Similarly, the features of the student-centred approach as emphasised by Zhao (2003) include encouraging various explanations and forms of learning, motivating students to examine and pose their questions, encouraging students to work together, and using their colleagues as learning resources. Hence, this approach produces active

learners as students are able to attain a higher thinking level (Abrams & Lockard, 2004).

The overall mean of means for Group 2 schools for teachers teaching approaches (M = 3.01) reports that teachers associate themselves with teacher-centred approaches to mathematics. The finding of this study is in line with the work of Kashefi, et al. (2017) which reported that a teacher-centred approach aids in the effectiveness of teaching and learning mathematics. The findings also conform to the statement of Ellsworth and Buss (2000) as they believe that teacher-centred teaching and learning approach focuses on students providing the right answers and encourages students to follow the exact processes that will result in the correct responses. They do not encourage wrong answers or mistakes. This approach has been identified in producing passive students, for this reason, the mathematics curriculum was revised in 2010 which was directed toward learner-centred approach to teaching and learning. Teachers still conform to this approach of teaching because they believe that it is an effective way of teaching various topics in mathematics and the relationships that exist between them (Boaler & Greeno, 2000). Hence, it is an easy way to achieve curriculum targets and objectives within a strict time frame (Jenkins, 2000). Others also aligned themselves with the teacher-centred approach to teaching because, during their secondary and training college education, they were trained using the same approach (Chapman, 2007).

About the analysis above, since the results indicated that teachers in Group 1 schools practice a student-centred approach and teachers in Group 2 schools were

also identified with a teacher-centred approach, the researcher sorted to establish or confirm the teaching approaches practiced by teachers by eliciting similar information from the students. Hence, this called for the next research question which seeks to investigate students' perception of their Core Mathematics teachers' teaching approaches.

Research Question Two: What are students' perceptions of their Core Mathematics teachers' teaching approaches?

The main goal of this research question was to ascertain how SHS 2 students perceived their Core Mathematics teachers teaching approaches in relation to student-centred approach and teacher-centred approach. Students' perceptions of their teachers' teaching approaches questionnaires were scaled on a 4-point Likert scale format. The options on the Likert scale were scored as follows; Strongly Disagree-1, Disagree-2, Agree-3, and Strongly Agree-4 where a value of 1 indicates that the teachers' teaching approaches being measured hardly takes place whiles 4 was interpreted as the teaching approaches that take place on a regular basis. Mean, standard deviation, and frequencies were used to analyse the data. The higher mean score implied that most of the respondents agreed with the specific statement. The criterion mean score (established mean cut-off point) for the perception of form two Senior High School students on teachers teaching approaches was 2.5. The results are presented in Table 9.

Table 9: Students' perceptions of their Core Mathematics teacher's teaching approaches

School Groupings	Group 1(A, B, C)			Group 2(D, E, F)		
Items	Mean	SD	Agree	Mean	SD	Agree
Student-centred Approach						
My core mathematics teacher encourages me to discuss my ideas with my colleagues.	3.40	0.83	90.2%	2.72	1.23	61.8%
My core mathematics teacher instructs us to work in small groups.	3.08	0.91	79.8%	2.37	1.16	47.0%
My teacher gives us time to discuss in our various groups during the core mathematics period.	2.51	0.95	48.6%	2.23	1.14	39.9%
My core mathematics teacher allows me to create and implement my methods.	2.75	0.98	64.0%	1.99	1.05	31.7%
My core mathematics teacher permits me to make mistakes in order to discuss them.	2.67	0.98	59.0%	2.12	1.05	39.9%

Table 9 continued

The core mathematics teacher wants me to compare and contrast various approaches to answering questions.	3.27	0.69	89.6%	2.51	1.08	60.1%
Normally, my core mathematics teacher grades our assignments and meets with us to discuss the solutions.	3.31	0.89	83.1%	2.38	1.22	50.8%
My core mathematics teacher sometimes gives us group assignments which each group reports to the class.	2.83	1.04	65.6%	2.10	1.22	33.9%
My core mathematics teacher sometimes gives us group assignments which each group reports to the class.	2.83	1.04	65.6%	2.10	1.22	33.9%
Mean of means	2.98			2.30		
Teacher-centred Approach						
My teacher tells me the type of questions to solve in core mathematics class.	2.43	1.11	46.5%	2.66	1.07	57.9%

Table 9 continued

My teacher requires me to work alone in core mathematics class.	2.24	1.08	38.8%	2.29	1.05	40.4%
My core mathematics teacher demonstrates which method to use before instructing me to use the same method.	2.78	1.16	66.1%	3.07	0.82	78.2%
My core mathematics teacher carefully explains concepts to me well in order not to make mistakes.	3.15	1.14	78.2%	3.25	0.90	80.8%
My core mathematics teacher wants me to strictly follow the procedures used in my notebook.	2.08	1.02	32.8%	2.49	0.94	50.9%
My core mathematics teacher determines the type of questions to solve.	2.19	0.98	36.6%	2.48	0.98	50.8%
My core mathematics teacher determines the type of questions to solve.	2.19	0.98	36.6%	2.48	0.98	50.8%

Table 9 continued

During core mathematics classes, I usually use my textbooks.	1.90	0.90	25.2%	2.03	0.99	31.2%
Mean of means	2.40			2.61		

Number of students in each group = 183, "SD" = Standard deviation.

Source: Field Data (2022).

Table 9 displays the results on students' perception of teachers teaching approaches from two groups of schools. From Group 1 which comprises Schools A, B, and C, the findings indicated that students strongly agree with the following statements under the student-centred approach of teaching; "My Core Mathematics teacher encourages me to discuss my ideas with my colleagues" (M = 3.40, Agree = 90.2%) and "Normally, my Core Mathematics teacher grades our assignments and meets with us to discuss the solutions" (M = 3.31, Agree = 83.1%). On the other hand, the following items "My Core Mathematics teacher permits me to make mistakes in order to discuss them" (M = 2.67, Agree = 59.0%) and "My teacher gives us time to discuss in our various groups during the Core Mathematics period" (M = 2.51, Agree = 48.6%) recorded low mean scores.

In concentrating on the subscale of the teacher-centred approach to the teaching of Group 1, these items recorded higher mean scores; "My Core Mathematics teacher carefully explains concepts to me well in order not to make mistakes" (M = 3.15, Agree = 78.2%) and "My Core Mathematics teacher demonstrates which method to use before instructing me to use the same method" (M = 2.78, Agree = 66.1%) while some of the items with the least mean scores are as followers; "My Core Mathematics teacher determines the type of questions to

solve" (M = 2.19, Agree = 36.6%) and "My Core Mathematics teacher wants me to strictly follow the procedures used in my notebook"(M = 2.08, Agree = 32.8%).

In comparing the mean of means of the type of teaching approaches, it can be inferred from the results that student-centred approach had the highest mean of 2.98 as compared with teacher-centred teaching approach of mean 2.40. In referring to the criterion mean score of 2.5 for students' perception of teaching approaches, it can be then concluded that students in Group 1 experience a student-centred approach to teaching and learning Core Mathematics in their respective classrooms.

From Group 2 which comprises Schools D, E, and F, students' responses to items under the student-centred approach showed that these statements recorded high mean scores; "My Core Mathematics teacher encourages me to discuss my ideas with my colleagues" (M = 2.72, Agree = 61.8%) and "The Core Mathematics teacher wants me to compare and contrast various approaches in answering questions" (M = 2.51, Agree = 60.1%) while these items also recorded low mean score; "My Core Mathematics teacher sometimes gives us group assignments which each group reports to the class" (M = 2.10, Agree = 33.9%) and "My Core Mathematics teacher allows me to create and implement my methods" (M = 1.99, Agree = 31.7%).

On the other hand, in addressing the items under the teacher-centred approach, the majority of the students agreed with the items "My Core Mathematics teacher carefully explains concepts to me well in order not to make mistakes" (M = 3.25, Agree = 80.8%) and "My Core Mathematics teacher demonstrates which method to use before instructing me to use the same method" (M = 3.07, Agree =

78.2%) been the second highest answered item. These statements "My teacher requires me to work alone in Core Mathematics class" (M = 2.26, Agree = 40.4%) and "During Core Mathematics classes, I usually use my textbooks" (M = 2.03, Agree = 31.2%) recorded the lowest mean.

In comparing the mean of means of the type of teaching approaches, as a consequence of the findings, it can be deduced that teacher-centred approach had the highest mean of 2.61 as compared with student-centred teaching approach of mean 2.30. In referring to the criterion mean score of 2.5 for teachers teaching approaches, it can be then concluded that students in Group 2 experience a teacher-centred approach to teaching and learning Core Mathematics in their respective classrooms.

The results suggest that students in Group 1 schools perceive their Core Mathematics teachers to use a student-centred approach to teaching with the overall mean of means being 2.98. The findings of this present study contradict the study conducted by Govender (2015) which focused on the perception of students on methods of teaching mathematics. The findings of the work of Govender (2015) revealed that students perceive their teachers to use teacher-centred teaching and learning approach. The work revealed that teachers always use the lecture method approach of teaching as compared to group work, individual presentation, and case study where the instructor always tells them what to do in class. Govender (2015) made it known that alternative teaching methods that involve active participation were perceived to be less commonly used by teachers. But the findings of the present study show that teachers in Group 1 schools encourage their students to

discuss their ideas with colleagues. This statement is backed by Ball and Bass (2000) as they emphasised that conversations between students or group discussions foster and improve the mathematical understanding of learners as their ideas and their responses are addressed in class.

Also, teachers in Group 1 schools give feedback to the students and permit students to make mistakes in order to discuss them. In concentrating on the constructive feedback given by teachers, Sharon (2008) established the fact that students can be academically competitive when they receive positive feedback. Also, Hong, Chui, Dweck, Lin, and Wan (1999) found that when people with a growth mentality are given negative feedback, they are more likely to ascribe lower achievement due to lack of effort and are willing to take remedial action to enhance their achievement as compared to people with fixed mentality. Hence, giving students feedback helps in identifying their mistakes that automatically affect their achievement either positively or negatively. When students learn from their mistakes, students are better equipped to deal with similar situations in the future (Boaler, 2013). According to Hall (2016), to prevent students from developing a fixed mindset, teachers should encourage them to think about why they made a mistake and how they may have avoided it.

The overall mean of means for Group 2 schools on how students perceive their teacher's teaching approaches (M = 2.61) revealed that teachers adopt the use of a teacher-centred approach. The finding affirmed that of Kurniati and Surya (2017) who stated that teachers still used the teacher-centred approach. The present study made it known that mathematics teachers carefully explain the concept to

them in order not to make mistakes. The finding was supported by Ellsworth and Buss (2000) as they believe that teacher-centred teaching and learning approach focuses on students providing the right answers and encourages students to follow the exact processes that will result in the correct responses. Regardless of these advantages, Ellsworth and Buss (2000) reported that the focus on laid down principles and rules only contributes to students engaging passively in lessons and influences their achievement adversely. As Ball and Kuhs (1986) reported that teacher-centred approach produces passive learners and students get to learn in a procedural and structured way.

Students also reported that their mathematics teachers demonstrate which method to use before instructing them to use the same. Similarly, among the findings of Adentunde (2007), it was reported that the teacher is regarded as the knowledge bank where students sit quietly and listen to what the teachers tell them of which they make their notes out of it. In addition, a work conducted by Owusu, Monney, Appiah, and Wilmot (2010) emphasised that students prefer the use of the teacher-centred approach rather than the use of computer-assisted instruments as the teacher-centred learning approach helps in boosting their achievement.

In comparing the results of research questions one and two, it revealed that there was a match between teachers' perception of their teaching approaches and students' perception of their Core Mathematics teachers' teaching approaches in Group 1 and Group 2 schools, hence there exist some level of consistency between the results of teachers and students. The results do not agree with the work of Ampadu (2012) who stated that teachers proclaim to use the constructivist (student-

centred) approach to instruction but from the student's perspective, the teachers use the behaviourist (teacher-centred) approach which shows some level of contradiction between students' perception and teachers' perception of teaching approaches.

Since the present study shows consistency between students' and teachers' results, the researcher followed to find out the mindset of students towards learning Core Mathematics from the various groups of schools as the next research question, as it is believed that teaching approaches or instruction to teaching affect or lead to the formation of the mindset of students (Yeager & Dweck, 2012).

Research Question Three: What are students' mathematical mindsets toward the learning of Core Mathematics?

The main purpose of this research question was to determine the mathematical mindset of SHS students of Group 1 and Group 2 schools. The questionnaire comprised of 20 closed-ended items and 4 open-ended items. The options on the Likert scale were scored as follows for the statement which reflected a fixed mindset; Strongly Agree-0, Agree-1, Disagree-2, and Strongly Disagree-3. Also, the options on the Likert scale were scored as follows for the statement which reflected a growth mindset; Strongly Agree-3, Agree-2, Disagree-1, and Strongly Disagree-0. Respondents with total points ranging from 60-45 possess a strong growth mindset, and respondents with points from 44 to 34 possess a growth mindset with some fixed ideas. Also, respondents with 33-21 total points were classified as having a fixed mindset with some growth ideas. Lastly, respondents with total points ranging from 20-0 are recognised as having a strong fixed mindset.

Results displayed in Figure 1 present the findings of students' mathematical mindsets toward learning Core Mathematics.

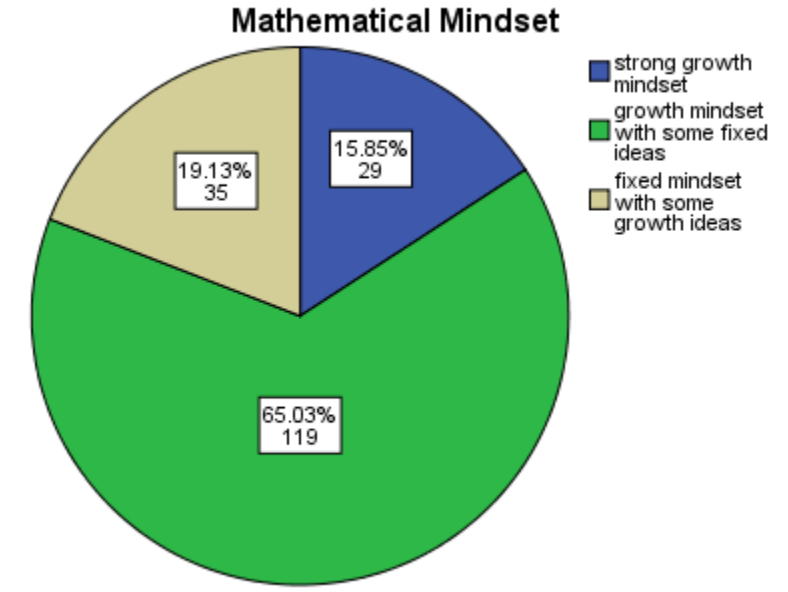

Figure 1: Mindset of SHS students in Group 1

It was discovered that fewer respondents representing 15.85% (N = 29) of students possess a strong growth mindset belief. Also, the most of the students (65.03%, N = 119) possess a growth mindset with some fixed ideas. It can be inferred from Figure 1 that none of the students possesses a strong fixed mindset.

In reacting to the open-ended items, out of 183 respondents, 39 students representing 21.3% wrote "Core Mathematics" as their favourite subject and 12 students representing 6.6% indicated that "Elective Mathematics" is their favourite subject. Meaning 51 students, representing 27.9% like the subject mathematics in general. While 132 students, representing 72.1% revealed that they liked other subjects being it English, Science, Social Studies, *etc*. The reasons why students selected these subjects are as follows: (i) Easy to understand or learn (N = 59,

32.2%), (ii) I love the subject (N = 48, 26.2%), (iii) It is applicable in our daily life (N = 39, 21.3%), (iv) It makes one reason logically (N=16, 8.7%), (v) The teacher influences (N = 10, 5.5%), (vi) I perform well or get good grades in the subject (N = 7, 3.8%), (vii) Future dreams or aspirations (N = 2, 1.1%), and two students (1.1%) did not state any reason for having a favourite subject.

The next question in the open items section was "Do you consider yourself a mathematics person?". The following responses were obtained, 111 (60.7%) students out of 183 indicated "Yes" and 72 (39.3%) students represented "No". Students who responded "Yes" gave the following reasons: (i) Mathematics is easy to understand and learn (N = 61, 54.9%), (ii) Am good and have an interest in the subject (N = 29, 26.1%), (iii) Positive influence of the teacher (N = 12, 10.8%), (iv) I perform well or get good grades in the subject (N = 10, 9.0%), and (v) Able to apply mathematics in my daily life activities (N = 1, 0.9%). The reasons for the students who answered "No" are as follows: (i) Difficulty in learning the subject (N = 46, 63.9%), (ii) Am not good at the subject (N = 16, 22.2%), and (iii) Negative influence of the teacher (N = 5, 6.9%), while 3 students (1.6%) did not answer this section of the items.

The majority of SHS students in Group 1 have a growth mindset, according to the findings. The findings also support the work of Adhitya and Prabawanto (2018) as they reported that majority of the students possess a growth mindset with fixed ideas while none of the students in the work of Adhitya and Prabawanto (2018) possesses a strong fixed mindset belief. The work of Madden (2015) indicated that the number of students with a growth mindset with some fixed ideas

surpasses that of students with a fixed mindset with some growth ideas. The work of Madden (2015) is in line with this present study as the results revealed that 65.03% of students possess a growth mindset with some fixed ideas while 19.13% of the students also showed to hold a fixed mindset with some growth ideas. The minority of students in this present study indicated that for them to consider themselves as mathematics people, much depends on the teacher factor which can be in the form of motivation, teacher-student interactions, and the approaches to teaching. This statement is backed by the work of Rothrock (2019) as it was indicated that teachers' approach to teaching, classroom environment, and mathematical identity are some major factors that count in the development of students' mindsets. Figure 2 also depicts the results obtained on students' mathematical mindsets toward learning Core Mathematics.

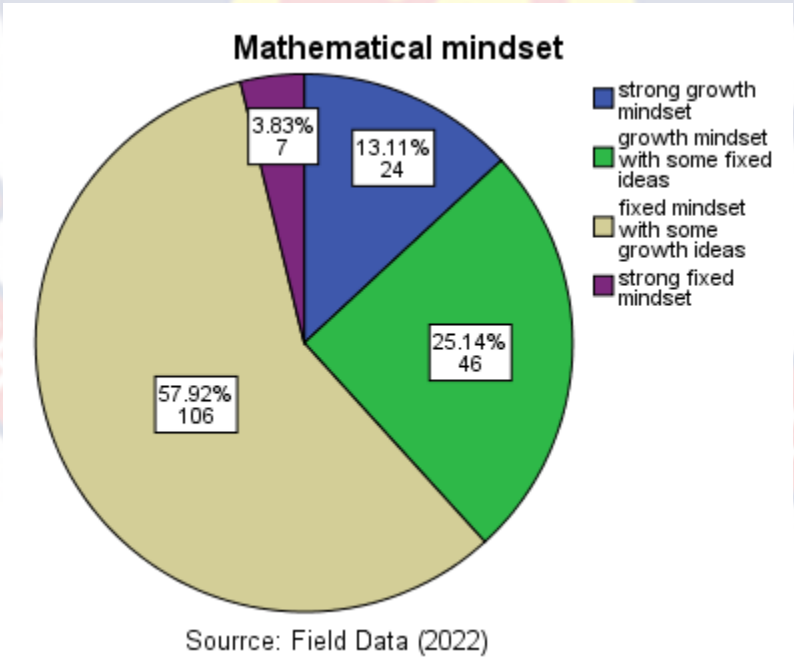

Figure 2: Mindset of SHS students in Group 2

The results revealed that 13.11% (N = 24) were classified as possessing a strong growth mindset. Also, the findings showed that most of the students possessed a fixed mindset with some growth ideas. This is represented by 57.92% (N = 106) of the total sample. However, 7 out of the 183 held a strong fixed mindset belief representing 3.83%.

In responding to the open-ended items, out of 183 respondents, 69 students representing 37.7% wrote "Core Mathematics" as their favourite subject, and 8 students representing 4.4% indicated that "Elective Mathematics" is their favourite subject. Meaning 77 students representing 41.7% like the subject mathematics in general. While 106 students signifying 57.9% revealed that they like other subjects being it English, Science, Social Studies, *etc*. The reasons why students selected these subjects are as follows: (i) Easy to understand or learn (N = 48, 26.2%), (ii) I love the subject (N = 41, 22.4%), (iii) The teacher influences (N = 31, 16.9%), (iv) It is applicable in our daily life (N = 26, 14.2%), (v) It makes one reason logically (N = 20, 10.9%), (vi) Future dreams or aspirations (N = 11, 6.0%), and (vii) I perform well or get good grades in the subject (N = 2, 1.1%), and four students (2.2%) did not state any reason for having a favourite subject.

The next question in the open items section was "Do you consider yourself a mathematics person". With the responses given, 126 (68.9%) students out of 183 indicated "Yes" and 57 (31.1%) students represented "No". Students who responded "Yes" were with the reason that: (i) Mathematics is easy to understand and learn (N = 59, 46.8%), (ii) Am good and have an interest in the subject (N = 34, 26.9%), (iii) Positive influence of the teacher (N = 13, 10.3%), (iv) I perform

well or get good grades in the subject (N = 13, 10.3%), and (v) Able to apply mathematics in my daily life activities (N = 8, 6.3%). The reasons for the students who answered "No" are as follows: (i) Difficulty in learning the subject (N = 36, 66.7%), (ii) Am not good at the subject (N = 9, 16.7%), and (iii) Negative influence of the teacher (N = 7, 12.9%), while 4 students (2.2%) did not answer this section of the items.

In most cases, students tend to favour one theory over the other, however, they may support both growth and fixed mindsets, depending on the context in which they are used (Hwang, Reyes, & Eccles, 2019). The results of this study support Boalor (2013) who emphasised that students might have a combination of the two mentalities where a growth mentality is held by 40 per cent of students, a fixed mindset by 40 per cent, and a mixed mindset by 20 per cent of students but did not indicate the extent to which growth or fixed mindset surpass the other. The present study indicates the extent to which a particular mindset surpasses the other, for instance, 57.92% of the students possess a fixed mindset with some growth ideas and 25.14% of students showed to hold a growth mindset with some fixed ideas.

Since the various mindset of students has been made known from the results above, the researcher followed up to find out whether there is any significant relationship between students' mathematical mindsets and their Core Mathematics academic achievement as the next research hypothesis.

Hypothesis One: There is no statistically significant relationship between students' mathematical mindsets and their academic achievement in Core Mathematics

Before the analysis of this research hypothesis, the researcher scaled the various mindset developed by students been; strong growth mindset, growth mindset with fixed ideas, fixed mindset with growth ideas, and strong fixed mindset of the mindset questionnaire into only growth mindset and fixed mindset. This aspect of the research hypothesis was to elicit the type of mindset students develop when they are taught with a particular teaching approach.

Table 10: Students' mathematical mindsets toward learning Core Mathematics for Group 1 schools

Students' mindset	Frequency	Percentages (%)
Growth mindset	148	80.9
Fixed mindset	35	19.1
Total	183	100.0

Source: Field Data (2022)

Results displayed in Table 10 present the findings of students' mathematical mindsets about the teaching approach used in Group 1 schools. The findings showed that most students possess a growth mindset in Group 1 schools as the approach to teaching in this group is student-centred approach. Hence, it can be concluded that when teaching is student-centred, the students possess a more growth mindset.

Table 11: Students' mathematical mindsets toward learning Core Mathematics for Group 2 schools

Students' mindset	Frequency	Percentages (%)
Growth mindset	71	38.8
Fixed mindset	112	61.2
Total	183	100.0

Source: Field Data (2022)

Table 11 presents the results of students' mathematical mindsets in relation to the teaching approach used in Group 2 schools. It can be inferred from the table that the majority of the students possess a fixed mindset in Group 2 schools as the approach to teaching in this group is the teacher-centred approach. Therefore, it can be established that the more teaching takes the form of teacher-centred, the more students possess a fixed mentality.

The results revealed that students develop a more growth mindset when they are taught with a student-centred approach while students possess a more fixed mindset when taught with a teacher-centred approach. The type of mindset developed by these students are as the result of their free will to think in the classroom, the approach used by the Core Mathematics teachers allows students to learn through their mistakes and discover information by their selves. Sun (2018) made it known that teaching approaches are one of the critical elements that influence the development of students' mindsets. But, Stohlmann (2022, p. 159) reported that "students may have a general growth mindset, but for a specific subject such as mathematics or science they may hold more fixed mindset beliefs". This result is not in confirmation with the present study, as the analysis of Table 10

revealed that when students are taught using a student-centred approach, they develop a growth mindset. It can be concluded that the mindsets developed by students are not the result of the subject but as a result of the approaches used in teaching.

The findings of Table 10 are in support of the findings of O'Brien, Makar, Fielding-Wells, and Hillman (2015) who reported that students possess a growth mindset when they are taught with a student-centred approach in the mathematics classroom. Similarly, the finding is in consonance with the findings of Sun (2015) as the study revealed that teaching mathematics in a student-centred approach that exceeds algorithm and procedural work aids in the formation of a growth mindset on the part of students. Sun (2015) further stated that exposing students to triggering questions helps them develop a growth mentality.

About the results of Table 11, the intelligence of students with a fixed mentality is seen as rigid and cannot be controlled (Dweck, 2006). These students are less willing to try something new in order to avoid making mistakes. But, Ellsworth and Buss (2000) reported that the teacher-centred teaching and learning approach focuses on students providing the right answers and encourages students to follow the exact processes in order to avoid mistakes that will result in the correct responses. Hence, there appears to exist a relationship between teacher-centred teaching and learning approach and a fixed mindset. The similarities between the studies imply that in different settings, the student-centred approach will elicit a growth mindset and the teacher-centred approach will also elicit a fixed mindset.

The next section sought to determine the relationship between the sub-dimensions of students' mathematical mindsets (Fixed Mindset and Growth Mindset) and their academic achievement in the learning of Core Mathematics. This section is in six-folds. The researcher used all the schools in the study since these schools did not answer the same achievement test but rather their end-of-second term results were used in determining their achievement. Because of confidentiality and anonymity, the schools were assigned with codes namely; School A, School B, School C, School D, School E, and School F. Schools A, B, and C aligned themselves to a student-centred approach while Schools D, E, and F aligned themselves to teacher-centred approach.

School A

This hypothesis sought to determine the significant relationship between the sub-dimensions of students' mathematical mindsets (Fixed Mindset and Growth Mindset) and their academic achievement in Core Mathematics. The analysis of School A results is presented in Table 12.

Table 12: Model summary and fit statistics of the relationship between sub-dimensions of student's mindset and their academic achievement

Model		Sum of Squares	*df*	Mean Square	*F*	Sig.	R^2
1	Regression	591.262	2	295.631	1.604	.210	.052
	Residual	10687.788	58	184.272			
	Total	11279.049	60				

Criterion Variable: Achievement Scores; Predictors: Growth and Fixed mindset

The model summary and fit statistics of the regression findings are highlighted in Table 12. Following the analysis, it was discovered that the data which comprised sub-dimensions of students' mindsets do not fit the model, $F(2, 58) = 1.604$, $p = .210$, which means that the results are not significant. The interpretation of the individual contributions is shown in Table 13.

Table 13: Coefficient of the prediction of student's mindset on academic achievement

Model	B	SE	beta	T	Sig.	LLCI	ULCI
(Constant)	87.006	12.230		7.114	.000	62.525	111.487
Fixed Mindset	-.574	.377	-.195	-1.524	.133	-1.328	.180
Growth Mindset	-.399	.456	-.112	-.875	.385	-1.312	.514

B = Unstandardised Coefficient; SE = Standard Error; LLCI = Lower Limit Confidence Interval; ULCI = Upper Limit Confidence Interval

The study findings revealed that fixed mindset and growth mindset jointly explained about 5.2% of the variability in academic achievement. The results revealed that fixed mindset (beta = -.195, SE = .377, t = -1.524, Boot*CI* (-1.328, .180) was not a predictor of student's academic achievement. The study again revealed that growth mindset (beta = -.112, SE = .456, t = -.875, BootCI (-1.312, .514) did not have any relationship with students' academic achievement.

School B

Table 14 sought to determine the relationship between the sub-dimensions of students' mathematical mindsets (Fixed Mindset and Growth Mindset) and their

academic achievement in the learning of Core Mathematics. The analysis of School B results is presented in Table 14.

Table 14: Model summary and fit statistics of the relationship between sub-dimensions of student's mindset and their academic achievement

Model		Sum of Squares	*df*	Mean Square	*F*	Sig.	R^2
2	Regression	2677.433	2	1338.717	5.097	.009	.149
	Residual	15233.616	58	262.649			
	Total	17911.049	60				

Criterion Variable: Achievement Scores; Predictors: Growth, Fixed Mindset

The model summary and fit statistics of the regression findings are highlighted in Table 14. Following the analysis, it was discovered that the data which comprised sub-dimensions of students' mindsets fit the model, $F(2, 58) = 5.097$, $p = .009$, which means that the results were statistically significant. The interpretation of the individual contributions is shown in Table 15.

Table 15: Coefficient of the prediction of student's mindset on academic achievement

Model	B	SE	beta	T	Sig.	LLCI	ULCI
(Constant)	13.454	18.012		.747	.458	-22.602	49.509
Fixed Mindset	1.046	.481	.264	2.173	.034	.083	2.009
Growth Mindset	1.494	.703	.359	2.126	.038	.087	2.900

B = Unstandardised Coefficient; SE = Standard Error; LLCI = Lower Limit Confidence Interval; ULCI = Upper Limit Confidence Interval

Achievement = 13.454 + 1.046 *fixed mindset* + 1.494 *growth mindset.*

The outcome of the analysis suggests that mindsets explained about 14.9% of the variance in academic achievement. The results revealed that fixed mindset [Boot*CI* (.083, 2.009)] and growth mindset [Boot*CI* (.087, 2.900)] were significant predictors of students' academic achievement. With the regression equation, a unit increase in fixed mindset causes achievement to increase by 1.046 when growth mindset is held constant and a unit increase in growth mindset causes achievement to increase by 1.494 when fixed mindset is held constant**.** The implication is that students with a growth mindset (beta = .359) predicted a higher academic achievement as compared to a fixed mindset (beta = .264).

School C

Table 16 sought to determine the significant relationship between the sub-dimensions of students' mathematical mindsets (Fixed Mindset and Growth Mindset) and their academic achievement in Core Mathematics. The analysis of School C results is presented in Table 16.

Table 16: Model summary and fit statistics of the relationship between sub-dimensions of student's mindset and their academic achievement

Model		Sum of Squares	*df*	Mean Square	*F*	Sig.	R^2
3	Regression	1577.537	2	788.768	1.564	.218	.051
	Residual	29248.529	58	504.285			
	Total	30826.066	60				

Criterion: Academic Scores; Predictor: Growth and fixed mindset

The model summary and fit statistics of the regression findings are highlighted in Table 16. Following the analysis, it was discovered that the data

which comprised sub-dimensions of students' mindsets do not fit the model, $F(2, 58) = 1.564$, $p = .218$, which means that the results were not significant. The interpretation of the individual contributions is shown in Table 17.

Table 17: Coefficient of the prediction of student's mindset on academic achievement

Model	B	SE	Beta	T	Sig.	LLCI	ULCI
(Constant)	7.874	25.052		.314	.754	-42.273	58.020
Fixed Mindset	.322	.594	.074	.543	.589	-.866	1.511
Growth Mindset	1.578	.893	.241	1.767	.083	-.210	3.367

B = Unstandardised Coefficient; SE = Standard Error; LLCI = Lower Limit Confidence Interval; ULCI = Upper Limit Confidence Interval

The study findings also revealed that fixed mindset and growth mindset jointly explained about 5.1% of the variability in academic achievement. The results revealed that fixed mindset (beta = .074, SE = .594, t = .543, Boot*CI* (-.866, 1.511) was not a predictor of student's academic achievement. The study again revealed that growth mindset (beta = .241, SE = .893, t = 1.767, Boot*CI* (-.210, 3.367) did not have any relationship with students' academic achievement.

School D

The results in Table 18 present the relationship between students' mathematical mindsets and students' academic achievement. The details of School D are presented in Table 18.

Table 18: Model summary and fit statistics of the relationship between sub-dimensions of student's mindset and their academic achievement

Model		Sum of Squares	*df*	Mean Square	*F*	Sig.	R^2
4	Regression	2291.695	2	1145.847	5.007	.010	.147
	Residual	13272.043	58	228.828			
	Total	15563.738	60				

Criterion: Academic Scores; Predictor: Growth and fixed mindset

The model summary and fit statistics of the regression findings are highlighted in Table 18. Following the analysis, it was discovered that the data which comprised sub-dimensions of students' mindsets fit the model, $F(2, 58) = 5.007$, $p = .010$, which means that the results were statistically significant. The interpretation of the individual contributions is shown in Table 19.

Table 19: Coefficient of the prediction of student's mindset on academic achievement

Model	B	SE	Beta	T	Sig.	LLCI	ULCI
(Constant)	40.829	9.448		4.321	.000	21.916	59.741
Fixed Mindset	1.115	.432	.318	2.580	.012	.250	1.980
Growth Mindset	.486	.365	.164	1.334	.188	-.244	1.216

B=Unstandardised Coefficient; SE=Standard Error; LLCI=Lower Limit Confidence Interval; ULCI=Upper Limit Confidence Interval

Achievement = 40.829 + 1.115 *fixed mindset.*

The study findings revealed that mindsets explained about 14.7% of the variability in academic achievement. The results revealed that fixed mindset (beta

= .318, SE = .432, t = 2.580, Boot*CI* (.250, 1.980) was a predictor of student's academic achievement. The study again revealed that growth mindset (beta = .164, SE = .365, t = 1.334, Boot*CI* (-.244, 1.216) did not have any relationship with students' academic achievement. With the regression equation, a unit increase in fixed mindset causes achievement to increase by 1.115 and students' achievement would be 40.829 when fixed mindset is held constant. The overall model summary was significant which concludes that students' mathematical mindsets influence students' academic achievement.

School E

The results in Table 20 present the significant relationship between the sub-dimensions of students' mathematical mindsets (Fixed Mindset and Growth Mindset) and their academic achievement in Core Mathematics. The analysis of School E results is presented in Table 20.

Table 20: Model summary and fit statistics of the relationship between sub-dimensions of student's mindset and their academic achievement

Model		Sum of Squares	*df*	Mean Square	*F*	Sig.	R^2
5	Regression	722.763	2	361.382	1.324	.274	.044
	Residual	15825.040	58	272.846			
	Total	16547.803	60				

Criterion: Academic Scores; Predictor: Growth and fixed mindset

The model summary and fit statistics of the regression findings are highlighted in Table 20. Following the analysis, it was discovered that the data which comprised sub-dimensions of students' mindsets do not fit the model, *F*(2,

58) = 1.324, p = .274. The results were not statistically significant. The interpretation of the individual contributions is shown in Table 21.

Table 21: Coefficient of the prediction of student's mindset on academic achievement

Model	B	SE	Beta	T	Sig.	LLCI	ULCI
(Constant)	53.506	8.093		6.612	.000	37.307	69.705
Fixed Mindset	-.588	.413	-.190	-1.423	.160	-1.414	.239
Growth Mindset	.411	.357	.153	1.150	.255	-.304	1.126

B = Unstandardised Coefficient; SE = Standard Error; LLCI = Lower Limit Confidence Interval; ULCI = Upper Limit Confidence Interval

The study findings revealed that fixed mindset and growth mindset jointly explained about 4.4% of the variability in academic achievement. The results revealed that fixed mindset (beta = -.190, *SE* = .413, *t* = 1.423, Boot*CI* (-1.414, .239) and growth mindset (beta = .153, *SE* = .357, *t* = 1.150, Boot*CI* (-.304, 1.126) were not predictors of student's academic achievement.

School F

In School F, the study looked at the relationship between the sub-dimensions of students' mathematical mindsets (Fixed Mindset and Growth Mindset) and their academic achievement in the learning of Core Mathematics. The analysis of School F results is presented in Table 22.

Table 22: Model summary and fit statistics of the relationship between sub-dimensions of student's mindset and their academic achievement

Model		Sum of Squares	*df*	Mean Square	*F*	Sig.	R^2
6	Regression	1108.519	2	554.260	1.409	.253	.056
	Residual	22819.710	58	393.443			
	Total	23928.230	60				

Criterion: Academic Scores; Predictor: Growth and fixed mindset

The model summary and fit statistics of the regression findings are highlighted in Table 22. Following the analysis, it was discovered that the data which comprised sub-dimensions of students' mindsets did not fit the model, F(2, 58) = 1.409, p = .253. The results were not statistically significant. The interpretation of the individual contributions is shown in Table 23.

Table 23: Coefficient of the prediction of student's mindset on academic achievement

Model	B	SE	beta	T	Sig.	LLCI	ULCI
(Constant)	48.195	12.992		3.710	.000	22.189	74.202
Fixed Mindset	-.684	.537	-.164	-1.273	.208	-1.759	.391
Growth Mindset	.670	.551	.157	1.216	.229	-.433	1.774

B = Unstandardised Coefficient; SE = Standard Error; LLCI = Lower Limit Confidence Interval; ULCI = Upper Limit Confidence Interval

Lastly, the study findings revealed that fixed mindset and growth mindset jointly explained about 5.6% of the variability in academic achievement. The results revealed that fixed mindset (beta = -.164, SE = .537, t = -1.273, Boot*CI* (-

1.759, .391) and growth mindset (beta = .157, *SE* = .551, *t* = 1.216, Boot*CI* (-.433, 1.774) did not have any influence on student's academic achievement.

Comparison of the Respective Schools

The study proceeded to compare the respective schools which include School A, School B, School C, School D, School E, and School F where Group 1 schools comprise Schools A to C while Group 2 schools also comprise Schools D, E, and F. Concerning School A, School C, School E, and School F, student mindset did not have any influence on students' academic achievement. The results again revealed that in School B, students' mathematical mindsets $F(2, 58) = 5.097$, $p = .009$) had a statistically significant relationship with students' academic achievement. Both growth and fixed mindset were identified to have a significant relationship with students' academic achievement. The results revealed that an increase in students' growth mindset will lead to an increase in academic achievement (B = 1.494). Also, when students have an increase in their fixed mentality, it increases achievement (B = 1.046). Hence, the growth mindset dominates that of the fixed mindset in terms of academic achievement in Core Mathematics with the beta values .359 and .264 respectively

Mathematical mindset of students in School D, $F(2, 58) = 5.007$, $p = .010$) had a statistically significant relationship with students' academic achievement. From the analysis, a growth mindset did not have any significant relationship with students' academic achievement with [B = .486, Boot*CI* (-.244, 1.216)] but fixed mindset was identified as having a significant relationship with students' academic achievement with Boot*CI* (.250, 1.980).

Generally, it can be concluded that students' mindsets in School B (student-centred approach) and School D (teacher-centred approach) had a relationship with students' academic achievement. This implies that both growth and fixed mindset predict students' academic achievement but, a growth mindset predicts a higher achievement in Core Mathematics as compared to a fixed mindset from School B. However, students' mindsets in School A, School C, School E, and School F, did not have any relationship with students' academic achievement.

The preceding analysis suggests that there is a statistically significant relationship between Group 1 and Group 2 Senior High School students' mathematical mindsets and their achievement in the learning of Core Mathematics. This discovery contradicts the findings of Dupeyrat and Mariné (2005) who found that the mindset of students has no significant relationship with their mathematics achievement. They emphasised that students endorsed a growth mindset as compared to a fixed mindset but have no influence on their achievement in mathematics. In revealing the type of mindset which can predict Core Mathematics achievement, from Schools in Group 1 that endorse student-centred teaching and learning approach, a growth mindset was identified as a higher predictor of achievement in Core Mathematics when there is an increase in their growth mentality as compared with a fixed mindset. This is in line with what Zhang, Kuusisto, and Tirri (2017) reported that a growth mindset predicts higher achievement while a fixed mindset predicts lower achievement as they emphasised that the cause and mediator of students' academic achievement is their mindset. Similarly, Grant and Dweck (2003) stated that students with a growth mindset

mentality produce higher grades as compared to students with a fixed mindset mentality. Kismiantini, Pierewan, and Montesinos-López (2021) also affirm the statement that a growth mindset serves as a strong predictor of students' achievement in mathematics.

In making known the type of mindset which can predict Core Mathematics achievement, from Schools in Group 2 that endorse teacher-centred teaching and learning approach, the fixed mindset was identified as a higher predictor of students' academic achievement in Core Mathematics when there is an increase in their fixed mentality. However, the findings of this study are in contrast to the findings of Hwang, Reyes, and Eccles (2019) that a fixed mindset predicted lower academic achievement in mathematics. The contradiction between the findings of the study and that of Hwang, Reyes, and Eccles (2019) could be due to the approaches teachers used in teaching that elicited lower grades.

Chapter Summary

The findings emanating from the data analysis of this study were discussed in this chapter. Discussions were made with inferences drawn from the findings in relation to other previous studies that were related to the variables in the present study. A sample of 366 students and 18 mathematics teachers participated in the study. Three research questions and one hypothesis were tested. It was discovered from the analysis that Senior High School mathematics teachers in Group 1 schools perceive their teaching and learning process to take the form of a student-centred approach while teachers in Group 2 schools perceive their instructional process to take the form of a teacher-centred approach. Again, the study found that Senior

High students in Group 1 schools perceive their teachers to use a student-centred teaching and learning approach. They also possess a strong growth mindset, growth mindset with some fixed ideas, and fixed mindset with some growth ideas. Also, students in Group 2 schools perceive their teachers to use a teacher-centred approach to teaching and learning mathematics in class and were identified as having a strong growth mindset, a growth mindset with some fixed ideas, a fixed mindset with some growth ideas, and strong fixed mindset. Generally, Group 1 schools were identified with a more growth mindset and Group 2 schools were also identified to possess a more fixed mindset. In testing the hypotheses, a significant relationship was found between students' mathematical mindsets and their academic achievement in the learning Core Mathematics among Group 1 and Group 2 schools.

CHAPTER FIVE

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

Overview

This chapter highlights the study's summary, conclusions, and recommendations. The study's main objective, aspects of the methodology, and key findings are all highlighted in the summary. The study's findings were used to draw conclusions and finally, this chapter offers recommendations, contributions to knowledge, and areas for further investigation.

Summary

The purpose of this study was to investigate the influence of teaching approaches on Senior High School students' mathematical mindsets and their achievement in Core Mathematics. The study was guided by the following research objectives; to determine teachers' perceptions of their Core Mathematics teaching approaches, to find out students' perceptions of their Core Mathematics teachers' teaching approaches, to find out the mathematical mindsets of students toward learning Core Mathematics, and to examine the relationship that exists between students' mathematical mindsets and their academic achievement in Core Mathematics. The study made use of a correlational ex post facto research design to assemble data from 18 teachers and 366 students from six selected Senior High Schools in the Kumasi Metropolis. Questionnaire and achievement scores were the instruments used for data collection. The results were presented using frequency tables, percentages, mean, standard deviations, and figures while multiple regression was used for further analysis.

The result of the study revealed the following key findings:

1. The various schools were put into two groups based on the approaches (student-centred and teacher-centred approach) used in teaching in these schools, which revealed that mathematics teachers in Group 1 schools (Schools A, B, and C) adopted a student-centred teaching and learning approach while mathematics teachers in Group 2 schools (Schools D, E, and F) were identified with a teacher-centred teaching and learning approach to Core Mathematics.
2. It was revealed from the study that there exists some consistency in the results of teachers and students as students in Group 1 schools perceived their teachers to use a student-centred teaching and learning approach while students in Group 2 schools also perceive their teachers to use a teacher-centred teaching and learning approach to Core Mathematics.
3. Students who are taught with a student-centred approach (Group 1 schools) possess a growth mindset with some fixed ideas while students taught with a teacher-centred approach (Group 2 schools) possess a fixed mindset with some growth ideas.
4. A significant relationship was found between students' mathematical mindsets and their academic achievement toward learning Core Mathematics among School B and School D, which fall under Group 1 and Group 2 schools respectively. From School B, a growth mindset was identified as predicting a higher academic achievement in Core Mathematics as compared to a fixed mindset.

Conclusions

The study revealed possible influences between the teaching approaches and students' mathematical mindsets. That is, students taught with a more student-centred approach were found to generally possess a growth mindset while those identified to possess a more fixed mindset were mostly students taught using a more teacher-centred approach. From School B, both fixed mindset and growth mindset were identified to influence students' mathematics achievement as an increase in fixed mindset and growth mindset would lead to an increase in students' achievement in mathematics. But, a growth mindset predicted a higher academic achievement than a fixed mindset.

Recommendations

Concerning the findings from this research study, the following recommendations are proposed to teachers and students of Senior High Schools.

1. Teachers should adopt the student-centred teaching and learning approach to mathematics since it has the potential to shape students' learning towards a strong growth mindset.
2. Students' perception of teaching approaches influences the type of mindset they develop so teachers should adopt an approach to teaching that incorporates students in the teaching-learning process to help students develop a strong growth mindset.
3. Schools identified with teacher-centred approach should consider organising professional development programmes for teachers on using student-centred approach of teaching and learning Core Mathematics.

4. Students should be admonished to develop a growth mindset toward Core Mathematics to enhance their academic achievement in Mathematics since growth mindset was identified as a good predictor of academic achievement as compared to fixed mindset from School B.

Suggestions for Further Research

In light of the current scope of the study, it is suggested that future research work should be expanded beyond the Kumasi Metropolis to include additional metropolises, assemblies, and districts around the country. In addition, comparable research including private Senior High Schools in the Kumasi Metropolis and other metropolises, assemblies, and districts should be considered in order to identify how the mindset of students influences their learning. Further studies that would deploy qualitative data collection methods are needed to identify the actual teaching approaches enacted by Senior High School mathematics teachers as qualitative research provides well detail-oriented data. Further research is needed to identify the impact of teachers' mathematical mindsets on students' mindsets toward learning mathematics as it has been identified by scholars that teachers' mathematical mindset plays an integral part in the development of students' mathematical mindsets. Finally, further research should concentrate on the effect of school categorisation on students' mindsets since the name of schools, structures, facilities, *etc*. count in the development of students' mindsets.

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APPENDICES

APPENDIX A

QUESTIONNAIRE FOR SHS CORE MATHEMATICS TEACHERS

Dear respondent,

This questionnaire aims to look at the impact of teaching approaches on SHS students' mathematical mindsets toward learning Core Mathematics in the Kumasi Metropolis. Because this research is only for academic purposes, your honesty and sincere response will be extremely beneficial to the study. Please know that your replies will be kept completely private and anonymous. Some statements look-alike in this questionnaire; do not worry about it, just tick [√] or provide the appropriate response.

SECTION A: Background information

1. Sex

   a. Male [ ] b. Female [ ]

2. Highest Qualification

   a. Bachelor's Degree [ ]

   b. Master's Degree [ ]

   c. PhD [ ]

   d. Others……

3. How long have you been working as a teacher at the SHS level?

   a. Below 5 years [ ] d. 16 – 20 years [ ]

   b. 6 – 10 years [ ] e. Above 20 years [ ]

   c. 11 – 15 years [ ]

SECTION B: Teachers' perception of their teaching approaches

The table below shows the various approaches exhibited by the teacher. Carefully read the statement and indicate the extent to which you agree or disagree to a statements by ticking. **[Strongly Agree (SA), Agree (A), Disagree (D), and Strongly Disagree (SD)]**

Statement	SA	A	D	SD
4. I tell my students the type of questions to solve in core mathematics class.				
5. I allow my students to work alone in core mathematics class.				
6. I demonstrate the type of method to use before instructing my students to do the same.				
7. I carefully explain concepts to my students well in order for them not to make mistakes.				
8. I sometimes restrict my students to following the procedures used in their notebooks.				
9. I determine the type of questions to be solved in class.				
10. I encourage my students to discuss their ideas with their colleagues.				

11. I sometimes instruct my students to work in small groups.				
12. I give my students time for discussion in their various groups during the core mathematics period.				
13. I allow my students to create and implement their own methods.				
14. I permit my students to make mistakes in order to discuss them.				
15. I allow my students to compare and contrast various approaches in answering core mathematics questions.				
16. My students listen and copy notes while I explain.				
17. I grade students' core mathematics assignments and meet with them to discuss the solutions.				
18. I sometimes give my student's group assignment which each group reports to the class during core mathematics period.				

APPENDIX B

QUESTIONNAIRE FOR SHS STUDENTS

Dear respondent,

This questionnaire aims to look at the impact of teaching approaches on SHS students' mathematical mindsets toward learning Core Mathematics in the Kumasi Metropolis. Because this research is only for academic purposes, your honesty and sincere response will be extremely beneficial to the study. Please know that your replies will be kept completely private and anonymous. Some statements look-alike in this questionnaire; do not worry about it, just tick [√] or provide the appropriate response.

SECTION A: Background information

1. Sex

   a. Male [ ] b. Female [ ]

2. How often do you learn Core Mathematics on your own after lessons?

   a. Everyday [ ] d. Thrice a week [ ]

   b. Twice a week [ ] e. Four or more times a week [ ]

   c. Thrice a week [ ] f. None [ ]

SECTION B: Student's Perceptions of Teachers Teaching Approaches

Please respond to the following statement regarding how students perceive the teaching approaches practiced by Core Mathematics in the classroom. Please indicate your level of agreement to the following statements. Use the Scale: **Strongly Agree (SA), Agree (A), Disagree (D), and Strongly Disagree (SD).**

STATEMENT	SA	A	D	SD
3. My teacher tells me the type of questions to solve in core mathematics class.				
4. My teacher requires me to work alone in core mathematics class.				
5. My core mathematics teacher demonstrates which method to use before instructing me to use the same method.				
6. My core mathematics teacher carefully explains concepts to me well in order not to make mistakes.				
7. My core mathematics teacher wants me to strictly follow the procedures used in my notebook.				
8. My core mathematics teacher determines the type of questions to solve.				
9. My core mathematics teacher encourages me to discuss my ideas with my colleagues.				
10. My core mathematics teacher instructs us to work in small groups.				
11. My teacher gives us time to discuss in our various groups during the core mathematics period.				

12. My core mathematics teacher allows me to create and implement my methods.				
13. My core mathematics teacher permits me to make mistakes in order to discuss them.				
14. The core mathematics teacher wants me to compare and contrast various approaches in answering questions.				
15. During core mathematics classes, I usually use my textbooks.				
16. Normally, my core mathematics teacher grades our assignments and meets with us to discuss the solutions.				
17. My core mathematics teacher sometimes gives us group assignments which each group reports to the class.				

Students' mathematical mindsets toward learning Core Mathematics

Please respond to the following statements by indicating the extent to which you: **Strongly Agree (SA), Agree (A), Disagree (D), and Strongly Disagree (SD).**

STATEMENT	SA	A	D	SD
1. My mathematical intelligence is something about me that I cannot change it.				

2. Regardless of how much mathematical intelligence I have, I can always improve it quite a little.				
3. I can always change how intelligent I am in mathematics.				
4. Nothing much can be done to change who I am as a person.				
5. Some basic things about me as a person can always be changed.				
6. Anyone can learn mathematics.				
7. Mathematics is a rare talent that only a select few people possess.				
8. Mathematics is easier to learn if you are a male or maybe come from a family that loves mathematics.				
9. The more I practice mathematics, the better I become good at it.				
10. I can always change significantly, no matter what kind of person I am.				
11. I dislike experimenting with new mathematics methods since it is stressful for me.				
12. People do not change very often.				

13. I appreciate it when others offer me feedback on my mathematics performance or skills, whether they are my parents, colleagues, mentors, coaches, or teachers.				
14. Feedback on my mathematics performance often makes me frustrated.				
15. Everyone has the potential to learn mathematics.				
16. I can learn new skills, but I cannot change how intelligent I am in mathematics.				
17. I can change how I do things, but I cannot change who I am.				
18. People are generally good, although they make bad decisions sometimes.				
19. I enjoy learning new things, which is one of the main reasons why I do my schoolwork or complete tasks.				
20. Truly intelligent people do not need to work hard to succeed in mathematics.				

21. What is your favourite subject?

……

……

22. Why is it your favourite subject?

……

……

……

……

……

23. Do you consider yourself a "mathematics person"?

Yes/No

24. Why "YES" or why "NO"?

……

……

……

……

……

APPENDIX C

INTRODUCTORY LETTER

UNIVERSITY OF CAPE COAST
COLLEGE OF EDUCATION STUDIES
FACULTY OF SCIENCE AND TECHNOLOGY EDUCATION
DEPARTMENT OF MATHEMATICS AND I.C.T EDUCATION

Telephone: 0332096951
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University Post Office
Cape Coast, Ghana

Your Ref:

Our Ref: DMICTE/P.3/V.3/063

Date: 13th January, 2022

TO WHOM IT MAY CONCERN:

Dear Sir/Madam,

RESEARCH VISIT

The bearer of this letter, **Mr. Bright Asante Britwum** with registration number ET/MDP/19/0023 is an MPhil. (Mathematics Education) student of the Department of Mathematics and ICT Education, College of Education Studies, University of Cape Coast.

As part of the requirements for the award of a master's degree, he is required to undertake a research visit at your outfit with the purpose of collecting data on the topic "**INFLUENCE OF TEACHING APPROACHES ON STUDENTS' MATHEMATICAL MINDSE**".

I would be grateful if you could give him the necessary assistance he may need.

Thank you for your usual support.

Yours faithfully,

Dr (Mrs) Christina Boateng
HEAD

APPENDIX D

ETHICAL CLEARANCE

UNIVERSITY OF CAPE COAST
INSTITUTIONAL REVIEW BOARD SECRETARIAT
TEL: 0558093143 / 0508878309
E-MAIL: irb@ucc.edu.gh
OUR REF: UCC/IRB/A/2016/1200
YOUR REF:
OMB NO: 0990-0279
IORG #: IORG0009096

10TH JANUARY, 2022

Mr. Bright Asante Britwum
Department of Mathematics and ICT Education
University of Cape Coast

Dear Mr. Britwum

ETHICAL CLEARANCE – ID (UCCIRB/CES/2021/134)

The University of Cape Coast Institutional Review Board (UCCIRB) has granted Provisional Approval for the implementation of your research titled **Influence of Teaching Approaches on Students' Mathematical Mind-set.** This approval is valid from 10th January, 2022 to 9th January, 2023. You may apply for a renewal subject to submission of all the required documents that will be prescribed by the UCCIRB.

Please note that any modification to the project must be submitted to the UCCIRB for review and approval before its implementation. You are required to submit periodic review of the protocol to the Board and a final full review to the UCCIRB on completion of the research. The UCCIRB may observe or cause to be observed procedures and records of the research during and after implementation.

You are also required to report all serious adverse events related to this study to the UCCIRB within seven days verbally and fourteen days in writing.

Always quote the protocol identification number in all future correspondence with us in relation to this protocol.

Yours faithfully,

Samuel Asiedu Owusu, PhD
UCCIRB Administrator

ADMINISTRATOR
INSTITUTIONAL REVIEW BOARD
UNIVERSITY OF CAPE COAST