UNIVERSITY OF CAPE COAST

MATHEMATICAL MINDSET OF STUDENTS: A CASE OF SOME SELECTED JUNIOR HIGH SCHOOLS IN THE BONGO DISTRICT

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BY

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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: William Ayuure Aniah

Supervisor's Declaration

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

Supervisor's Signature: …… Date: ……..

Name: Dr. Forster D. Ntow

ABSTRACT

This study focused on the mathematical mindsets of students in some selected Junior High Schools in the Bongo District of the Upper East Region, Ghana. Specifically, three research objectives were investigated; to assess the types of mathematical mindset students at the selected Junior High Schools in Bongo District possess; to examine assessment practices likely to influence students' mathematical mindset at the selected Junior High Schools in Bongo District, and to analyze the effect of mathematical mindsets on the achievement of students in mathematics. The study used the mixed method concurrent design with a sample size of 458 students. A structured questionnaire and interview were used to gather data from respondents of the study. Both descriptive (mean and standard deviation) and inferential statistics (simple regression) were used to address the objectives in the quantitative aspect while thematic analysis was used for qualitative part of the study. The results showed that the students exhibited more of a fixed mindset than a growth mindset about mathematics. Again, the study found that the mathematics teachers use effective questioning, feedback approach and pre-solution procedures as some assessment practices in the schools and finally, it was found that mathematical mindset has a significant positive effect on participating students' mathematical achievements. The study concluded that approaches aimed at promoting growth mindset of students should be included in every aspect of classroom practice, calling for a change in many mathematics norms at the basic level.

KEYWORDS

Mathematical Mindset

Growth Mindset

Fixed Mindset

Junior High School

Academic Achievements

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DEDICATION

To my lovely and caring wife, Georgina Ayuure.

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CHAPTER ONE

INTRODUCTION

Background to the Study

Poor performance in mathematics both at the Junior High and Senior High levels has become a common issue of concern to teachers, parents, and the directorate of the Ghana Education Service in Ghana. Anytime Basic Education Certificate Examination (BECE) and West African Senior School Certificate Examination (WASSCE) results are released, teachers and students often receive the blame for students' abysmal performance during School Performance and Appraisal Meetings (SPAM) especially in the Bongo District of the Upper East region of Ghana. Mathematics and Science are usually the worst hit in terms of poor grades obtained. This has led to the traditional authorities who included Chiefs and elders, being tasked to ensure that children attend school regularly, and again prevent students from attending recreational activities organized at odd hours of the day. On the other hand, the District Directorate are tasked to step up with monitoring and supervision to ensure teachers' regular and punctual attendance to school as well as coverage of their planned scheme of work for each term (Bongo District Education Office, 2019). This implies that the focus of stakeholders appears to fall on only cognitive factors while neglecting non-cognitive factors. According to Dweck, Walton and Cohen (2014), non-cognitive factors such as mindset also contribute significantly to students' academic achievement.

Everyone is born to acquire skills to be able to function competently as an adult in society. The processes and methods of learning are key to understanding how people develop important competencies (National Research

Council, 2000). Most educational reforms focus on content and pedagogy, thus what material is taught and how it is taught giving little or no attention to non-cognitive elements. Students' mindset influences their level of resilience, how much effort they will expend and how much stress and anxiety they will experience as they engage on a task, thus, learning is a product of effort (Boaler, 2013). According to Dweck (2015) students hold some level of perception about themselves that help them to change, achieve and grow in their academic discourse. These beliefs students hold are able to shape the way they view their world and the things around them. It is incumbent therefore, on educators to create an atmosphere for learners to easily grasp concepts through the way they think about the subject and the related activities around it (Yeager & Dweck, 2012).

It is therefore prudent that, mathematics educators get to identify the type of mathematical mindset their students have, in order to support them to develop productive mindsets to improve their interest and commitment to learning mathematics. This is because the experiences that children go through in and out of school can affect their mindset, with consequences for learning. According to Boaler (2016), a mathematical mindset reflects an active approach to mathematics knowledge, in which students see their role as understanding and sense making. Number sense reflects a deep understanding of mathematics, but it comes about through a mathematical mindset that is focused on making sense of numbers and quantities. In present times, students' achievement in high stakes test is often regarded as a more important goal than deep learning (Haimovitz & Dweck, 2017).

Research indicates that many students see tests as a measure of their lifelong intelligence and not just their current skills and knowledge (Haimovitz & Dweck, 2017). This implies that one's inability to pass the test might attract responses from parents, peers and teachers which promote mindlessness. "The approaches we take to assessing learning, the kinds of tasks we assign and the way we report success or failure at school send powerful messages to students not only about their own learning, but also about the nature of learning itself. Assessment and reporting processes shape student, parent and community beliefs about learning – sometimes in unintended ways'' (Masters, 2013, p. 1).

Masters (2013), describes three approaches to assessing and giving feedback on the outcomes of learning; providing 'success' experiences, judging performances against 'standards', and assessing growth overtime. Each of these approaches has implications on how students see themselves as learners as well as understanding how effort and success are related. Many educators think that giving tasks that are within students' capabilities, will give students' success experience and enhance self-esteem. Yuan, Savadatti and Zheng (2020) described assessment as tests, examinations and all other methods of gauging or measuring learner's learning. Nakabugo and Siebörger (2001) too regarded assessment as the measurement of a degree of learning one has acquired, while Blake, Hanley, Jennings and Lloyd (1995) thought of it as the judgement of the learner's learning and that judgement can be made from the learner's paper-pencil work, projects and performance.

Cullingford (1997) opines that assessment is an estimation of the amount of learning the student has accomplished. Assessment has been thought of as meaning any method that can be used to provide information on the exact

understanding that the student has (Ruiz-Primo Furtak, 2007). On the contrary, Dweck (2006) argues that lowering the standards makes students feel entitled to easy work and praise which will eventually result in poorly educated students.

Also, cultural beliefs about learning and about smartness influence students' mindsets (Boaler, 2013). Research has also shown that the brain is malleable and that students have the ability to develop smartness through efforts and challenge (Boaler, 2015). On the contrary, some schools still communicate to students with the messages that some students have talents and intelligence while others do not, thus promoting the fixed mindset. In a fixed mindset, people believe their qualities are fixed traits and therefore cannot change (Dweck, 2008; Haimovitz & Dweck, 2017). These people document their intelligence and talents rather than working to develop and improve them. They also believe that talent alone leads to success, and effort is not required. Thus, a fixed mindset represents the belief that one's intelligence is set in stone, unable to be changed. Alternatively, in a growth mindset, people have an underlying belief that their learning and intelligence can grow with time and experience (Haimovitz & Dweck, 2017). When people believe they can become smarter, they realize that their effort has an effect on their success, so they put in extra time, leading to higher achievement. A growth mindset represents the belief that one's intelligence is something that can be cultivated through effort.

Statement of the Problem

Measures such as instilling discipline, improving monitoring, ensuring regular and punctual attendance, and as well as organizing in-service training have been put in place to help improve performance in the Bongo District. However, these interventions have brought little improvement, did not include

affective factors and again have not been subject-based. Therefore, undertaking a subject based study to ascertain the mindset of the students in mathematics should be a fundamental step, since mathematical mindset influences performance (Boaler, 2015). Mathematics at the basic level, is a prerequisite for further studies. At the Junior High level, students are required to study mathematics as a subject in its own right. This is because, students are expected to use the skills and knowledge acquired in other disciplines at the senior high level and beyond. Teachers teaching the subject, typically complain that students are unable to use their mathematical knowledge in context (Brittan, Mew, Sharman & Yardlay, 2005), and students eventually perform poorly at the Basic Education Certificate Examination (BECE) in Ghana (Butakor, Ampadu & Cole, 2017). Again, the mathematics performance of students in Ghana is well below that of the industrialized nations according to Trends in International Mathematics and Science Study (TIMSS) 2011 results in mathematics (Mullis, Martin, Foy & Arora, 2012).

Studies have shown that positive disposition, thus, having a growth mindset towards mathematics learning promotes deep learning and transfer of knowledge in mathematical situations (Adams, 2014; Watson, 2015; Haimovitz & Dweck, 2017; Ritchhart & Perkins, 2000). According to mindset theorists, children's intelligent quotient (IQ) and school grades are positively linked to their belief that ability is developed rather than fixed (Dweck, 2006, Li & Bates, 2017; Haimovitz & Dweck, 2017; Ingebrigtsen, 2018). Mindset socialization does not occur only in the classroom; children also adopt beliefs about themselves within a broader cultural context.

Furthermore, studies done on mindset of students have been level biased and focusing on tertiary students (Seabrook, 2017; Froedge, 2017; Liu, Robinson & Xu, 2018) and second cycle (Brummelman & Thomaes, 2017) rather than the basic level where more of the pupils' intellectual capacity to think and react develops. Again, the nature of assessment tasks, thus whether more challenging or less challenging tasks, given to students in class and their effect on the mathematical mindset of the students have been neglected by prior researchers (De Castella & Byrne, 2015; Paunesku, Walton, Romero, Smith, Yeager & Dweck, 2015; Yeager, Romero, Paunesku, Hulleman, Schneider, Hinojosa & Trott, 2016). Many mathematics educators think that giving tasks that are within students' capabilities, will give students' success experience and enhance self-esteem. On the contrary, Dweck (2006) argues that lowering the standards makes students feel entitled to easy work and praise which will eventually result in poorly educated students.

After several years of teaching at the Junior High level, the researcher has seen students often describing their colleagues as having "brain", a direct translation from their local dialect meaning gifted with intelligence. This term is mostly used for those students who do well in examinations. Interestingly, those students who perform well in only mathematics are referred to as having "mathematics brain". A student once remarked; "if you read your social studies note well, you can score all, but it is not like that for mathematics". They perceive mathematics to be a difficult subject, even at that level. It is clear that students have a certain mindset towards mathematics. Do mathematics assessment practices such as grading, questioning, feedback, giving more challenging tasks, creating competition, stress, and fear among students,

influence their mindset? What is the disposition of students towards challenging assessment tasks in mathematics at the junior high level? From the researcher's interactions with his students for the past years, there is an indication that students have varying mindsets towards different subjects of study at the Junior High level which are likely to account for their performance in mathematics. Thus, how students learn a subject depends on their mindset towards the subject (Haimovitz & Dweck, 2017).

As a result, Haimovitze and Dweck (2017) suggest that future research should consider more diverse population to help provide enough insight into how differences in beliefs and socialization practices across cultures affect children's mindsets. Bongo district is one of the deplorable educational districts in the Upper East Region of Ghana. Ever since it was carved out of the then Bolgatanga district, now Bolgatanga municipality in 1987 the district has since been faced with challenges in term of passes at the basic school level. Available data from Ghana Education Service (Bongo District BECE Report, 2016, 2017, 2018, 2019), all show abysmal performance of Junior High Schools in the District during their Basic Education Certificate Examination (BECE). Evidence from these sources suggest that, the performance of the students on the BECE continue to change downwards over the past three years and has reached to only 43.3% pass in mathematics as at 2019 as shown in Table 1 below.

Table 1: Summary of District BECE Report

YEAR	OVERALL PERCENTAGE PASS	PERCENTAGE PASS IN MATHEMATICS
2016	16.4%	28.8%sss
2017	21.3%	40.7%
2018	15.8%	51.1%
2019	34.4%	43.3%

Source: Bongo District BECE Analysis Report

Analysis of the performances of JHS students at the BECE level over four-year period from 2016 to 2019 further shows that, Junior High Schools in Bongo District continue to face challenges with performance in the core subjects particularly Mathematics. For instance, while a 51.1 percent pass was recorded in 2018, a decline from that percentage to 43.9 percent was recorded in 2019. It is most likely that a focus on students' mathematical mindset will help explain why the underachievement in the subject recorded in the Bongo District.

Studying the mathematical mindset of students at the lower levels of educational ladder will give an understanding of the beliefs they hold about themselves, the academic environment and their performance.

Purpose of the Study

This study therefore investigates the mathematical mindset of students at the Junior High School level in Bongo district, how assessment influences mindset and possible relationship between mindsets and their performance in mathematics.

Research Objectives

Specifically, the study seeks to address the following objectives;

1. To assess the type of mathematical mindset possessed by students at the selected Junior High Schools in Bongo District.

2. To examine assessment practices and their influence on students' mathematical mindset.
3. Analyze the influence of students' mathematical mindsets on their mathematical achievement.

Research Questions

1. What are the mathematical mindsets of students at the selected Junior High Schools in the Bongo District?
2. What assessment practices are likely to influence Junior High School students' mathematical mindset in the Bongo District?
3. What is the relationship between mathematical mindsets and mathematical achievement of students at the Junior High Schools in Bongo District?

Significance of the Study

This study offers a significant contribution to the causes of poor performance of students in mathematics by focusing on mindset, an affective factor which has received little attention as compared to the cognitive factors. Assessment is an indispensable component of classroom practices in mathematics, and so the study considered its influence on pupils' mathematics mindset. The study observed that the kinds of tasks assigned during assessment and the reporting processes influences students' beliefs about learning. This calls for a change in many mathematics norms at the basic level.

The study presents evidenced-based information to students, mathematics educators and parents which calls for practices to promote growth mindset to improve students' achievement overtime. Although the research is a case study making it difficult to generalize, it however offers the needed insight

and as well increases the pool of research in mathematics education and the field of psychology.

Delimitations

Though there are several districts in the Upper East Region of Ghana, the current study is confined within only Bongo district in the Upper East. region of Ghana. This notwithstanding, the restriction of the study to this district is not without premise, since similar studies were conducted by Froedge (2017) and Jacobs (2019), using selected cities, instead of the entire country. The respondents were all the total number of students in selected schools in the district. The study did not investigate mindsets of students in general but was subject specific, mathematics, and focused at the junior high level focusing on basic 9 students.

Limitations

This study like any other study was not without limitations. The study sought to investigate the mathematical mindsets of students in the Bongo district of the Upper East Region of Ghana. This required that the researcher gathered relevant information from all the potential respondents in order to get thorough understanding about how the constructs are related to each other. However, of the 10 schools only one school accepted to allow the researcher engage the students for qualitative interviews. Furthermore, due to the outbreak of the COVID 19 in the early months of the year, data collection became cumbersome and had to take a long time before administering questionnaire to respondents. Despite the challenges enumerated, the researcher followed the required research processes that ensured that the study's result was not affected.

Organisation of the Study

This study is divided into five chapters. Chapter One represents the background to the study, the statement of the problem as well as the research questions. Chapter Two discusses concepts, theories and literature on mindset, confidence, persistence, perceptions about mathematics learning, motivational challenges associated with a mathematics learning, perceptions about failure in the classroom. Chapter Three explains methods of the study which includes research design, population, sampling procedure, instrument for data collection and data analysis. Chapter Four present the results, findings, and discussions with reference to the literature, while Chapter 5 is made up of the summary, conclusions and recommendations.

CHAPTER TWO

LITERATURE REVIEW

Introduction

In this chapter, the researcher draws from literature to investigate the mathematical mindset of students at the Junior High school level. This review of literature helps the reader understand how the study supports theories of intelligence, effort and aptitude, and fixed and growth mindsets. Moreover, this body of literature explores how assessment practices influence mindsets in the classroom.

Theoretical Framework

The theory of mindset provides an important framework for understanding student motivation and related learning behaviors. The study was guided by the Social Cognitive Theory of Motivation and Personality (Dweck & Leggett, 1988). The theory consists of impressions or opinions that learners hold about the nature of intelligence and learners' goal orientation. This current study was based on the implicit theory of intelligence which is the specific belief in one's intelligence. The theory (Dweck & Leggett, 1988; Dweck, 2000) asserts that, students may hold different theories about the nature of their intelligence. There are those who believe that intelligence is more of an unchangeable, inherent or fixed trait and nothing can be done to it. This is also called entity theory of intelligence or the fixed mindset (Dweck, 2008). However, there are those students who believe that intelligence is an increasable, controllable quality and through effort or hard work it can be developed. This is also called the incremental theory of intelligence or malleable or growth mindset (Dweck, 2008).

According to Dweck and Leggett (1988), implicit theories of intelligence influence the way students approach learning and achievement situations, the kind of goals they adopt, their effort and persistence and their achievement. Students with fixed mindsets mainly focus on obtaining good grades in order to document to themselves or others the adequacy of their ability. Such students pursue performance goals which lead them to compromise their effort, to give up easily when faced with challenges or setbacks, and generally to avoid difficult tasks. On the other hand, those with malleable mindsets mainly focus on improving their competence and acquiring new knowledge. They pursue mastery goals which lead them to expend more effort, seek challenging tasks and to persist whenever they encounter setbacks. This theory was used by McWilliams (2015) who conducted an exploratory study to find out whether low academic achievement among the ninth-grade students was a consequence of self-efficacy, implicit theory of intelligence and goal orientation. Results revealed that, the beliefs that students held influenced their academic achievement. Consistent findings were reported by Blackwell, Trensniewski, and Dweck (2007) who reported a significant relationship between theories of intelligence and academic achievement.

Conversely, different findings were reported by P'pool (2012) who used Dweck's theory of motivation to determine how a student's view of intelligence affects their overall academic achievement in a school located in the South-Central Region of the United States. Results revealed that there was no significant relationship between fixed and malleable mindset students in regard to academic achievement. Similar findings were reported by Rudig (2014) who used Dweck's theory to examine implicit theories of intelligence and learning

mathematics. Results revealed that, participants' incremental or entity theories of intelligence did not elicit different patterns of studying behavior in learning a new mathematics task. These studies reported mixed findings and were conducted in the USA and Asia and mainly with college students. Therefore, there is a need to conduct a local study in Ghana, using Dweck's implicit theory of intelligence to compare the findings.

Theories of Intelligence

People hold two contrasting beliefs or theories about intelligence. One theory says that intelligence is innate or fixed and cannot be changed over time. Those who believe that intelligence is fixed are entity theorists (Dweck & Leggett, 1988). These people equate success to internal abilities. Students who possess an entity theorist's view of intelligence avoid challenging situations and become helpless in the midst of failure, which leads to a decline of performance over time (Blackwell, Trzesniewski & Dweck 2007). An entity theorist views a student as having low innate ability and believes the student's capacity to learn at high levels is limited (Dweck, 2000). Entity theorists tend to hold strong stereotypes of students and their ability to learn (Plaks, Stroessner, Dweck & Sherman, 2001). The other theory of intelligence is incremental theory (Dweck & Leggett, 1988). People who embrace this theory of intelligence believe that intelligence is malleable and can grow overtime (Dweck & Leggett, 1988). They strive to continue to learn and grow and view setbacks as opportunities for learning. Incremental theorists are goal-driven. Their focus is on mastering key concepts and striving to improve their ability through effort (Dweck, 2006). Incremental theorists focus on the student's effort and need to grow.

Moreover, they consider the kinds of instruction or remediation needed that would help the student experience success (Dweck,2000) like entity theorists, incremental theorists do internalize negative and positive human behaviors; however, they view these fundamental issues as a way to promote growth in students rather than place judgment or criticism on them (Dweck, 2000; Plaks et al., 2001). Resnick and Hall (1998) discussed the factors that have much to do with people's beliefs about the relationship between effort and ability. In their research, Resnick and Hall identified two broad classes of goals: performance-orientated and learning-orientated. People with performance-orientated goals strive to obtain positive evaluations of their ability (Resnick & Hall, 1998).

In contrast, many learners think that passing an examination indicates the amount of intelligence one has. So those who do not do well in exams have a limited amount of intelligence. In effect, learners who view learning as acquiring knowledge only to enable them pass an examination, see themselves as not smart if they fail the exam, thus judging their level of intelligence.

Mindset

According to Dweck (2008), having a growth mentality is vital for individuals to excel and thrive to their full potential. Boaler (2016) stressed that students with a growing mind believe that they can increase their mathematical skills through hard work whiles students with a fixed mind believe that individuals are born with a set mathematical ability and that no matter how hard the individual works, if he/she is not born with a strong mathematics ability, he/she will not do well in the subject. Boaler (2016) also noted that mathematics

is one of the single content areas that dispenses strong and abundant fixed mindset labels and messages.

Growth and Fixed Mindsets

Dweck (2008) spent more than 20 years researching how students respond to different forms of praise from parents and educators. Dweck's research found that more than 80 per cent of the parents thought it important to applaud their children on purposeful circumstances. This implies that mindset emanates from how we communicate success and failure. In this research the study area consists of illiterate parents who are mainly farmers, blacksmiths, potters and weavers. Anyone who is unable to do well in these occupations including children is blamed for his or her lack of efforts and not lack of innate ability as observed from the culture of the indigens. Thus, those who do well either in school or out of school are praised by their parents for expending more effort than others. According to Dweck, an appreciation that honors intelligence and performance can lead students to fixed mentalities. This type of praise supports a fixed attitude, because students are often praised for their ability and not for their efforts. This also implies that fixed mindset traits can be traced to the school environment. Thus, students do not see the importance of working hard and persevering when they feel their intelligence level is a stagnant characteristic with which they are born. It is therefore not out of point to conclude that parents in the area do not honour intelligence and performance but rather efforts. Parents were therefore not included in this study. Hence, Hochanadel and Finamore (2015, p. 48) concurred that “students who value effort are said to have a growth mindset. They perceive ability as a malleable skill”.

A growth mindset is "oriented towards learning, not measuring the self" (Gutshall, 2013, p. 17). Growth mindset supports the concept that an individual's intelligence can grow and increase in increments (Orosz, Péter-Szarka, Bőthe, Tóth-Király & Berger, 2017). Children with a growth mindset may interpret their academic performance as a result of their effort and experience. The mindset of students influences the way they perceive their academic world. Students with a growth mindset believe their abilities can be improved with practice, so they are in control of their own learning (Stec, 2015).

"Students with a growth mindset understand that mistakes and effort are critical to learning" (Dweck, 2008, p. 56). Hochanadel and Finamore (2015) pointed that, Dweck's research was centred on demonstrating the benefits of training and teaching students how to change their intellects in order to nurture, grow perseverance and a growth mindset. The authors further averred that when adults' places emphasis on offering praises for children's perseverance and hard work, the children develop a growth mindset and develops the abilities to build their problem-solving skills and abilities when faced with difficulty or new circumstances. Pawlina and Stanford (2011) also reported that when studying growth mindset, students should be empowered through development of mental strategies to gain knowledge that can be applied in challenging situations.

According to Hanson, Albert, Iselin, Carre, Dodge, and Hariri (2016), growth mindset students will focus on the process of learning, whereas students with a fixed mindset will be more concerned with the outcome of a learning task. In addition, teachers with growth mindset have developed positive psychosocial skills in students that improve students' engagement in academic behaviors and as well improve school outcomes (Hanson et al., 2016). This

previous research demonstrates the impact of growth mindset on many aspects of a student's academic achievement and progress. According to Carol Dweck in her interview for Educational Horizons, the researcher found that "one can teach kids a growth mindset directly by teaching them about the brain and how it changes with learning. When children are taught the growth mindset, their motivation changes and their grades increase" (Gutshall, 2013, p. 17).

In contrast, the opposing view, fixed mindset, sees intelligence as unalterable or static. Students with a fixed mindset believe their academic performance is a measurement of their intellect and ability that they naturally acquired (Dweck, 2015). Individuals classified with a fixed mindset believe intelligence is a limited and stable characteristic (Orosz et al., 2017). Students with the fixed mindset who adopt performance goals may be more concerned with maximising desirable performance or minimising poor performance, as opposed to engaging in instructional activities for the sole purpose of learning (Yilmaz Soylu et al., 2017).

In view of the above arguments, when students are challenged and are required to formulate new ways to attack a problem, they grow and build new connections in their brains through firing new synapses from one neuron to the next (Boaler, 2013; Pawlina & Stanford, 2011; Sparks, 2015). One of the most important strategies for helping students develop a growth mindset is to use praise focused on effort and perseverance rather than on scores on tests or on correct answers (Boaler, 2016; Dweck, 2008). This type of praise helps students to see the value of working hard and scrutinizing their mistakes.

Boaler (2016) pointed out that teachers should be encouraged to teach students that they can acquire mathematical understanding through making errors and learning from the process. When students do not make errors, they are often playing it safe and staying in their comfort zone of already mastered material (Boaler, 2013; Boaler, 2016; Dweck, 2008). In that regard, both educators and parents must clearly understand the importance of students' having opportunities to explore mathematical concepts without being evaluated as right or wrong (Blad, 2015; Boaler, 2013; Boaler, 2016). Students must understand that making mistakes is a normal part of the learning process, but especially in learning mathematics. If teachers design their mathematical lessons with open-ended problem-solving scenarios rather than with questions having a set solution, then students would grow their brains and toolkits for future troubleshooting (Blad, 2015; Boaler, 2013; Boaler, 2016; Dweck, 2008; Hochanadel & Finamore, 2015; Pawlina & Stanford, 2011; Sparks, 2015).

Even though several researchers concentrated on the impact of mindset in education (Blad, 2015; Boaler, 2016; Chen & Wong, 2015; Claro, Paunesku, & Dweck, 2016; Dweck, 2006; Dweck, 2008; Hochanadel & Finamore, 2015), few studies have examined how mindset affects the academic progress of struggling young adult students who are attempting to earn a high school diploma despite past challenges in educational performance. Schools and policy makers have dedicated lots of resources towards efforts to prevent at-risk youth from dropping out of the educational system; perhaps classroom sessions on the importance of mindset towards reaching their goals could be one of the most effective options.

Assessment Practices

Yuan, Savadatti and Zheng (2020) define assessment as tests, examinations and all other methods of gauging or measuring learner's learning; as can be seen, their understanding of assessment is not different from that of those authors who take assessment to be the measurement of learner's learning. Nakabugo and Siebörger (2001) too regarded assessment as the measurement of a degree of learning one has acquired, while Blake, Hanley, Jennings and Lloyd (1995) thought of it as the judgement of the learner's learning and that judgement can be made from the learner's paper-pencil work, projects and performance.

Cullingford (1997) opines that assessment is an estimation of the amount of learning the student has accomplished. Assessment has been thought of as meaning any method that can be used to provide information on the exact understanding that the student has (Ruiz-Primo Furtak, 2007). Chapman, King and King (2005) perceive assessment as the way of gathering, explaining and recording information about the learner's work. The authors further opined that assessment concerns the practice of gathering, interpretation and arrangement of the information that assist teachers and/or people to make decisions about the learners. The literature on the meaning of the concept assessment revealed that assessment is a multifaceted concept, one aspect of which is that of measurement. The other aspects include testing, evaluation/judgement and the interpretation of the learner's learning (Chapman et al., 2005). Some assessment practices cited in literature (Black et al., 1995; Chapman et al., 2005) ensue.

Questioning

Black and William (2005) have identified three requirements for effective questioning. First, the quality of questions is important to motivate deep learning. Questions that require only factual recall may lead to a superficial approach to learning. To promote deep learning, open-ended questions or problem-based questions should be used. Second, "wait time" is considered as a vital factor in effective questioning. Students' poor responses occur because teachers have not given sufficient time for students to think and form their answers (Black & William, 2005).

Observation

Observation involves teachers in observing students' performance during teaching and learning processes (Maxwell, 2001). This is a useful assessment strategy as it allows the teacher to gain authentic, comprehensive and contextualized information about student learning. Despite its importance, observation is an under-utilized assessment strategy because information obtained from this method is usually claimed to be subjective and contain potential bias (Brown, 1999). This limitation requires teachers to carefully plan classroom observation with transparent and explicit criteria (Brown, 1999; Tran, 2015). Further, the use of observation combined with other assessment strategies is suggested to enhance its effectiveness (Maxwell, 2001).

Feedback

In general, feedback is understood "as information provided by an agent regarding aspects of one's performance or understanding" (Hattie & Timperley, 2007, p. 82). Feedback can be oral or in written form provided by the teacher, by peers and through self-assessment. Feedback is considered as central to

assessment for learning and the benefit of providing feedback has now gained significant agreement among researchers (Black & William, 2005; Boud, 2000; Evans, 2013).

Peer Assessment

According to Sridharan, Tai and Boud (2019), peer assessment is the process through which groups of individuals make judgements on the performance of their peers. Apart from the teacher's feedback, feedback from peers is considered a vital element of formative assessment in the classroom (Black & William, 2009). Research has found that peer assessment contributes benefits for both givers and receivers. These practices enhance learning as they motivate students to learn together in a collaborative environment (Black &William, 2005; Pham, 2014). Further, peer assessment helps students to develop certain skills such as teamwork and meta-cognition (Dochy, Segers & Sluijsmans, 1999). Several strategies are suggested to organise peer assessment such as group discussions and oral presentations. Carless (2013) has identified that oral presentations are a common and useful tool for peer assessment. This form not only stimulates classroom dialogues through giving and receiving peer feedback, but also helps students to recognize quality performance. Involving students in dialogues and raising awareness of expected standards are considered crucial to develop the culture of sustainable feedback in classrooms (Carless, 2013).

Self-Assessment

Self-assessment is "the involvement of students in identifying standards and/or criteria to apply to their work and making judgements about the extent to which they have met these criteria and standards" (Boud, 2000, p. 12). This

reflective process, created by and for students through using success criteria to evaluate and monitor their own work, is an integral element of self-regulated learning (Panadero & Alonso-Tapia, 2013). When students effectively self-assess their work, they must understand the assessment criteria which helps them take responsibility for their learning, form meta-cognitive skills and act as autonomous learners (Boud, 2000).

Teasing (Violent Communication)

The motivation for learning and the desire attached to a particular subject has a significant influence on young people's school performance in any subject of study including mathematics (Lazowski & Hulleman, 2016). This implies that motivation is an internal state that rekindles, directs and maintains someone's behavior towards specific goals. In effect, it is the cause of behavior (Trigueros et al., 2019). Therefore, if someone lacks motivation, he/she does not have the force that moves him/her to perform certain activities and to persist for their completion. Motivation is influenced by the experiences of the individual in relation to the social context (Lazowski & Hulleman, 2016), and so it is not something that emanates from nowhere.

In the light of the foregoing, according to the self-determination theory, the social context is influenced by two opposing forms, autonomy support as against controlling style. Autonomy support refers to the promotion of physical, psychological and social self-development and to the student's own initiative. On the other hand, a controlling style on the part of the teacher and peers is perceived by the student as the origin of his or her own behavior by diminishing his or her own initiative, personal self-knowledge and active participation in the classroom. Depending on the predominant role in the `social context, and

especially the teacher, it may affect the motivation of the student. The self-development theory suggests four different types of regulation under the extrinsic motivation which are the integrated regulation, identified regulation, introjected regulation and external regulation (Sun & Shen, 2017).

Integrated regulation refers to when behaviors are ordered and equated in a meaningful and hierarchical way according to the values and needs that we have; identified regulation refers to when the individual identifies with the activity he or she performs; introjected regulation refers to the establishment of a series of obligations to carry out the action and which are linked to self-approval, and to the avoidance of negative emotions and feelings ; external regulation refers to the carrying out of the action due to the search for desired consequences or to avoid punishment. There is a long tradition of research focusing on the role of motivation in academic achievement (Vasconcellos et al., 2019). Current studies, particularly in the area of mathematics, have hardly ever analyzed the effect of teasing on motivation and on metacognitive strategies.

Teasing is central to human social life. People tease to socialize, flirt, resolve conflicts, and pass the time in imaginative and playful ways. Researchers have used the term teasing to refer to diverse behaviors. With slight variations in utterance and display, teasing can lead to more disturbing ends, as when teasing humiliates or harasses. As prevalent as teasing is in everyday life, it is absent as a coherent topic in empirical psychology. Teasing in the classroom has the tendency of creating an unsafe learning environment. Students may not feel safe to ask questions, seek for help and participate actively in classroom activities. Thus, aggressive teasing in the mathematics class can invoke

amotivation, thus, the complete absence of both intrinsic and extrinsic motivation.

The concept of Non-Violent Communication affirms that needing support is not a weakness, but rather a basic human need. On the other hand, Non-Violent Communication allows that someone may say "no" to a request for support, for example, refusing to directly answer a question. Instead of answering a question directly, a teacher may recognize the learner's need for more agency and autonomy and instead encourage the learner to explore alternative ways of becoming unstuck. Some support will also come from being part of a classroom community, in which learners have suggested rules such as not laughing at mistakes and listening to each other in order to create safe space for learning (e.g., Johnston-Wilder & Moreton, 2018). In the assessment of learners in mathematics; the kinds of tasks we give learners and the way we report success or failure, presents the tendency of influencing students' view about themselves as learners as well as understanding the relationship between effort and success. Many think that learning with the mindset of passing an examination is a compelling factor to exert more efforts. In effect, learners who view learning as acquiring knowledge only to enable them pass an examination, might under-learn.

Empirical Review

According to Dweck (2008), having a growth mindset is essential for individuals to excel and prosper to their full potential. Boaler (2016) emphasized that students with a growth mindset believe that they can increase their mathematics abilities through hard work; students with a fixed mindset believe that individuals are born with a set mathematics ability and that no

matter how hard that individual works, if he/she is not born with a strong mathematics ability, he/she will not excel in mathematics. Boaler also labeled mathematics as the single content area that distributes strong and abundant fixed mindset labels and messages (2016). "A blend of family attitudes, cultural ideas, and personal frustration often lead students to believe that mathematics ability is a fixed trait like eye color" (Blad, 2015, p. 1).

Blackwell et al. (2007) conducted two studies researching learning theories in early adolescents' mathematics achievement. The first of these studies was a five-year longitudinal study that followed four cohort groups of moderately high-achieving students through their Junior High 7th - and 8th-grades (n = 373) to study the relationship between students' achievement in mathematics and their mindset. The researchers followed the student cohort groups from the beginning of 7th-grade to the end of 8th - grade. The cohort students were moderately high-achieving mathematics students based on their mean mathematics examination scores (≥ 75th percentile) from 6th-grade on the Citywide Achievement Test (CAT), a nationally normed examination (NYC Department of Education, n.d.). Cohort students had the same mathematics teacher and the same curriculum. Each student filled out a survey at the beginning of their 7th-grade school year that assessed their views on mindset ("theory of intelligence"), learning goals, effort beliefs, and perceptions of helpless responses to failure.

The researchers collected students' mathematics semester grade averages at the end of each term during their two-year participation in order to assess mathematics achievement (Blackwell et al., 2007). In this longitudinal study, Blackwell et al. used the students' 6th-grade percentile scores on the CAT

exam as a baseline and the semester grades in mathematics classes at the end of each term during the study to measure mathematics learning outcomes. Using the initial survey items gathered at the beginning of 7th-grade, the researchers gathered subscale scores on mindset (theory of intelligence), effort beliefs, perceptions of helpless responses to failure versus positive problem-solving strategies, and learning goals (from the Patterns of Adaptive Learning Survey (PALS)). Analysis of the data based on the 6th grade baseline CAT scores and the fall and spring term grades from 7th and 8th grade revealed that students with a fixed mindset regressed in mathematics performance over time, while students with a growth mindset saw success as measured by their semester grades in mathematics classes. In addition, the research revealed statistically significant correlations between positive mindset (incremental theory of intelligence) and positive effort beliefs ($p < .01$); positive mindset and low helpless attributions ($p < .01$); positive mindset and learning goals ($p < .01$); and positive mindset and positive problem-solving strategies ($p < .01$) (Blackwell et al., 2007). The researchers stated, "these variables were all significantly positively correlated with one another (ranged from .34 to .72, $p < .05$).

According to Paunesku et al. (2015), mindset interventions to improve learning had been studied on a small scale, but little data existed on a large scale. For this reason, they chose to target a large sample of high school students ($n = 1,594$) using an online curriculum addressing sense-of-purpose and growth mindset interventions in 13 secondary schools. The participating schools were diverse and included public charter schools ($n = 4$), traditional public schools ($n = 8$), and private schools ($n = 1$) in the sample. The schools were in the east, west, and southwest regions of the United States and representative of various

levels of economic status. Of the 13 schools used for the study, five schools served very few low socioeconomic students, and six schools served a population with more than 50% of students receiving free or reduced lunch. Participating schools used a study coordinator who worked with staff to ensure that students participated in an online mindset intervention during two separate 45-minute sessions approximately two weeks apart (Paunesku et al., 2015). Students were informed before participating in the research that the study was "part of an ongoing Stanford University study about why and how students learn" (Paunesku et al., 2015, p. 786).

After the high school students had logged into the research website, they were randomly assigned by the computer to one of four 45-minute interventions: a control group, a growth mindset intervention, a sense of purpose intervention, or an intervention combining both growth mindset and a sense of purpose. During the first 45-minute session, groups were assigned to either the growth mindset intervention or the control condition. The growth mindset intervention shared the message that students could increase their academic ability through hard work and perseverance during challenging situations or when mistakes occur. The control group session focused on functions of the brain and did not address the neural plasticity of the brain. The sense of purpose intervention promoted reflection on reaching meaningful goals that promote the good of others through hard work and determination in academics. The fourth condition blended the information from the mindset intervention and the sense of purpose session into one 45-minute intervention (Paunesku et al., 2015). All students included in the research analysis completed the assigned online

sessions and had pre- and post-intervention class grades in core academic courses (English, mathematics, science, and social studies).

Researchers gathered pre- and post-measures of mindset, the students' perceived purpose of academic tasks, and GPA scores for core academic courses (Paunesku et al., 2015). As reported by Paunesku et al., pre-intervention GPA of the control and intervention groups were not significantly different in the four academic core areas, indicating that the groups were similar in achievement levels before the intervention. Analysis of the data illustrated a significant positive correlation between pre-intervention GPA scores and growth mindset scores ($p = .008$); this result indicated that the higher the student pre-intervention GPA scores, the higher the sense of purpose scores. Using linear regression and controlling for prior mindset orientations, analysis revealed a statistically significant correlation between the growth mindset intervention and students' beliefs supporting the malleability of academic learning ability or positive mindset ($p < .005$). However, the sense-of-purpose intervention and the combined growth mindset/sense of purpose intervention were not significantly correlated with beliefs in mindset indicating that the sense of purpose and mindset interventions interacted with students differently (Paunesku et al., 2015).

Combining the mindset and sense-of-purpose content in the combined intervention may have overloaded the students with too much information or may have resulted in less rigorous coverage of the essential information on mindset that resulted in the statistically significant results in beliefs alterations in the pure mindset condition. Further research may be necessary to investigate these phenomena. Linear regression revealed a statistically significant positive

relationship between student perceptions of importance of academic tasks in growth and learning among the sense of purpose intervention group ($p < .018$); while the growth mindset intervention group did not ($p < .078$). These results indicated that students who held higher sense of purpose beliefs also exhibited higher perceptions of academic task importance; there was no significant relationship between perception of growth mindset and the importance of academic tasks.

The combination of the growth mindset/sense of purpose intervention was not significantly predictive of GPA for the participants in that group (Paunesku et al., 2015). Paunesku et al. subsequently disaggregated the GPA scores for at-risk high school students ($n = 519$) from the original sample of 1,594 students. These students exhibited pre-intervention GPA scores at 2.0 or below for the fall semester of the study and/or had failed one or more core content courses. Statistically significant positive correlations in post-intervention GPA scores of at-risk students were observed in the growth mindset intervention group ($p < .048$) and the sense-of-purpose intervention group ($p < .021$), but were not significant for the combined intervention or the control group (Paunesku et al., 2015).

These findings supported the findings from the first analysis of the larger data set by Paunesku et al. When analyzing the satisfactory completion rates in core courses for at-risk students in all mindset intervention groups, Paunesku et al. found statistically 20 significant correlations ($p < .007$) between the likelihood of the students passing a core course and participation in the mindset intervention. These findings indicate that exposure to just 45 minutes of intervention on mindset could lead to better academic performance in at-risk

high school students. These significant results illustrated the relationship between growth mindset instruction and academic performance among at-risk students. The bulk of mindset research has concentrated on American students that may not apply to all youth.

A study by Chen and Wong (2015) researched mindset and academic achievement of Hong Kong's 1st - and 2nd-year education students (n = 418) from two different universities that were considered average in academic competitiveness. The students were education students who attended one of two universities in Hong Kong. More females (n = 226) than males (n = 192) participated in the study due to the composition of the students in the education department; the average age of participants was 19.88 years. Students voluntarily completed a seventeen-item survey created by researchers assessing goal orientations and mindset at the end of their Sociology of Education course. Seventeen survey items in four categories measured the areas of students' performance approach, endorsement of mastery, performance avoidance goals, and mindset (Chen & Wong, 2015). Students responded to items measuring their performance-approach goals beliefs including this exemplar: "I just want to avoid doing poorly in this class" (Chen & Wong, 2015, p. 718). Students responded to items measuring their mastery goals beliefs including this exemplar sample: "I hope to have gained a broader and deeper knowledge when I am done with this class" (Chen & Wong, 2015, p. 718). The data analysis by Chen and Wong revealed several statistically significant findings.

The self-reported beliefs of the students' mastery goals were positively correlated with growth mindset (incremental theory) ($p < .01$), performance-approach goals ($p < .01$), and GPA ($p < .01$). Beliefs in performance-approach

goals were also positively correlated with beliefs in growth mindset (incremental theory) ($p < .01$) and GPA ($p < .01$) (Chen & Wong, 2015). In addition, a positive correlation existed between participants' growth mindset and GPA ($p < .05$) (Chen & Wong, 2015). These results indicated significant positive relationships between participants' positive growth mindset and participants' positive mastery goals, positive performance-approach goals, and higher GPA scores.

In an international high school study, a national database of 10th graders enrolled in public schools in Chile was utilized by Claro, Paunesku and Dweck (2016) to correlate mindset measures and standardized mathematics test scores ($n = 168,203$) and standardized language test scores ($n = 168,553$). Subjects represented a sample of 75% of all Chilean 10th graders enrolled in public education and 98% of all public-school campuses in Chile. The data were gathered from the Chilean Government's 2012 10th - grade standardized mathematics and language skills examination and a required student survey which included items measuring mindset from a previous tool used by Dweck (2002) (Claro et al., 2016).

The research by Claro et al. (2016) identified a highly significant positive correlation between mindset and 10th-grade achievement in mathematics ($p < .001$) and 10th-grade language achievement ($p < .001$). Student mindset explained 11.8% of the variance ($r = 0.343$) on a composite average of language and mathematics scores; the highest socioeconomic level group explained 11.3% of the variance on the composite average of language and mathematics scores. Further analyses stratified student data according to SES income levels. Interestingly, a significant correlation existed between

family income and the reported mindset of 10th-grade students ($p < .001$) (Claro et al., 2016). Students with high SES showed stronger beliefs in the importance of a growth mindset than low SES students. Claro et al. (2016) reported that students from the lowest-income families were twice as likely to endorse a fixed mindset as students from the top-income families and schools.

Claro et al. (2016) further reported a significant negative correlation between mindset and family income in predicting mathematics and language combined test scores ($p < .001$). "Students from low-income families (the lowest 10%) who had a growth mindset showed comparable test scores with fixed mindset students whose families earned times more (80th percentile)" (Claro et al., 2016, p. 8667). Claro et al. (ibid) reported that a growth mindset is a comparably strong predictor of achievement and that it exhibits a positive relationship with achievement across all of the socioeconomic strata in the country. In the lowest decile of family income of the research participants, approximately 60% reported having a fixed mindset while approximately 30% of the participants in the highest decile of family income reported a fixed mindset. Participants in the highest decile of family income were twice as likely to report a growth mindset as members from the lowest decile (Claro et al., 2016). Claro et al. (2016) reported this study as the first that illustrated that a growth mindset predicted achievement throughout a national student sample.

A study of 5th and 6th-grade African-American students living in poverty was conducted by Gutman and Midgley (2000) who extracted data from a survey used in a longitudinal study in Michigan (n = 901). In Gutman and Midgley's study, 62 African and American students responded to a survey measuring academic self-efficacy using items from the Patterns of Adaptive

Learning (PALS). The survey items asked questions that illustrated whether or not students felt they could be successful in challenging situations (Gutman & Midgley, 2000). The feelings of competence expressed by students in the PALS were considered key components of having a positive mindset (Dweck, 2006). This study's results found statistically significant correlations ($p < .01$) between 5th and 6th-grade African-American students' self-reported academic self-efficacy and their overall grade point average as well as with the combined mean grades of mathematics, science, language arts, and social studies at the end of the 5th and 6th grades. The 5th and 6th-grade African-American students' mindset/academic self-efficacy, and feelings of competency revealed statistically significant positive correlations to academic performance in their combined grade point averages in the four content areas of mathematics, science, language arts, and social studies (Gutman & Midgley, 2000).

These findings point to the need for further study of the effects of mindset on the mathematics performance of students in this population and similar populations that are underrepresented in STEM fields. According to Dweck (2008), each person has a unique genetic endowment. People may start with different temperaments and different aptitudes, but it is clear that experience, training, and personal effort take them the rest of the way. Basing her statement on thirty years of research on the effects of mindset, she stated, "The views you adopt for yourself profoundly affect the way you lead your life" (Dweck, 2006, p. 6). This research led to Dweck's coining of two categories of mindset: 1) a fixed mindset with talents that are set and finite, and 2) a growth mindset in which potential exists to cultivate and grow abilities. Individuals with a fixed mindset feel the pressures of proving themselves on every task they

undertake, and they may avoid challenging situations once they have already shown success (Dweck, 2006; Dweck, 2008).

Individuals with a growth mindset realize that they must struggle and make errors as they tackle new and challenging material to strengthen their knowledge and skill (Boaler, 2016; Dweck, 2006). Researchers have demonstrated significant relationships between mindset and academic performance in a variety of student populations ranging from early elementary to adults. Research also points to connections between mindset and academic performance of specific demographic groups of students including low socioeconomic levels, minorities, and young adults (Boaler, 2016; Chen & Wong, 2015; Claro et al., 2016; Paunesku et al., 2015).

Chapter Summary

The study discussed existing literature about mindset of pupils towards mathematics and the contributing factors that shapes mathematical mindsets. Mindsets towards mathematics learning contribute to recent educational theories geared towards promoting a better understanding of how and why students develop certain beliefs about their mathematical abilities. Research has suggested that mindset correlates with pupils' success, achievement and mental wellbeing (Boaler, 2013, Dweck, 2010). A limited number of studies exists that examines mathematics successes (Liu, 2017), mathematical mindsets and the factors contributing to mathematical mindsets formation. However, research continues to grow in terms of how mindsets develop towards mathematics.

The effects of students' beliefs or perceptions towards learning, parental involvement, teacher influence, societal perceptions, and prior experiences in mathematics need further examination (Boaler, 2013, Dweck, 2008). The

inclusion of assessment in this study helped further create a comprehensive understanding of a major influential contributor of mindset formation and its effects on students' ability and mathematics success. In assessing mathematics learning, the approaches used, the kinds of tasks assigned, and how success or failure is reported influences students' beliefs about their own learning and the nature of learning as a whole (Masters, 2014, Dweck, 2006). Psychologist Carol is of the view that providing easy tasks to students and praising them for doing well on those tasks makes the students feel entitled to easy work and praise. Thus, teachers need to communicate to students that those unchallenging tasks are a waste of time and eventually raises poorly educated students.

The review has shown that mathematics educators must learn from research-based techniques and strategies to increase mathematics achievement, improve students' views of mathematics, and develop students' growth mindsets. Teachers must emphasize problem-solving skills and conceptual understanding necessary for the demands of twenty-first century basic schools. Research supports the benefits of teaching students the importance of mindset in exploring mathematics.

CHAPTER THREE

RESEARCH METHODS

This chapter describes how the study was conducted. It deals with the design employed, the study population, the number of respondents who were selected from the population and the sampling procedure. Also, it focuses on the instrument that was used to collect the data from the respondents, how the data was collected and how it was analyzed.

Research Approach

Three categories of research approaches have been recognized in literature and have been used by researchers extensively for investigating a particular phenomenon. Saunders, Lewis and Thornhill (2016) and Sekaran and Bougie (2016), the most predominantly used methods are the quantitative, qualitative and mixed methods. While researchers argue that no particular method supersedes the other in terms of use, there is a need to carefully choose one method that suits the purpose of a given study (Saunders et al., 2016). According to Denzin and Lincoln (2006), the quantitative methodology aims at collecting numerical data and analysing it in line with statistical principles and drawing conclusions based on the results. This method follows rigorous statistical procedures which allow generalisation of the findings, to measure and analyse descriptive and causal relationships between variables (Saunders et al., 2016). Also, a quantitative approach is a method concerned with logically and critically testing, verifying and identifying variables, in an objective manner.

The qualitative methodology on the other hand deals with method of investigating a phenomenon of which the purpose is not to generalise findings across a given population. Qualitative research can be defined as an approach

for exploring and understanding the meaning individuals or groups ascribe to a social or human problem (Creswell, 2014). According to Daymon & Holloway (2010), qualitative research method is an approach or technique designed with the aim of enabling writers gain understanding of the socio-cultural surrounding of people.

In the view of Creswell (2014), mixed methods concern the combination of both qualitative and quantitative philosophical techniques so that evidence may be mixed and will increase the knowledge gathered on a given interest of inquiry. According to Saunders et al. (2016), mixed method is more robust and provides comprehensive answers to research questions. It aims to minimise the limitations encountered in qualitative or quantitative studies. Creswell and Plano-Clark (2007, p. 224) stated that the use of "both forms of data allow researchers to simultaneously generalize results from a sample to a population and to gain a deeper understanding of the phenomena of interest". This means that researchers are able to generalize from the sample to a population, which is one of the aspects of the quantitative research process, which is done by a quantitative researcher. On the other hand, these generalizations can be further supported and enhanced through descriptions of some aspects of the data, which is an approach that is normally taken by qualitative researchers. This study adopted the mixed method, given the nature and objective of the research.

Research Design

This study employed a mixed method research approach, which is made of up of three major research designs: sequential, concurrent and embedded (Saunders et al., 2016). The concurrent design best favors this study as both quantitative and qualitative data are collected simultaneously before

commencing analysis. It gives equal emphasis on both the interview and the questionnaire for qualitative and quantitative data respectively. With this design, data collection from both the quantitative, that is the questionnaire, and the qualitative, that is the interview are done at the same time and analyzed concurrently (Creswell, 2014). The design is used when researchers wish to collect both data and analyse at the same time, make comparison between the results and draw conclusion from both sides. The rationale behind the choice of this design was that the researcher valued equally the two forms of data and treated them as such. Both the quantitative and the qualitative data were collected concurrently on the same days. Data was thereby merged, and the results of analyses used simultaneously to understand the research questions through the comparison of findings from the quantitative and qualitative analysis. Cresswell and Plano Clark (2007, p. 62) stated that "during interpretation, this design helps the researcher to directly compare and contrast quantitative statistical results with qualitative findings in order to elaborate valid and well-substantiated conclusions about the problem under study".

Furthermore, the choice of this design was based on the premise of its flexibility of use when collecting data because the researcher was interested in investigating the mathematical mindset of students at the Junior High Schools using structured questionnaire to obtain the quantitative data and structured interview to obtain the qualitative data.

Study Area

The study will be carried out in the Bongo district of the Upper East region of Ghana. The district is described as one of the deprived districts in the country. Bongo district was carved out of the then Bolgatanga district, now

Bolgatanga municipality in 1987. The researcher has been a teacher in the district from 2007 till date. The district is divided into 10 circuits by the District Education Directorate.

It is important to study Mathematical mindset of students from this area because available data from Ghana Education Service (GES, 2019) West African Examination Council (WAEC, 2019) and District League Table (2019) all show abysmal performance of students of the Junior High Schools in the District during their Basic Education Certificate Examination (BECE). Evidence from these sources suggest that, the performance of the students at BECE level over the past four years has been below 50%. Thus, from 51.1 percent in 2018 to 40 percent in 2020. Analysis of the performances of JHS students at the BECE level over six-year period from 2010 to 2016 by Ghana Statistical Service (GSS, 2017) further shows that, Junior High Schools in Bongo District continue to perform poorly particularly in Mathematics and Integrated Science. On this basis, investigating mathematical mindset of students in the district will help bring out solutions to stakeholders of education and policy makers.

Population

The study focused on the Junior High level because it is a critical level that prepares children for mathematics, which impacts their ultimate mathematics achievement (Gamoran & Hannigan, 2000; Moses & Cobb, 2001). Also, the Junior High school marks a significant transition in children's educational (between primary and senior high school) and developmental (between childhood and adolescence) experiences, which can lead to significant shifts in motivation and perception of ability (Eccles, Wigfield, Midgley,

Reuman, Mac &Feldlaufer, 1993; Eccles, Lord & Midgley, 1991). There are 58 Junior High Schools scattered across the 10 circuits of the district.

The total student population of the 58 Junior High Schools is seven thousand, four hundred and seventy-nine (7479) of which 2822 are in form one, 2497 in JHS two and 2159 in JHS three (Bongo District Education Office, 2019). Furthermore, out of the 58 schools the target population for the study was students from 10 schools in the district. The accessible population of the study was therefore four hundred and fifty-eight (458) constituting only the JHS 3 students. The JHS 3 students were considered the most appropriate tom use for this study because, they had taken enough lessons in Mathematics as per GES syllabus and possess adequate knowledge to respond to the research questions.

Sampling Procedures

Sampling is done to select from the population a representative. Data is often not taken from the entire population when that population is large (Saunders, Lewis & Thornhill, 2016). The main objective of sampling is to select a representative group of components that reflect the characteristics of the population. In this study, with each circuit consisting of at least two Junior High Schools, the accessible student population for the 10 schools was 458. In using all the 10 schools, a multi-staged sampling was adopted. By using multi-staged sampling, researchers put the populations into groups or clusters and drew samples from the clusters (Saunders et al., 2016). The schools are put into 10 clusters referred to as circuits. Each circuit has between two to six Junior High Schools. One school is randomly selected from each of the 10 circuits to obtain

10 schools from the 58 Junior High Schools in the district. Again, a census method was adopted in the study.

According to Pandey and Pandey (2015), a census or parametric method is an attempt to gather information about every member of some group, called the population. It deals with the investigation of the entire population without excluding any unit or group. In view of Sekaran and Bougie (2016), a census method allows for all the units of the analysis to be included in the study to offer more opportunity for all to participate in a given study.

Furthermore, census technique provides a more accurate and exact information as no unit is left out (Pandey & Pandey, 2015). Moreover, all 25 students belonging to one of the 10 schools were engaged for the interview for qualitative analysis. The school was selected because of accessibility and willingness of the head teacher to allow the students to participate in the interview session.

Data Collection Instruments

Collecting data for a study involves using certain research instruments and procedures for collecting the data. In this study, questionnaire and interview guide were used in the collection of information from respondents on their mathematical mindset as well as assessment practices that influence mathematical mindsets. A questionnaire is a written document in survey research that has a set of questions given to respondents or used by an interviewer to ask questions and record the answers (Neuman & Kreuger, 2003). A questionnaire could be answered by the person from whom information is sought or through an interpreter.

According to Neelankavil (2007), questionnaires guarantee greater uniformity, consistency and objectivity in data collected. They also provide privacy and convenience for respondents during completion while guaranteeing greater anonymity (Neelankavil, 2007). Groves, Fowler, Couper, Lepkowski, Singer and Tourangeau (2011) posit that there are distinct advantages in using questionnaires rather than interview methodology. One of such advantage is that questionnaires are less expensive and easier to administer than personal interview.

The questionnaire included closed-ended items, in which the questions permit only certain responses such as 'yes' or 'no' or the Likert type to choose from answers provided in the questionnaire, as well as some open-ended questions. Items on the study's questionnaire totalled seventeen in number (see Appendix A). The First Part captures information about the respondent age and the Second Part was for measuring mindset and was adopted from Dweck (2006). The Part Three was dedicated to determining assessment practices that influence students' mindsets.

The researcher used secondary data obtained from the schools, particularly, the final common mock mathematics scores to determine the relationship between students' mathematics mindset and academic achievement. All the schools in the district wrote a common mock exam. These scores were picked directly from the mock reports and used as the composite scores for the students. This is in line with the procedures laid by Seabrook (2017) who used the GPA scores of students within the last semester of their course to determine the relationship between their mindset and their academic achievement.

In respect of the qualitative data, a structured interview guide developed and used to collect the data on the perception of the students towards their mindset in mathematics. The selection of the respondents for the interview was based on the respondents' availability and the willingness of the head teachers to allow their students participate due to time constraints for writing the BECE. All the students in one school comprising 25 students were used for the interview. The interview was intended to provide time to explore, in greater depth, the type of mindset (fixed and growth mindset) the students have concerning the teaching and learning of mathematics. A sample of 25 students all selected from one JHS 3 class comprised the interview pool. The school and students were used because of the willingness of the head teacher to allow the students to participate. Alphanumeric pseudonyms were assigned to each interview participant combining with the number assigned them in the order of the interview (thus, S1, S2, etc.). During the interviews, participants shared anecdotal information regarding their age and gender.

The interview data was collected by the researcher and linked to the central research question. The interview was recorded on an audio tape and later transcribed and reviewed by the researcher. The central objective that was analysed by this method is "to assess the mathematical mindset that students at the selected JHSs in Bongo District have". The researcher used further questions to probe the respondents to the get specific details of components (fixed and growth) mindset.

Pre-Testing

According to Pallant (2016) and Saunders et al. (2016), pre-tests are required ahead of a main survey for the following reasons. Firstly, they ensure

that instructions, questions and scale items are clear. They further help potential respondents to comprehend the questions and respond appropriately. Finally, they help researchers to do away with any questions that may offend potential respondents.

In line with this, after approval of the questionnaire by supervisor, the researcher engaged in pre-testing on ten (10) students from one Junior High School within the district. This site for the pre-test was chosen because of proximity to researcher and participant similarity with the main target respondents. This sample size was deemed appropriate as it conforms to Saunders et al.'s (2016) minimum criteria of 10 for pilot studies by students. The outcome of the pre-testing indicated the instructions and scale items were clear to the respondents. This led to the maintenance of all the modified scale items.

Reliability and Validity

Reliability is a key component to be considered when evaluating a particular instrument. Reliability, according to Bless, Higson-Smith and Kagee (2006), is concerned with consistency of the instrument. An instrument is said to have high reliability if it can be trusted to give an accurate and consistent measurement of an unchanging value. Reliability means dependability or consistency (Neuman & Kreuger, 2003; Creswell, 2014). It indicates the likelihood that a given measurement technique will repeatedly yield the same description of a given phenomenon.

The role of reliability is to minimise the errors and biases in a study (Saunders et al., 2016). In line with the foregoing, Cronbach's Alpha coefficient, as depicted in Table 1, was generated on the pre-test data so as to

validate the internal consistency of the study elements. It has been revealed in the earlier researches that reliable scales are those with Cronbach's Alpha coefficient of 0.70 or more (Pallant, 2016). Based on this threshold, it can be concluded that the study had good internal consistency.

Table 2: Computed Reliability Coefficients for the Pre-Test Data Collected

	No. of items	Cronbach Alpha
Mindset	8	.842
Assessment Practices	10	.744

Source: Field Survey (2020)

Data Collection Procedure

Primary and secondary data were used for this study. At each school, the introductory letter from the District Director of Education and the Ethical Clearance Letter from the IRB of UCC, were presented to the heads and mathematics teachers to attract their approval since the researcher was a known teacher in the district. The researcher also explained to the respondents that their responses would be kept confidential and that the study was purely for academic work aimed at finding out the underlying causes of performance in mathematics in order to improve teaching and learning of the subject. This gave them confidence and comfort as some students even encouraged their colleagues to respond truthfully to make the study trustworthy.

Primary data are original data sources that are collected fresh and for the first time and therefore happen to be the original in nature. The primary data was collected using the survey method. This involved the distribution of questionnaires and collection of data from respondents as well as data gathered from the interview. In other to achieve the objectives of the study, well designed

questionnaires and interview guide were used. The questionnaires were distributed to the respondents by the researcher. The secondary data was obtained from their scores in their mock exam. A total of 10 days was used for data collection of the data.

Data Processing and Analysis

Data collected was organised and presented in tables in a meaningful way for easy analysis to aid decision making. The raw quantitative data obtained from the questionnaires were processed and organised using Statistical Package for Social Sciences (SPSS) version 26. Frequencies, percentages, means and standard deviation, and regression analysis are the statistical tools used for analyses of the quantitative data. To answer research questions one and two which were; 'What are the mathematical mindsets of students at the selected Junior High Schools in the Bongo District?' and 'What assessment practices is likely to influence Junior High School students' mathematical mindset in the Bongo District? ', descriptive statistics (means and standard deviations; see also frequencies in the next chapter) were used. Inferential statistics (correlation and regression) were used for analysis of research question 3 which was; 'What is the relationship between mathematical mindsets and mathematical achievement of students at the Junior High Schools in Bongo District?'. This was done to gain the overall view of how mathematical mindset causes changes in the academic performance of the students.

Descriptive statistics are used to determine the characteristics of the study constructs. They are also used to determine whether the constructs used for the study do not violate assumptions underlying the usage of any of the statistical techniques employed by the researcher in addressing study objectives.

Whereas statistics such as means, median and standard deviations are used for continuous variables, frequencies and percentages are used for categorical variables (Pallant, 2016). Again, the overall assessment of the objectives 1 and 2 were done using mean values generated for the constructs with 1 to 2.9 representing low levels and 3 to 6 representing high levels of a variable; a 0.1 cut-off point, as applied by Boaler, Dieckmann, Pérez-Núñez, Sun and Williams (2018) and Onyefulu (2018). Thus, for objective 1, students are said to exhibit a fixed mindset when the mean score is higher than 2.9. Likewise, in objective 2, an assessment practice that influences the growth mindset is applicable in the schools when the mean scores of the various used assessment practices are higher than 2.9.

In addition, data from the interview was analysed thematically in order to identify the fixed and growth mindset elements and to get an in-depth understanding of the quantitative data. The themes included precise ways in which the students in the selected schools perceive their mathematics ability, level of resilience in learning mathematics, praise and reward, as well as learners' awareness of the importance of mathematics as a subject. Thus, each main interview question represented a theme. A total of 7 themes were obtained indicating the views of the participants and the type of mathematical mindsets they possessed.

Data Screening

Data collected through the questionnaires were coded and entered into SPSS to check the dataset for errors to firstly identify and subsequently correct variables that were either out-of-range or erroneous (Pallant, 2016). Errors present in the dataset may distort the statistical analysis and need to be corrected

by inspecting each indicator to ensure that the values fall within the allowed minimum and maximum values. Screening the dataset before the conduct of any analysis further enabled the researcher to develop a basic understanding of the data and of any relationship that may exist between indicators. As suggested by Pallant (2016), the frequencies for the continuous variables (mindset, practices and academic achievement) in the dataset as well as the corresponding minimum and maximum values were checked to ensure that they were within range (See Appendix C). As part of the preparation and screening process, data were also examined for missing data, normality and outliers.

Missing data refers to the non-availability of valid values on one or more variables for the conduct of multivariate analysis and is a common problem in multivariate analysis. The missing values analysis function within the SPSS was used to assess the missing data within the dataset. A four-step approach for identifying and applying remedies for the missing data was then carried out as suggested by Pallant (2016). The first step involved in examining the missing data to determine whether the missing data was "ignorable or not ignorable". The ignorable missing data, defined as missing data that are expected and part of the research design, do not require specific remedies (Pallant, 2016). Pallant (2016) stated that these are common forms of missing data where respondents skip sections of the questions that are not applicable to them. The results of the present study showed no missing data existed (Appendix C).

Correlation

Correlation analysis is utilised when the researcher is interested in the determination of strength (small, medium and large) and direction (positive and negative) of the study variables. There are two forms of correlation: Pearson

Product-Moment correlation and Spearman Rank Order correlation. Pearson's Product-Moment correlation is used for the analysis of continuous variables or one continuous variable and one dichotomous variable while Spearman's Rank Order correlation is used when data is at ordinal level (Pallant, 2016). A positive correlation shows that all the variables of interest move in the same direction whilst a negative correlation shows that the variables of interest move in the opposite direction. Thus, in the study's context, the Pearson's Product-Moment correlation coefficient denoted by R was deployed to aid analysis of the objectives.

Normality Assessment

Central to the assumptions underlining the use of correlation and regression technique for data analysis is the checking of how well the data is evenly distributed within the constructs employed in a study. According to Pallant's (2016) criteria for assessing normality, Skewness values ranging between 0 to ± 1 and Kurtosis values ranging between 0 to ± 1.5 are enough to justify that, normality rules are not violated in a study. Mindset, assessment practices and academic achievement items as well as the composite construct were checked for normality using the Skewness and Kurtosis range and other checks including missing data, outliers and normality (Q-Q plots etc.) are shown in the Appendix C. From the output presented in the Appendix C, all criteria were met for further analysis.

Ethical Issues

According to Li (2006), ethics is mostly associated with morality and deals with issues of right and wrong among groups, society or communities. It is therefore important that everyone who is engaged in research should be aware

of the ethical concern (Rubin & Babbie, 2016). The researcher employed every effort to avoid as far as possible violation of ethical principles. Edginton et al. (2012) have identified the basic ethical consideration for research as; respondents being fully informed about the aims, methods and benefits of the research, granting voluntary consent and maintaining the right of withdrawal. The researcher applied for ethical clearance from the Institutional Review Board (IRB) of the University of Cape Coast. The research proposal together with the instruments for data collection were scrutinized to ensure they satisfied all ethical requirements of the board. The IRB finally approved the research proposal and then issued an ethical clearance letter dated 20th January, 2022 granting the researcher permission to undertake the study.

The researcher also obtained the letters of introduction from the Department of Mathematics Education and the Bongo District Director of education regarding the researcher's intention to conduct the study and presented copies to the head teachers and mathematics teachers of the selected schools to seek their prior approval to engage the respondents. The rationale for the study, assurance of confidentiality and the right of withdrawal was explained to the participants. The researcher in the conduct of the study also educated the participants concerning the details needed for the study, the reasons why the information are being gathered, as well as the way in which they were expected to participate.

Chapter Summary

This chapter has provided information as to the research design appropriate for the study, how the primary data for the study were collected, organized, analysed and presented for easy comprehension. This chapter also

presented information on the scientific approach adopted in terms of approach to data needs, statistical techniques and systematic enquiry into the investigation under consideration. In the next chapter, results of the data gathered and the accompanying discussions were be presented

CHAPTER FOUR

RESULTS AND DISCUSSION

Overview

This chapter presents the results and discussion of the data gathered from the field exercise. The chapter is organized under the background characteristics of respondents, the normality assessment of the mindset, assessment practices and academic achievement data followed by the analysis of the various objectives of the study. The specific questions of the study were; What are the levels of mathematical mindsets of students at the selected Junior High Schools in the Bongo District? What assessment practices is likely to influence Junior High School students' mathematical mindset in the Bongo District? What is the relationship between mathematical mindsets and mathematical achievement of students at the Junior High Schools in Bongo District? A total of four hundred and fifty-eight (458) responses were obtained while twenty-five (25) students participated in the interview for the qualitative analysis.

Background Characteristics of Respondents

To ascertain a fair knowledge on the background of the respondents the researcher collected few information from the participants including their age and gender. This information in brief offered the researcher an understanding of what the students are composed of and in line with the position reached by Dweck (2008) that mindsets in children should be investigated among those at age 12 years and above. With respect to the age, the minimum age of the respondents was 13 years while the maximum age of the students in the schools sampled was 22 years. This age range is in line with the recommended minimum

12-year age for mathematical mindset investigation among pupils in basic schools (Dweck, 2008). On average, the students' age is approximately 17 years (M=16.78, *SD*=1.42).

The gender distribution indicates that the number of females is 263 (57.4%) with the number of males being195 (42.6%); which is not surprising as there are more calls in the district and the Upper East as a whole from non-governmental organisations (NGOs) such as World Vision International, Afrikids, Campaign for Female Education (CAMFED) to increase female enrolment in schools in the region. These calls and campaigns have over the years increased female school enrolment in recent years (CAMFED, 2019).

Results

This section presents the findings for each question that guided the study. The analysis has been structured in two parts comprising quantitative analysis for part one and the qualitative inquiries for part two. In respect of the quantitative analysis, means, standard deviations and correlation and regression techniques were employed to address the research questions of the study, whiles thematic content analysis was adopted for qualitative analysis.

Mathematical Mindset of Students

This section discusses the first research question of the study which sought to assess the mathematical mindset that students have at the Junior High Schools in Bongo District. The items of mindset were assessed based on the fixed and growth mindset orientation suggested by Dweck (2006). The respondents were presented a series of questions rated on a 6-Likert Scale to express their opinion on the mindset they have about teaching and learning of mathematics. The results are presented in Table 3.

Table 3: Mathematical Mindset of Students- Item, Frequencies (%), Means and Standard Deviation

Mindset Items	Distributions of the 6-point Likert scale 1	2	3	4	5	6	Mean	S.d
Fixed Mindset statements								
The amount of intelligence I have in mathematics cannot change	170	91	30	46	70	51	2.80	1.83
I can learn new things in mathematics, but cannot really change my basic level of intelligence in the subject.	116	70	42	39	126	65	3.40	1.86
To tell the truth, when I work hard to understand a mathematics problem, it makes me feel as though I'm not very smart	70	64	31	41	160	92	3.95	1.78
I like mathematics problems that I can really do well without too much trouble	39	36	21	53	168	141	4.52	1.57
Mean of means							3.67	.96
Growth Mindset Statements								
I like work that I'll learn from even if I make a lot of mistakes	336	17	36	8	61	0	2.14	.61
I like my work best when I can do it perfectly without any mistakes	458	0	0	0	0	0	1.95	.65
When a mathematics problem is hard, it just makes me want to work more on it, not less	14	404	5	6	10	19	1.90	.69
I like mathematics problems that make me think hard	118	75	42	37	83	103	1.91	.78
Mean of means							1.98	.48

Source: Field Survey, 2022

The results as captured from Table 2 indicated that the students exhibit high fixed (M=3.67, *SD*= 0.96) than growth (M=1.98, *SD*= 0.48) mindsets in the selected schools in the district. This is because the means score of the fixed mindset was within the 3 to 6 cut-off point for high level of fixed mathematical mindset while the score for growth mindset was far below the acceptable range. Furthermore, from Table 2, the specific statements defining the fixed mindsets all show high levels except the first item "The amount of intelligence I have in mathematics cannot change" (M=2.80, *SD*= 1.83) that recorded a relatively low

mean score. It has 167 respondents out of the 458 agreeing that their level of intelligence in mathematics cannot change. The results imply that the students of the selected Junior High Schools possess the fixed mindset and think that the amount of intelligence they have cannot be changed. They also prefer mathematics problems that they can do well without much trouble. The third item ("To tell the truth, when I work hard to understand a mathematics problem, it makes me feel as though I am not smart") had 293 out of 458 responding in support of the statement. They believe that if you work hard to understand a mathematics concept, it implies that you do not have the mathematics ability, in other words, you are not good in mathematics. Thus, the respondents believe that one needs smartness rather than efforts to succeed in mathematics. The implication this has on students' learning of mathematics is that they are most likely to be less resilient which affects their mastery of these concepts. They fail to understand that hard work also helps to achieve mastery goals. Out of the 458 respondents, 362 confirmed that they do not like challenging tasks, implying that they do not want to be challenged as it may make them not feel smart. The implication of this on their learning is that, students embrace fewer challenging tasks, and learn below the standards, leading to under attainment. On item 6, all the 458 respondents indicated that they do not like mistakes and therefore are afraid to make mistakes. Mistakes however should be welcomed in the learning process of mathematics to make room for discovery and improvement.

Previous research works have argued that the kind of mindset that guarantees student's success is the growth mindset (Blad, 2015; Boaler, 2016; Dweck, 2008; Hochanadel & Finamore, 2015). The findings of the study are not surprising as the academic achievement of the students in the district keep

falling at the BECE level. Furthermore, Stec (2015) concluded that students with a growth mindset believe their abilities can be improved and tend to build their problem-solving abilities when faced with adversity or new situations with practice, so they are in control of their own learning. Teachers must emphasise problem-solving skills and conceptual understanding necessary for the demands of twenty-first century's technological advancements and societal demands by improving students' views of mathematics, and develop students' growth mindsets (Cunningham, Hoyer, & Sparks, 2015). Blad (2015), Boaler (2016) and Hochanadel and Finamore (2015) noted in their studies that future and current mathematics educators need to be trained to implement growth mindsets that lead students to appreciate the importance of perseverance and errors in building a stronger knowledge base.

Assessment Practices that Influence Students' Mathematical Mindset

The second objective assessed the assessment practices by teachers that influence the mathematical mindsets of the students in the selected schools in the district. Grading, praise and reward, the level of difficulty of assessments task, and timing during assessment are amongst the assessment practices that can influence learners' mindset towards mathematics. These practices have the tendency to make students afraid of mistakes, and shield their weaknesses rather than striving to improve. According to Ruiz-Primo Furtak (2007), assessment has been thought of as any method that can be used by teachers to provide information on the exact understanding that the student has and a way of gathering, explaining and recording information about the learner's work. Here, a number of questions were asked the students on how they are assessed in the

schools by their mathematics teachers. The results are summarized below in Table 4.

Table 4: Distribution of Assessment Practices in the Junior High Schools

Assessment practices	5-point Likert scale						
Items	1	2	3	4	5	Mean	S.d
My mathematics assignments are graded when I learn something new.	24	27	91	62	25	44.08	1.21
I am provided with rubrics (procedure) before I begin a mathematics assignment.	66	26	104	69	19	33.65	1.43
My mathematics teacher encourages us to ask questions like why the class is learning a topic.	95	42	100	60	16	13.33	1.54
All students are expected to reach a common high standard but we are given different levels of support and time to accomplish it	98	33	136	86	10	52.24	0.95
My mathematics teacher gives recognition such as awards, for effort in mathematics.	133	47	153	53	72	2.75	1.40
My mathematics teacher tells us that we are smart in mathematics when we perform well.	57	43	131	82	14	53.47	1.35
When we make mistakes or give a wrong answer, we get specific feedback on how to improve.	144	37	116	58	13	33.13	1.54
I am rewarded or praised for completing work quickly.	66	37	135	70	15	03.44	1.41
Our grades reflect mastery of specific standards rather than average or sum of points earned.	112	54	100	62	13	03.10	1.55
We tease one another for making mistakes in mathematics problems.	65	21	71	76	22	53.82	1.45
Valid N (listwise)							

Source: Field Survey (2022)

From Table 4, students indicated that "their mathematics assignments are graded when they learn something new" (M=4.08, *SD*=1.21). Again, the students (M=3.65, *SD*=1.44). indicated that they are usually provided with some hints as to how to go about a mathematics assignment before they attempt the

problem Furthermore, some of the students (N = 161; M = 3.33, *SD* =1.54) agreed that their mathematics teacher always encourages them to ask questions in class, seek other ways of improving their mathematics knowledge, provides the students with feedback on how they perform, as well as recognize the efforts of students for completing their task. One worrying concern emanated when all the 458 respondents indicated that they tease one another for making mistakes in mathematics problems. It is worrying because, respondents who have been teased before feel that it intimidates them, and discourages them from speaking in class. They would therefore prefer to shield their weaknesses to avoid the intimidation. The implication on learning mathematics is that, since the students' tease each other, they may not feel safe to make mistakes or even make their mistakes known to their teacher and to allow for corrections for improvement. This makes the learning environment unsafe. Students therefore pretend to follow lessons without questioning and not responding to questions during and after mathematics lessons.

However, on item 4, 267 out of the 458 students indicated that they are not given different levels of support and time to accomplish mathematics task although they are expected to reach a common high standard (M=2.24, *SD*=0.95). This is surprising since students have varying levels of mathematics ability. This has the tendency to make students believe that mathematics is about speed and smartness. Also, the study found that mathematics teacher gives recognition such as awards, but not for effort of the students dispensed in obtaining those grades in mathematics (M=2.75, *SD*=1.40). The results suggest that, when the mathematics teachers adopt more advanced ways of assessing the students in class such as questioning, providing adequate feedback on the

progress of their students, encouraging the students to seek their colleagues review their task as well as giving pre–solution procedures, it will go a long way to influence the mathematical mindset of the student. Moreover, because teachers always grade students work, and give rewards for marks without taking efforts into consideration, students feel that their goal for learning is to acquire marks to attract rewards, and when they fail, may not feel like working hard. This then creates room for malpractices on the side of students, in order to acquire good marks to shield their weaknesses and to avoid being teased.

Again, the current system of teaching and testing seems to develop in learners an entity or fixed theory of learning (Dweck 2000, Harlen, 2005) that makes them believe that they are either good at mathematics or they are not. Even those who see themselves as being good at mathematics when at school may not develop mathematical resilience as every time, they get stuck they ask their teacher. Thus, it can be concluded that some assessment practices used in the schools studied are questioning, feedback, peers' review, rewards, pre-solution or hints to solving mathematical problems.

Effect of Mathematical Mindsets on Mathematical Achievement of Students

This section of the study presents the results and the discussions to the final objective which analysed the effect of mathematical mindset and academic achievement. With respect to mathematical achievement, the mock examination scores in mathematics of the students were taken and a regression analysis was run against the students' mindset. The analysis was specifically based on the values of correlation (R), coefficient of determination (R squared) and statistical significance as well as the magnitude of the effect of the independent variable (mathematical mindset) on the dependent variable (mathematical achievement). The R describes the direction and the strength of the association between the independent and dependent variable in a study. Cohen (1992) suggests the

following guidelines for the interpretation of the magnitude of correlation coefficient; r = .10 to .29 or r = –.10 to –.29 small, r = .30 to .49 or r = –.30 to –.4.9 moderate, r = .50 to 1.0 or r = –.50 to –1.0 strong.

Moreover, the coefficient of determination (R-squared) represents the variation in the dependent variable that is accounted for by the independent variable(s). In view of Sarstedt, Henseler, & Ringle, 2011), R^2 values of 0.75, 0.50, or 0.25 for dependents variables can, as a rough rule of thumb, be respectively described as substantial, moderate, or weak. A statistical significance of variables or constructs are achieved when a 95% confidence interval probability is less or equal to 0.05 or 5%; t-statistic of 1.96 or more (Pallant, 2016). In light of the above the results of the research question were assessed and reported in tables that ensue under each objective.

Table 5: Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.548[a]	.300	.297	.38928

a. Predictors: (Constant), Mathematical Mindset

Source: Field Survey (2022)

From Table 5 the results indicated that there is a large positive relationship (R = 0.548) between mathematical mindset and mathematical achievement of the students in the selected Junior High Schools in Bongo district. Moreover, the results showed that 30% of variation in the mathematical achievement of the students was accounted for by their mathematical mindset. Hence, the remaining 70% maybe due to other factors which were not captured in the present study.

Table 6: ANOVA[a]

Model		Sum of Squares	Df	Mean Square	F	Sig.
1	Regression	15.549	1	15.549	102.609	.000[b]
	Residual	36.217	456	.152		
	Total	51.766	567			

a. Dependent Variable: Mathematical Achievement

b. Predictors: (Constant), Mathematical Mindset

Source: Field Survey (2022)

Results in Table 6 suggests that the R and R-squared for mathematical mindset and mathematical achievement was statistically significant at 95%, 2-tailed ($F(1,456) = 102.609$, $p<0.001$). Hence, it can be concluded that there is a positive significant relationship between mathematical mindset and mathematical achievement of the students in the selected JHSs in Bongo district. Finally, Table 6 gives the full indication of the magnitude of the effect of mathematical mindset and mathematical achievement**.**

Table 7: Coefficients[a]

Model	Unstandardized Coefficients		Standardized Coefficients	T	Sig.
	B	Std. Error	Beta		
(Constant)	2.144	.101		21.143	.000
Mathematical Mindset	.338	.033	.548	10.130	.000

a. Dependent Variable: Mathematical Achievement

Source: Field Survey (2022)

The results in Table 7 explain the predictability of the independent variable (mathematical mindset) on the dependent variable (mathematical achievement). The table indicates a standardized Beta of .548 and this was

significant at $p<0.000<0.05$, t-statistics = 21.143. The results imply that the mathematical mindset has a positive significant effect on the mathematical achievement of the students.

Moreover, the findings suggest that when the students of the selected Junior High Schools perceive themselves as being capable of tackling mathematical problems, they are able to perform well or achieve high scores in mathematics. Thus, when the students are encouraged by teachers and other educational stakeholders such as parents to shift to believing that their intelligence is flexible, their mathematical or overall academic achievement increases.

It follows also that teachers seeking to build mathematical resilience in learners will encourage collaborative working where learners support one another in learning, use the power of assessment for learning (Williams, 2015) to enable the pupils to both understand their own rights and responsibilities in the process of learning and to support them in knowing when and where to put in their learning effort. There will not be 'competitions' to see who can recite memorized answers most quickly but rather activities designed to help pupils learn mathematics and also to use their mathematical understanding. In this way we are seeking to interpret Dweck's work on mindsets (Dweck, 2000) in the context of learning mathematics. Therefore, teachers need to focus on the characteristics of the construct mathematical resilience to help change mindsets and overcome current negative attitudes to mathematics. Mathematical resilience can be developed in learners when the school encourages people to see that learning takes effort but that that effort will result in improvement.

These findings corroborate with those of Chen and Wong (2015) and Claro et al. (2016) who concurred that mindset especially students' growth mindset has significant implication on the academic performance and progress of the students. According to the aforementioned pioneers when students are taught the growth mindset, their motivation changes and their grades increase. In addition, Yilmaz Soylu, Zeleny, Zhao, Bruning, Dempsey, and Kauffman (2017) found that when students are challenged and are required to formulate new ways to attack a problem, they grow and build new connections in their brains for which is able to increase the students' chances of performing well in mathematics. In light of the above, it can be concluded that mathematical mindset positively and significantly has effect on the mathematical achievement of the students in selected schools in Bongo District.

Students' Mathematical Mindset

The research question that was addressed by the qualitative structured interview was question one and its related main research objective. Qualitative interviews were primarily constructed to provide detailed insight into the precise ways in which the students in the selected schools perceive their mathematics ability, level of resilience in learning mathematics, praise and reward, as well as learners' awareness of the importance of mathematics as a subject. Thus, each main interview question represented a theme. The findings are as follows:

In the first place, the participants were asked to express their opinion on whether they were good in mathematics with brief explanations. The question was stated as "Do you think you are good in mathematics? Explain". All the 25

respondents except S11, S19, S20, S22 and S23 indicated they were not all that good at mathematics. Some of the responses are as follows:

S1 noted: "when I write mathematics [*sic*] exams, I don't pass".

S3 said: "any time I write mathematics [*sic*] test, I always fail and my teachers will always tell me that I should go back to class 1, that is where I belong". In the view of S8, the respondent feels listening to mathematics lessons makes him understand but feels otherwise after class. The respondent explained that "I understand the concepts and procedures but I forget everything in the next day". The common reason of the 20 respondents who think they are not good in mathematics was that they do not obtain good marks in mathematics exams. Although some (S5, S8, S9, S14, S15) they understood the mathematics concepts taught during classroom lessons but forget them later and so perform poorly in exams. These respondents use their performance in test as a measure of their ability in mathematics. They fail to understand that, once they have understood the mathematics concepts during lessons, it is then dependent on their efforts to sustain or improve their understanding levels to be able to solve mathematics problems.

The other five respondents who believed they are good in mathematics explained that they always understand mathematics concepts taught during lessons and also do well in mathematics exams. Interestingly, S19 and S23 added that sometimes their inability to obtain good grades in mathematics is due to their inability to study hard to improve their understanding. S19 said: " yes, I think I am good in mathematics, when the teacher is in class, I understand everything , but I don't normally get time to practice, that is why sometimes I get low mark". S23 also said, "yes, I understand in class, but I don't normally

do well in exams because mathematics needs constant practice". In this question, these five respondents seem to exhibit growth mindset traits.

The next question read "Do you think spending lots of time to understand a concept in mathematics is a good thing?". Fourteen respondents exclaimed that it was a good thing to spend more time in learning mathematics. "When you spend a lot of time to understand a concept, and you meet it in exam [*sic*] it becomes easier" (S2). S5 said "yes, mathematics [*sic*] is difficult and requires a lot of time learning it. This will help you pass well". "Yes. Because when you spend more time to understand a mathematics concept, it stays longer in your mind. You always remember it so easily" (S14). However, eleven respondents were of a contrary view that it is not good to spend more time to understand a single concept. S11: "No, if you spend more time, it is not good, it means you are not good". S12: No, because you need to learn other things, so wasting much time on one thing means you will not learn much to enable you pass". S22: "No, it is waste time". They explained that it is an indication that you are not good and that mathematics is about how fast you are. The 11 participants who responded no explained that, if one spends a lot of time to understand a concept it is a waste of time and an indication that you are not good. Among these 11 includes s22, s23 who explained in the first question that they are good in mathematics because they easily understand concepts taught in class, but do not perform well in exams. They, S22, S23 however explain in this question that spending lots of time to understand a concept is a waste of time and one will not learn much. This seems to be a contributory factor to their poor performance in exams, since they do not appreciate spending lots of time to understand a concept. This illustrates a fixed mindset trait. On the other hand,

the 14 respondents, in their reply to the question of time spent in learning a concept, explained that it is a good thing to spend lots of time to understand a concept. This will help you not to forget it easily.

When the respondents were further asked "How do you feel when you do not understand a concept in mathematics?" The students unanimously indicated they do not feel happy…. "I feel bad" (S2), … "I feel bad and hopeless" (S4), I always feel bad since my colleagues might understand it even more" (S6). All the 25 respondents stated that they feel bad, and bored anytime they do not understand a concept in mathematics. The responses here indicates that those that demonstrated the fixed mindset and that of the growth mindset in the previous questions have not responded differently. However, students with growth mindset should feel challenged to try to understand mathematics concepts that appears difficult to them, rather than feeling bored and not willing to continue studies as it is in their case.

Again, the fourth question was a follow up to three which asked the respondents "How do you feel when you get a challenging question or you are unable to solve a question in mathematics?" Similar views were obtained from all the 25 students as those from question three. S5 stated "… I always feel like dropping out of school because you spend a lot of time to learn and yet you cannot solve enough questions to enable you pass well". S4 said "I feel ashamed, because I always think that my colleagues can do it and I am not able to do it, that means I am not a smart person". "I feel bad and lazy to continue again" (S6). S10 also said "That one dee, I feel bad, sometimes I feel like sleeping and I don't want to learn again". These respondents demonstrate their readiness to give up easily in the midst of mathematical challenges as would a

fixed mindset person do rather than persevering as would a growth mindset person. On the other side, S21, S22, S23 added that they feel they have not studied enough which might have accounted for their inability to solve such questions. S21: "I feel like I have not studied well". S22: "I feel happy and want to try hard to get it, … because it is a difficult question if I try hard to solve it, I feel happy and proud". S23: "I feel I have to study more and become smarter". Again, in this question, most of the respondents who seem to have demonstrated growth mindset characteristics in questions 1 and 2, responded the same way as those with the mindset characteristics.

The next question was "How do you feel when your teacher comments positively about your work?". Again, all the respondents stated that they feel happy and proud anytime their teacher comments positively about their work. Interestingly, only four respondents, S8, S9, S10, and S13, added that if the teacher gives praises frequently and also on less difficult work, it can make one feel complacent and over confident.

S8 said "I feel happy but sometimes it can make you proud and then you relax, so sometimes if the teacher praises you all the time, I don't feel happy like that". S10 also said "If it is a difficult thing and I have done it well, and many pupils did not get it correct, and I am among the few that got it correct, I will be happy. But if it is an easy work, I will not feel anything because it is a cheap thing." Why these responses appear interesting is these four respondents earlier demonstrated fixed mindset traits in their responses to questions 1, 2, 3 and 4. In conclusion, most of the respondents appreciate praise regardless of whether the praise is worthy for the task accomplished.

With regards to the sixth probe question ("How do you feel when your mathematics teacher comments negatively about your performance after marking your work?"), 21 respondents unanimously stated that they feel they have disappointed their teacher in such instances.

S1 said "I feel I am a disappointment".

In view of S5, the respondent bemoaned that "I begin to hate mathematics and my teacher". The other 4 respondents S8, S9, S10, and S13 stated that they are moved and challenged to do better next time, though the negative comments hurt sometimes.

S8 said "I feel okay and because it will help me to correct my mistakes and do well next time".

S9 also said "I will feel bad in the presence of my colleagues, but I know very well that after that I will try my best to correct the mistakes". These four respondents demonstrated the growth mindset in the preceding question and have done same in this question. Negative comments are welcomed by people with the growth mindset and therefore urges them to expend more efforts to improve. The other 21 respondents seem not to accept negative comments, hence their hatred towards mathematics and the teacher as well.

The final probe question in relation to the objective was on whether the respondents believed that mathematics as a subject should be optional ("Do you think mathematics should be optional? Explain"). The respondents had different views. While 14 respondents indicated "Yes", 11 respondents said "No". The following are excerpts of students' responses:

S1: …mathematics [*sic*] should be optional, so that those students that are good in mathematics can choose to do it and we those who are not good will have our freedom from insulted [*sic*]". This respondent holds the view that some students are made for mathematics while others are not. To be free from insults implies that the respondent does not welcome negative comments and is therefore afraid of mistakes. Consequently, the teacher's comments of insults do not encourage students to relate effort and success thereby igniting fixed mindset traits.

Similarly, S15 opined "mathematics takes a lot of time for us to understand it, meanwhile there are other subjects that we can learn to pass well without much struggle". This implies that the respondent does not welcome challenging tasks or subjects which takes a lot of time to accomplish, and will therefore opt for subjects within his/her comfort zone. In effect, those who said yes mathematics should be made an optional subject, are of the view that a lot of students fail in mathematics exams especially at BECE, thereby limiting students' chances of getting placement to senior high schools. In this sense, mathematics should be made optional so that those that cannot do well in the subject can avoid it. S7 stated "Yes mathematics should be an optional subject, because if you fail mathematics, you will not get placement, and mathematics too is difficult to pass". All these respondents stated in the first question that they are not good in mathematics because they always obtain low marks in exams, hence a confirmation of their mindset towards mathematics.

For those who said 'no' mathematics should not be made an optional subject holds the view that it is an important subject, since its concepts are found in other subjects and are also useful in daily life activities. Again, some of these

respondents including S2, S3, S4, S8, S9, S10, S17 earlier stated in the first question that they think they are not good in mathematics. This implies that despite their inability to perform well in the subject, they do not wish that it is made an optional subject. S17 indicated in his response to the question that "No; because, I have heard that those who manufacture cars, TV, computers and dressmakers use mathematics". These respondents seem to be aware of the usefulness of mathematics and are ready to expend energy to study to attain success, an indication that they possess the growth mindset.

Based on the above information gathered from the respondents on their perception on mathematical mindset, the responses suggested the students reflect features of fixed mindset as compared to the features of growth mindset. This is because, Martin (2015) and Wilkins (2014) pointed that student who adhere to a growth mindset, or incremental theory of intelligence, tend to pursue mastery goals, gaining deep understanding, and are more focused on the process of understanding concepts and improving academic performance. Hence, it could be concluded in these qualitative findings that students of the selected JHSs in Bongo District have high fixed mindset in mathematics than growth mindset confirming the quantitative findings.

Chapter Summary

The main aim of the chapter was to analyse collected data based on the three research questions to address the overall purpose of the study. Having begun the chapter with preliminaries such as background characteristics of respondents, and normality, the chapter delve into the assessment of the key objectives highlighting the mindsets of students, assessment practices and effects of mindset on mathematical achievement of the students studied.

CHAPTER FIVE

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

Introduction

The chapter presents an overview of the main findings of the study. This was preceded by a summary of the research methods employed in the study. In addition to that, the chapter presents an overview of the analytical tools employed in this study and the results based on the objectives of this study, recommendations based on the key findings of the study and suggestions for further research.

Summary of Key Findings

The study was based on conceptual opinions in relation to the significant contributions of mathematical mindset in improving the mathematical achievement of students at the selected Junior High Schools in Bongo District. The purpose of the study was to investigate the mathematical mindsets of students at the selected Junior High Schools in Bongo District of the Upper East Region of Ghana. Specifically, the study examined the following research objectives in order to:

1. assess the type of mathematical mindset that students have at the selected Junior High Schools in Bongo District.
2. examine assessment practices that influences students' mathematical mindset at the selected Junior High Schools in Bongo District.
3. analyse the effect of mathematical mindsets and mathematical achievement of students at the selected Junior High Schools in Bongo District.

The study employed the concurrent design of mixed method to meet the methodological underpinning of the research design. Using all the 458 students of the selected Junior High Schools in Bongo District as respondents, the study employed a structured questionnaire and interview guide to gather data from the respondents. To analyse the specific objectives of the study, different statistical techniques were employed. Whereas descriptive statistics such as mean and standard deviation were utilised to address the first and second objectives, inferential statistics (regression) was adopted for analysis of the third objective. Moreover, the study conducted a preliminary assessment of the normality of the data collected for constructs of the study after running commentary of the demographic characteristics of the respondents. The assessment showed that data was normal and was furthered applied for advanced analysis of the objectives of the study. The next sections presented the major findings of the study.

In the discussions of the findings, it is obvious that mathematics is one of the subjects that sparks emotions. The Excerpts above such as "I am not good in mathematics because I always score low marks", "when I meet a difficult question, I feel discouraged", amongst others are negative emotions that these students possess. Students' experiences during problem solving in mathematics creates emotions that affects their success (Di Martino & Zan, 2011). Negative emotional disposition towards mathematics therefore affects performance negatively.

In relation to research objective 1, the study found that the students exhibit more of the fixed mindset than the growth mindset in the selected schools in the Bongo district of the Upper East Region of Ghana. This means

that, the students of the selected Junior High Schools studied possess the fixed mindset philosophy and who do not like to learn from even their mistakes, and are not willing to tackle mathematics problems that make them think hard.

The study also examined the assessment practices that influences students' mathematical mindset at the selected Junior High Schools in Bongo District. The finding indicated that questioning, providing adequate feedback on the progress of their students, encouraging the students to seek their colleagues review their task as well as giving pre –solution procedures were some of the assessment practices being used by the mathematics teachers in the selected schools. Again, the findings showed that teachers do not award students for their efforts but rather their grades. This makes students feel that grades are more important than efforts and as a result will only expend more efforts if only, they will attain good grades at the end. As such, these assessment practices are able to influence the students' mathematical mindset at the selected Junior High Schools in Bongo District.

The final research objective focused on examining the effect of mathematical mindsets and mathematical achievement of students at the selected Junior High Schools in Bongo District. The study found mathematical mindset to have a significant positive effect on mathematical achievement of students at the selected Junior High Schools in Bongo District. This implied that, when the students are encouraged by teachers and other educational stakeholders such as parents to shift to believing that their intelligence is flexible, their mathematical or overall academic achievement is likely to increase.

Conclusions

The following conclusions were, therefore, drawn based on the study's key findings: In reference to the first research objective, the study's result revealed high levels of fixed mindset than the growth mindset of students in the selected schools in the Bongo district of the Upper East Region of Ghana. The result has largely been supported by previous empirical studies which suggest that mathematics teachers and other teachers should encourage students and teach them to have the believe that they (students) can influence their intelligence. Thus, the students can improve on their current status in the study of mathematics to increase overall academic performance in the district.

With reference to the second research objective, the study's result indicated that grading, general feedback, pre –solution hints were some of the assessment practices being used by the mathematics teachers in the selected schools. As such, when the teachers of the schools are able to devise more practical ways of assessing the students, it will promote their progress in learning mathematics to influence their performance in the schools.

In relation to the objective three, the study found mathematical mindset to have a significant positive effect on mathematical achievement of students at the selected Junior High Schools in Bongo District. This result was largely in line with previous empirical studies which implied that, teachers should be concerned about challenging and formulating new ways to help students tackle mathematics problems, in order to enhance the students' chances of performing well in mathematics.

Recommendations

On the strength of the research findings and conclusions made, the following recommendations are hereby offered:

The study recommended that, teachers should continuously communicate to students about the usefulness of mathematics so that they will appreciate the subject and strive to do well in mathematics. Teachers should as well communicate the importance of having a positive mindset towards mathematics, and view mistakes and challenging tasks as opportunities for progress. This will eliminate students' perception that mathematics is difficult to learn and pass. Also, in order to overcome the negative disposition towards mathematics and the consequences associated with perceived ability in mathematics, students should be encouraged to view mathematics as a subject of applying meaningful logical processes to solve real life problems. This will move students away from relating to mathematics as a subject of just applying pre-existent formulars to arrive at correct answers in order to obtain just good marks. Time should also be managed in the classroom so as to meet the needs and varying ability of students. These actions might be difficult to implement if teachers are not prepared to modify their teaching methods to change the low perceived ability and their distorted vision of mathematics.

The study also recommended that teachers in the basic schools should plan their teaching lessons incorporating effective and innovative ways of assessing the students so they will feel encouraged to dedicate more time and develop love for mathematics. Some of which include discouraging students from teasing each other's performance, giving positive and specific feedbacks to students, identifying and coaching students who need special attention in

mathematics and encouraging the students to take part in every assignment and class tests.

Finally, the study recommended that head teachers, teachers and parents should keep encouraging, teaching and motivating the students to think positively about themselves and the ability they possess to handle challenging mathematical problems. This can be done by incorporating mindset intervention activities in their lessons and sustaining mathematics clubs, intermittent mathematics competitions in the basic schools to make the subject attractive for students to learn it.

Suggestions for Further Research

The study focused on mathematical mindset of students in some selected JHSs in the Bongo district of the Upper East Region, Ghana. The study focused on some selected JHS within the district and for that matter the region, which are only few of the numerous JHSs in the region. As a result, generalising the study's findings to cover all JHSs across district and the country could be misleading. The study, therefore, suggested that further research can extend the study area to capture all districts or other regions within the country in order to aid generalisation of findings.

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APPENDIX A: QUESTIONNAIRE

UNIVERSITY OF CAPE COAST

COLLEGE OF EDUCATION STUDIES

DEPARTMENT OF MATHEMATICS AND ICT EDUCATION

I am a student of University of Cape Coast, Department of Mathematics and ICT Education. As part of my programme requirements, I am submitting this questionnaire to seek your opinion on the topic "MATHEMATICAL MINDSET OF JUNIOR HIGH SCHOOL STUDENTS". All responses will be treated strictly confidential and will solely be used for Academic Research.

PART I

1. Write down your Age (years) ……

2. Sex: please tick (√) male [ ] female [ ]

Part II: Mindset Assessment Questionnaire

Mindset Assessment is a diagnostic tool drawn from research validated measures for people age 12 and over to use to assess their mindsets. The goal is to assess the level of mathematical mindset elements in you. Please tick (√) in the appropriate column. SD=strongly disagree; D= Disagree; MD= Mostly disagree, MA= Mostly agree; A= Agree and SA= Strongly Agree.

Statement	SD	D	MD	MA	A	SA
1. The amount of intelligence I have in mathematics cannot change.						
2. I can learn new things in mathematics, but cannot really						

change my basic level of intelligence in the subject.						
3. To tell the truth, when I work hard to understand a mathematics problem, it makes me feel as though I'm not very smart						
4. I like mathematics problems that I can really do well without too much trouble						
5. I like work that I'll learn from even if I make a lot of mistakes						
6. I like my work best when I can do it perfectly without any mistakes.						
7. When a mathematics problem is hard, it just makes me want to work more on it, not less						
8. I like mathematics problems that make me think hard						

PART III: Assessment Practices

This survey seeks to find out assessment practices by mathematics teachers that influence mathematical mindsets of learners. Please tick (√) in the appropriate column

No.	Statement	Never	Rarely	Sometimes	Usually	Always
1.	My mathematics assignments are graded when I learn something new					
2.	I am provided with rubrics which is language before I					

	begin a mathematics assignment					
3.	My mathematics teacher encourages us to ask questions like why the class is learning a topic.					
4.	All students are expected to reach a common high standard but we are given different levels of support and time to accomplish it.					
5.	My mathematics teacher gives recognition such as awards, for effort in mathematics					
6.	My mathematics teacher tells us that we are smart in mathematics when we perform well					
7.	When we make mistakes or give a wrong answer, we get specific feedback on how to improve.					
8.	I am rewarded or praised for					

	completing work quickly					
9.	Our grades reflect mastery of specific standards rather than average or sum of points earned.					
10.	We tease one another for making mistakes in mathematics problems					

Thank you.

APPENDIX B: INTERVIEW GUIDE

Questions

1. Do you think you are good in mathematic? Explain.
2. Do you think spending lots of time to understand a concept in mathematics is a good thing?
3. How do you feel when you do not understand a concept in mathematics?
4. How do you feel when you get a challenging question or when you unable to solve a question in mathematics?
5. How do you feel when your mathematics teacher comments positively about your performance after marking your work?
6. How do you feel when your mathematics teacher comments negatively about your performance after marking your work?
7. Do you think mathematics should be optional? Explain.

Thank you for your time.

APPENDIX C: TEST OF MISSING DATA, OUTLIERS AND NORMALITY

MISSING DATA

	Cases					
	Valid		Missing		Total	
	N	Percent	N	Percent	N	Percent
The amount of intelligence I have in mathematics cannot change	458	100.0%	0	0.0%	458	100.0%
I can learn new things in mathematics, but cannot really change my basic level of intelligence in the subject.	458	100.0%	0	0.0%	458	100.0%
To tell the truth, when I work hard to understand a mathematics problem, it makes me feel as though I'm not very smart	458	100.0%	0	0.0%	458	100.0%
I like mathematics problems that I can really do well without too much trouble	458	100.0%	0	0.0%	458	100.0%
I like work that I'll learn from even if I make a lot of mistakes	458	100.0%	0	0.0%	458	100.0%
I like my work best when I can do it perfectly without any mistakes	458	100.0%	0	0.0%	458	100.0%
When a mathematics problem is hard, it just makes me want to work more on it, not less	458	100.0%	0	0.0%	458	100.0%
I like mathematics problems that make me think hard	458	100.0%	0	0.0%	458	100.0%

My mathematics assignments are graded when I learn something new.	458	100.0%	0	0.0%	458	100.0%
I am provided with rubrics(procedure) before I begin a mathematics assignment.	458	100.0%	0	0.0%	458	100.0%
My mathematics teacher encourages us to ask questions like why the class is learning a topic.	458	100.0%	0	0.0%	458	100.0%
All students are expected to reach a common high standard but we are given different levels of support and time to accomplish it	458	100.0%	0	0.0%	458	100.0%
My mathematics teacher gives recognition such as awards, for effort in mathematics.	458	100.0%	0	0.0%	458	100.0%
My mathematics teacher tells us that we are smart in mathematics when we perform well.	458	100.0%	0	0.0%	458	100.0%
When we make mistakes or give a wrong answer, we get specific feedback on how to improve	458	100.0%	0	0.0%	458	100.0%
I am rewarded or praised for completing work quickly.	458	100.0%	0	0.0%	458	100.0%

Our grades reflect mastery of specific standards rather than average or sum of points earned.	458	100.0%	0	0.0%	458	100.0%
We tease one another for making mistakes in mathematics problems	458	100.0%	0	0.0%	458	100.0%
ACH	458	100.0%	0	0.0%	458	100.0%
Fixed MindSet	458	100.0%	0	0.0%	458	100.0%
Growth Mindset	458	100.0%	0	0.0%	458	100.0%
Mind Set	458	100.0%	0	0.0%	458	100.0%
Assessment Practices	458	100.0%	0	0.0%	458	100.0%
Growth Mindset	458	100.0%	0	0.0%	458	100.0%

DESCRIPTIVE AND OUTLIERS

			Statistic	Std. Error
ACH	Mean		30.5983	.80505
	95% Confidence Interval for Mean	Lower Bound	29.0162	
		Upper Bound	32.1803	
	5% Trimmed Mean		29.6926	
	Median		27.0000	
	Variance		296.832	
	Std. Deviation		17.22880	
	Minimum		7.00	
	Maximum		86.00	
	Range		79.00	
	Interquartile Range		28.00	
	Skewness		.644	.114
	Kurtosis		-.422	.228
Fixed MindSet	Mean		3.6676	.04494
	95% Confidence Interval for Mean	Lower Bound	3.5793	
		Upper Bound	3.7559	
	5% Trimmed Mean		3.6801	
	Median		3.7500	
	Variance		.925	
	Std. Deviation		.96174	
	Minimum		1.00	
	Maximum		6.00	
	Range		5.00	
	Interquartile Range		1.00	
	Skewness		-.262	.114
	Kurtosis		-.039	.228
Growth Mindset	Mean		4.0579	.05078
	95% Confidence Interval for Mean	Lower Bound	3.9581	
		Upper Bound	4.1577	
	5% Trimmed Mean		4.0795	
	Median		4.0000	
	Variance		1.181	
	Std. Deviation		1.08674	
	Minimum		1.00	
	Maximum		6.00	
	Range		5.00	
	Interquartile Range		1.75	
	Skewness		-.198	.114
	Kurtosis		-.402	.228

	Mean		3.8627	.03719
	95% Confidence Interval for Mean	Lower Bound	3.7896	
		Upper Bound	3.9358	
	5% Trimmed Mean		3.8798	
	Median		3.8750	
	Variance		.633	
Mind Set	Std. Deviation		.79584	
	Minimum		1.00	
	Maximum		6.00	
	Range		5.00	
	Interquartile Range		1.00	
	Skewness		-.386	.114
	Kurtosis		.639	.228

NORMALITY

Skewness and Kurtosis test for Normality of Mindset

	Minimum Statistic	Maximum Statistic	Skewness Statistic	Skewness Std. Error	Kurtosis Statistic	Kurtosis Std. Error
The amount of intelligence I have in mathematics cannot change	1.00	6.00	.521	.114	-1.275	.228
I can learn new things in mathematics, but cannot really change my basic level of intelligence in the subject.	1.00	6.00	-.047	.114	-1.566	.228
To tell the truth, when I work hard to understand a mathematics problem, it makes me feel as though I'm not very smart	1.00	6.00	-.509	.114	-1.232	.228
I like mathematics problems that I can really do well without too much trouble	1.00	6.00	-1.083	.114	.021	.228
I like work that I'll learn from even if I make a lot of mistakes	1.00	6.00	-.828	.114	-.659	.228
I like my work best when I can do it perfectly without any mistakes	1.00	6.00	-1.400	.114	.810	.228
When a mathematics problem is hard, it just makes me want to work more on it, not less	1.00	6.00	-.185	.114	-1.573	.228
I like mathematics problems that make me think hard	1.00	6.00	.033	.114	-1.602	.228

Fixed Mindset	1.00	6.00	-.262	.114	-.039	.228
Growth Mindset	1.00	6.00	-.198	.114	-.402	.228
Mindset	1.00	6.00	-.386	.114	.639	.228
Valid N (listwise)						

Skewness and Kurtosis test for Normality of Assessment Practices

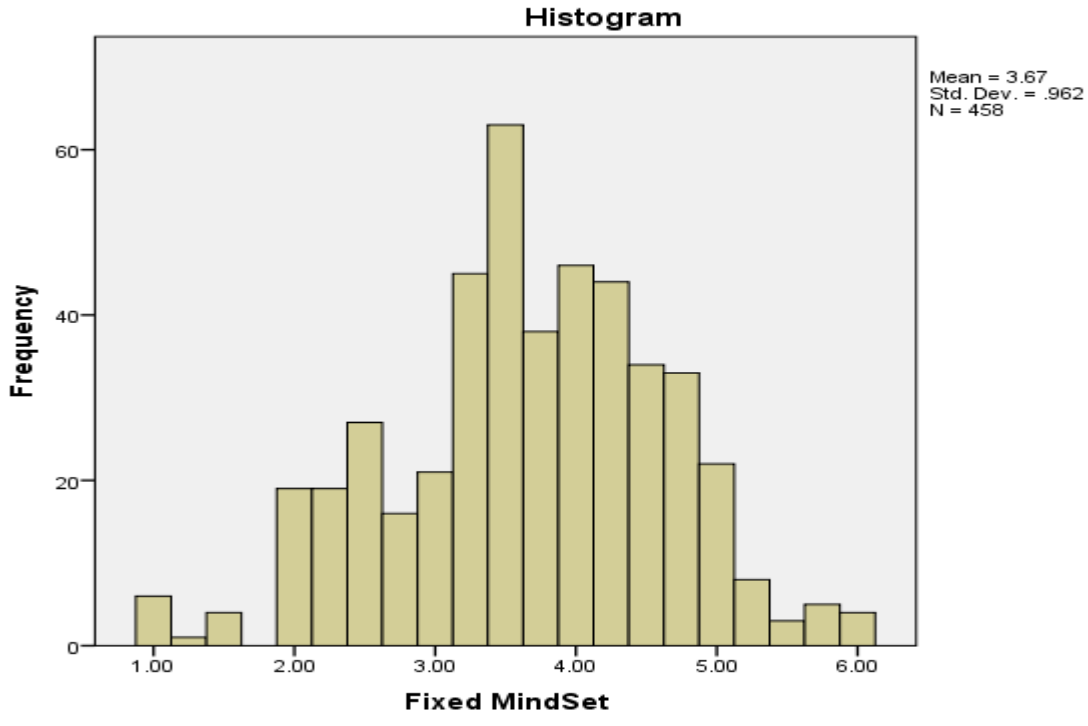
Items	Minimum	Maximum	Skewness		Kurtosis	
	Statistic	Statistic	Statistic	Std. Error	Statistic	Std. Error
My mathematics assignments are graded when I learn something new.	1.00	5.00	-1.078	.114	.084	.228
I am provided with rubrics(procedure) before I begin a mathematics assignment.	1.00	5.00	-.666	.114	-.862	.228
My mathematics teacher encourages us to ask questions like why the class is learning a topic.	1.00	5.00	-.321	.114	-1.346	.228
All students are expected to reach a common high standard but we are given different levels of support and time to accomplish it	1.00	5.00	-.228	.114	-1.153	.228

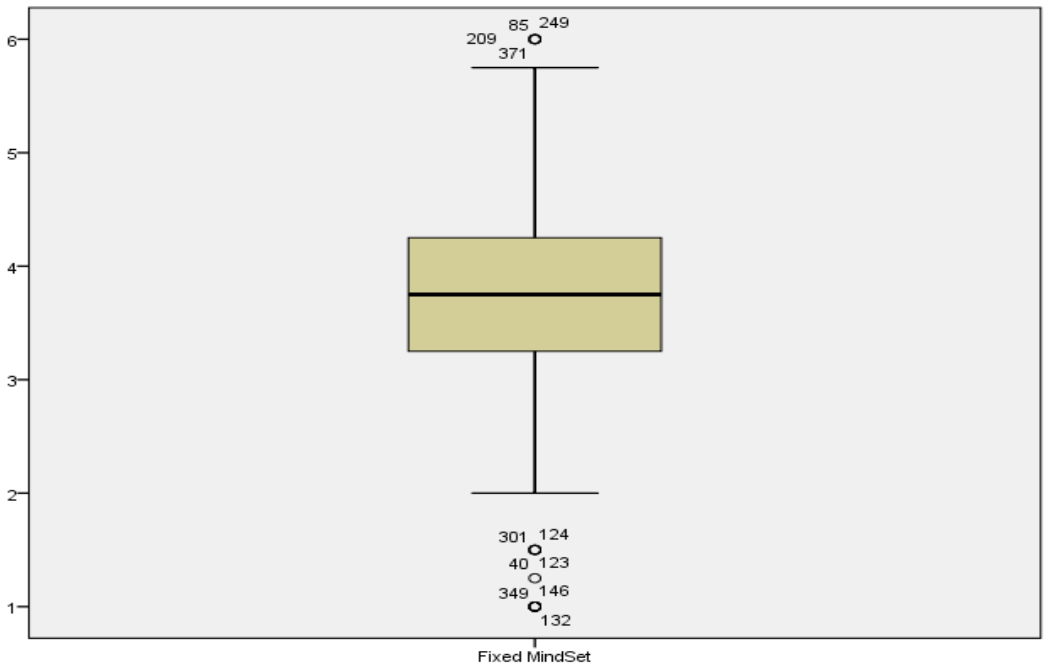
My mathematics teacher gives recognition such as awards, for effort in mathematics.	1.00	5.00	.163	.114	-1.128	.228
My mathematics teacher tells us that we are smart in mathematics when we perform well.	1.00	5.00	-.426	.114	-.927	.228
When we make mistakes or give a wrong answer, we get specific feedback on how to improve	1.00	6.00	-.141	.114	-1.383	.228
I am rewarded or praised for completing work quickly.	1.00	6.00	-.364	.114	-.976	.228
Our grades reflect mastery of specific standards rather than the average or sum of points earned.	1.00	6.00	-.076	.114	-1.408	.228
We tease one another for making mistakes in mathematics problems	1.00	6.00	-.897	.114	-.559	.228
Assessment Practices	1.40	5.00	.021	.114	-.166	.228

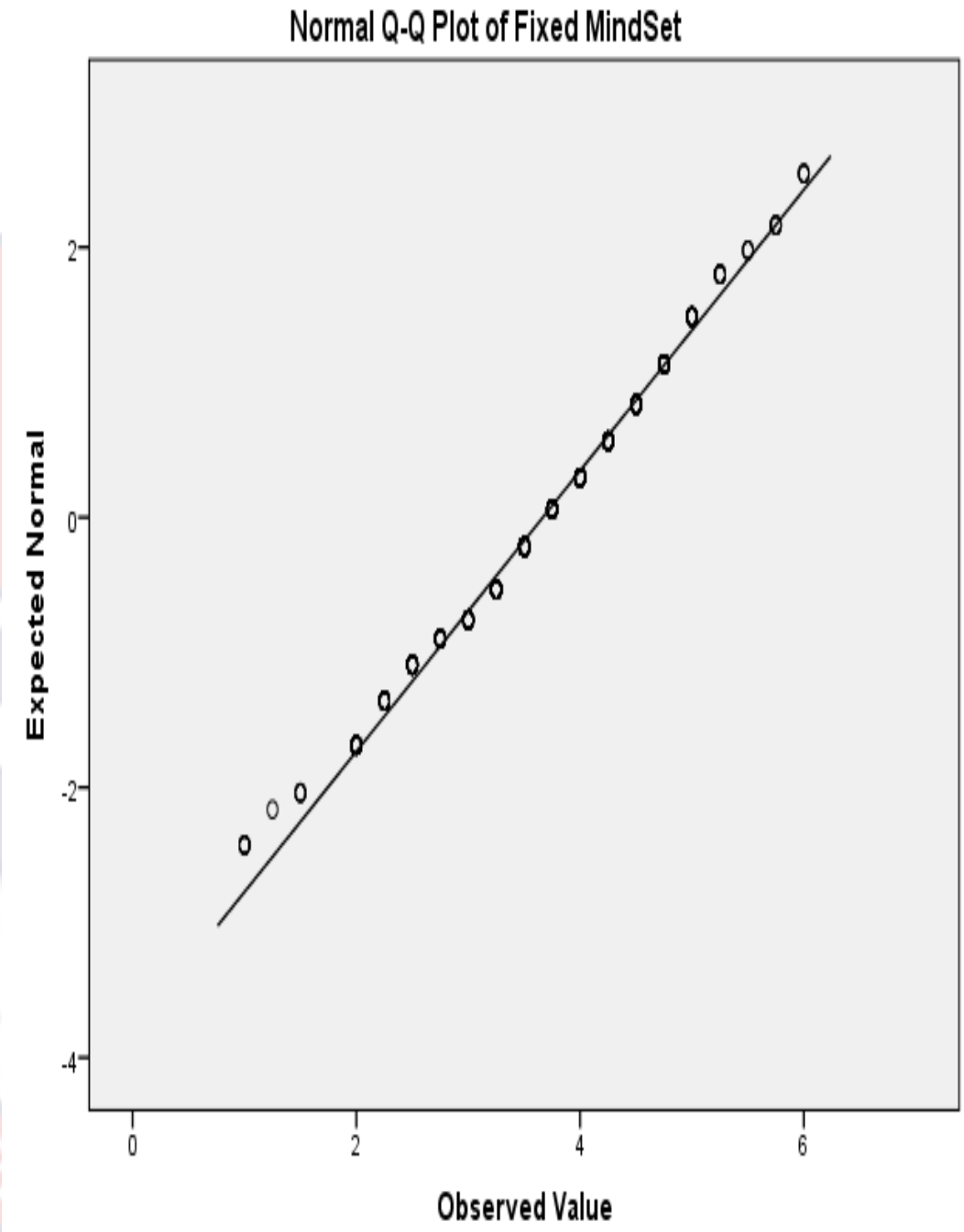
Skewness and Kurtosis test for Normality of Academic Achievement

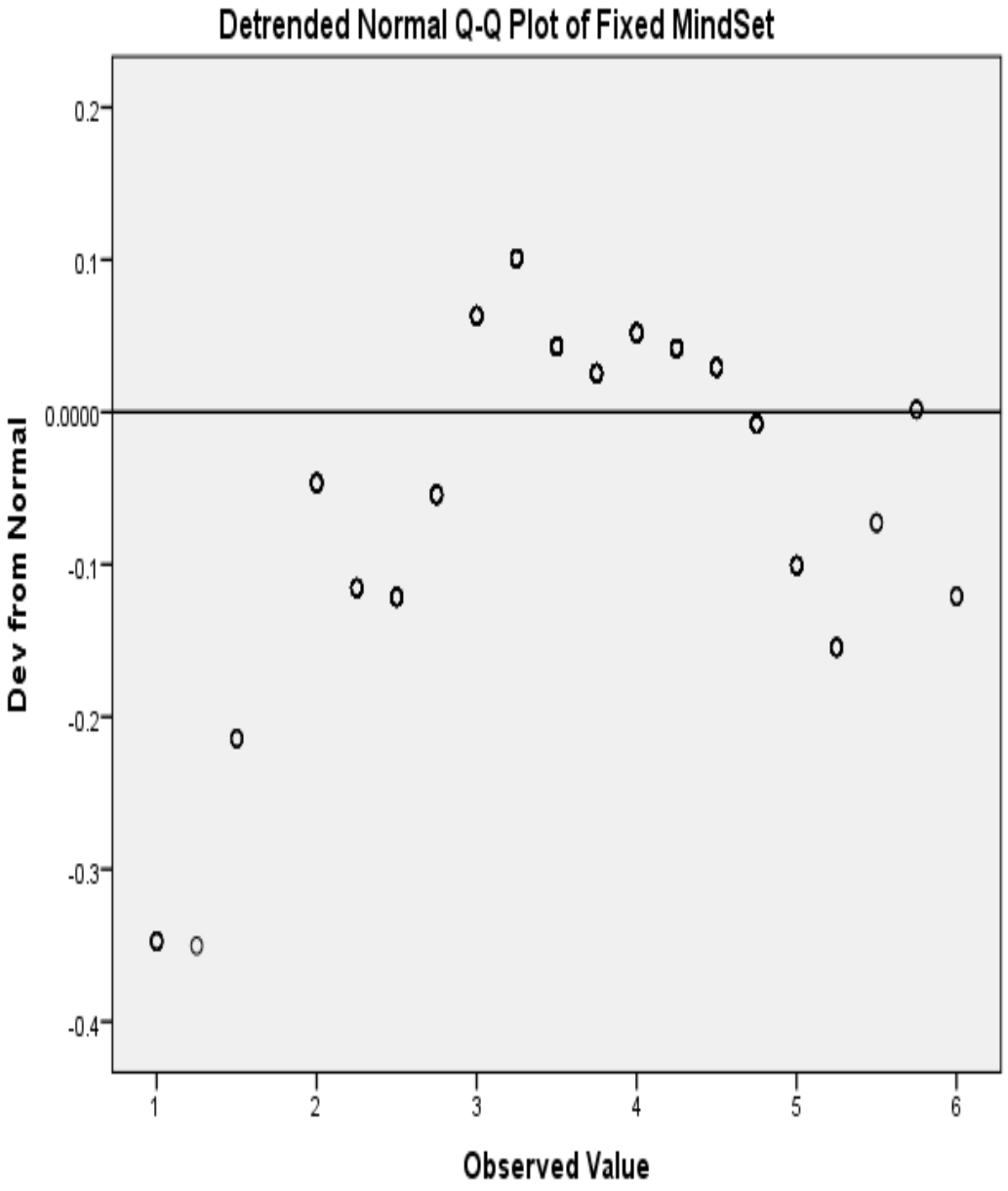
	Minimum	Maximum	Skewness		Kurtosis	
	Statistic	Statistic	Statistic	Std. Error	Statistic	Std. Error
Academic Achievement	7.00	86.00	.644	.114	-.422	.228
Valid N (listwise)						

Fixed Mind-Set

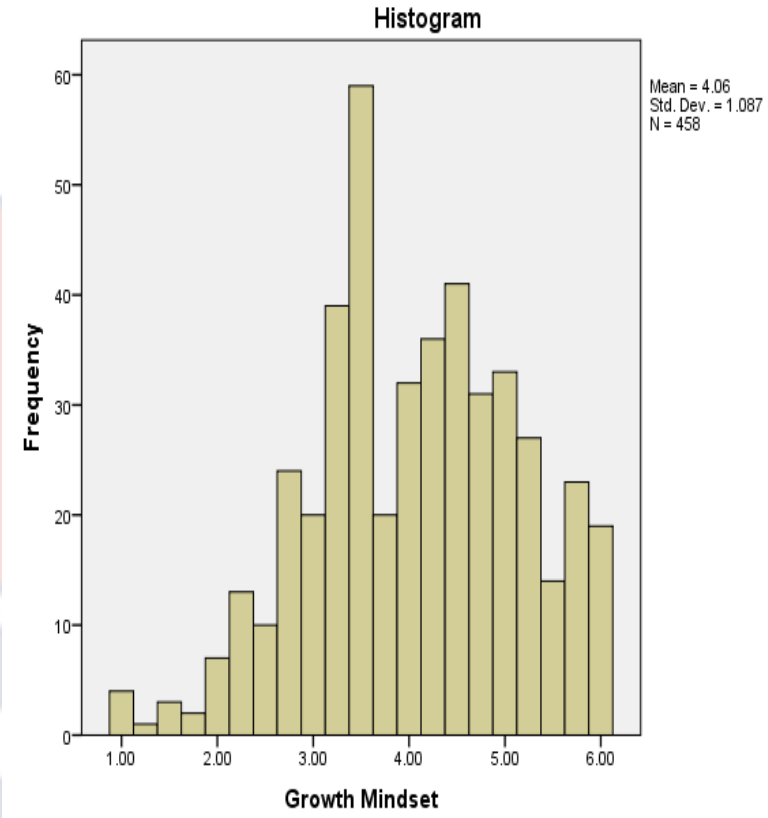


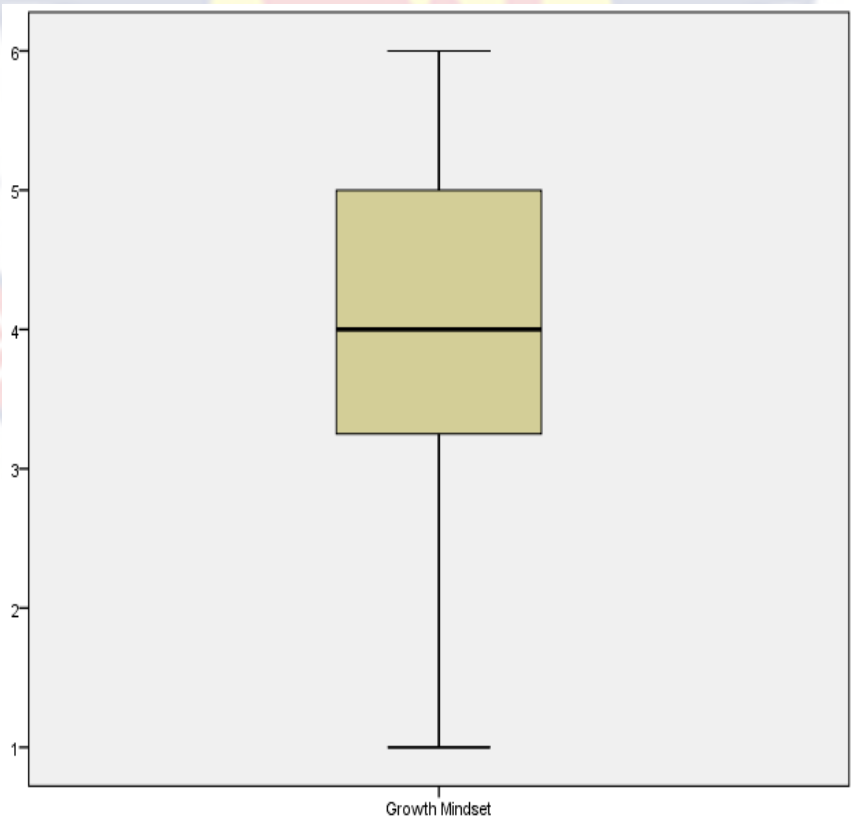


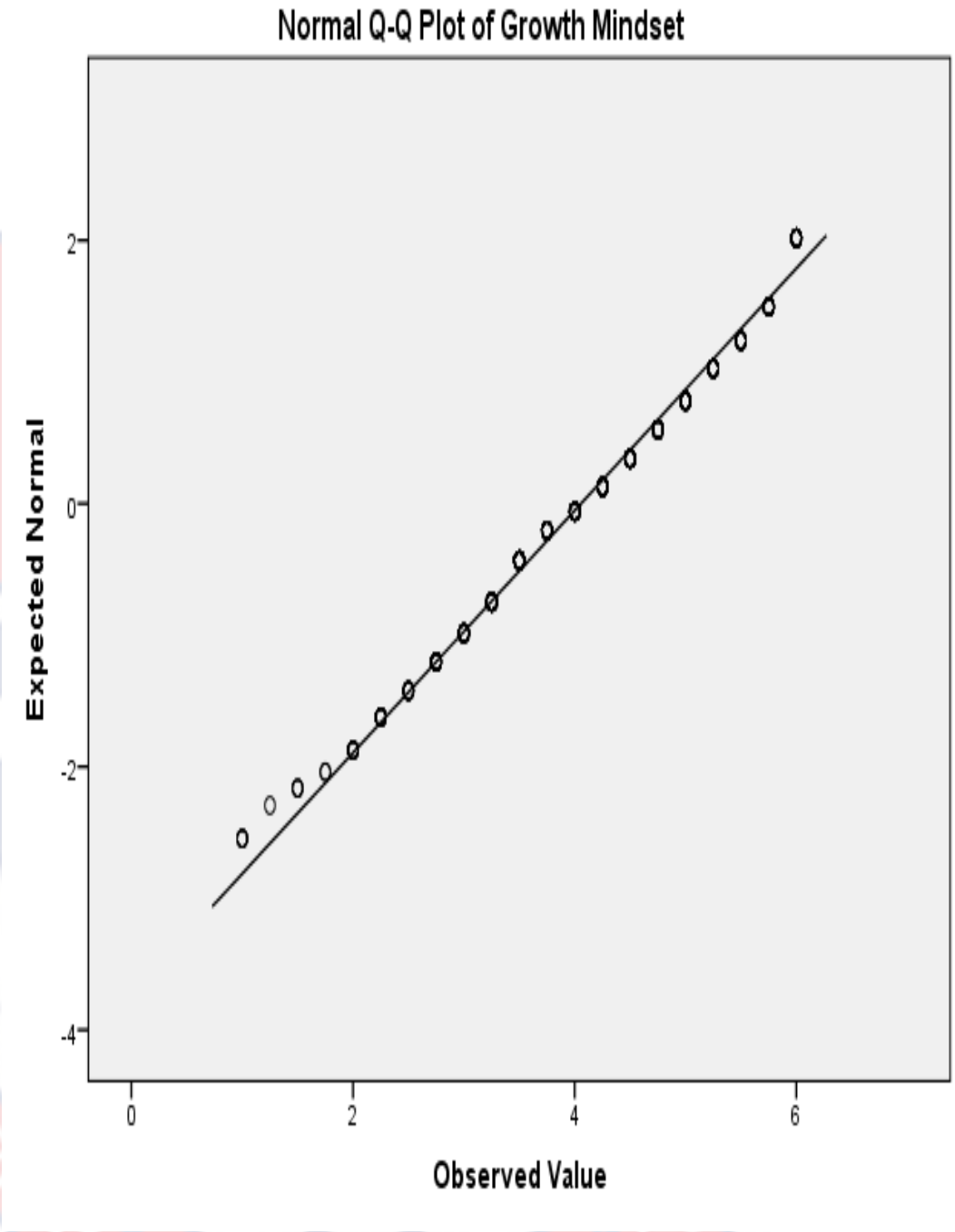


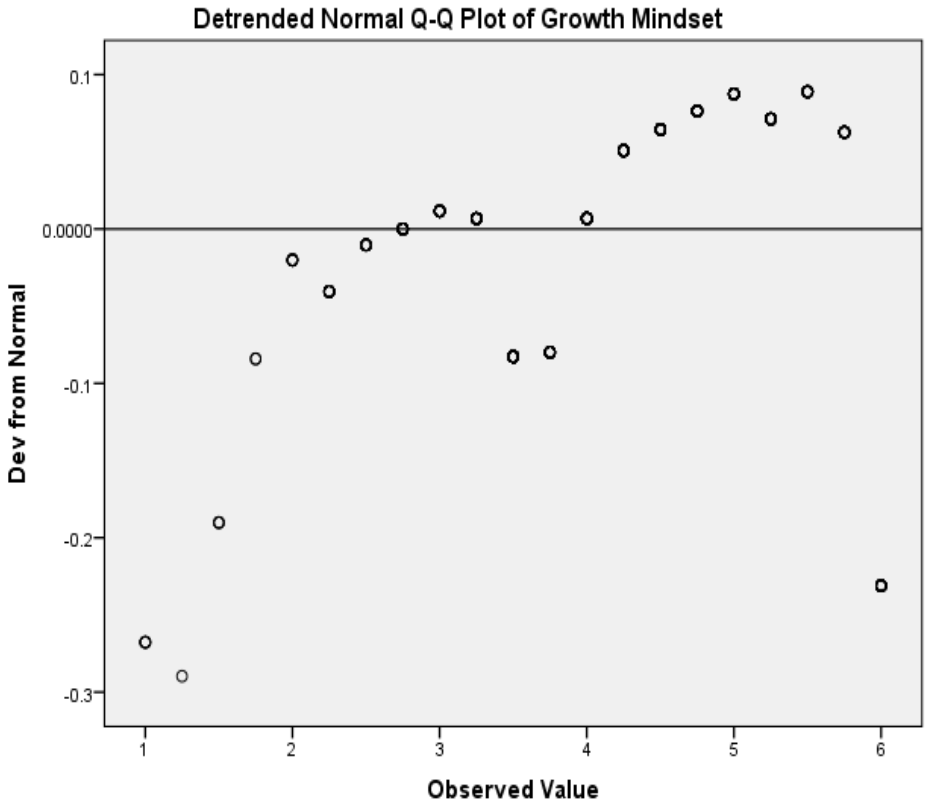


Growth Mindset

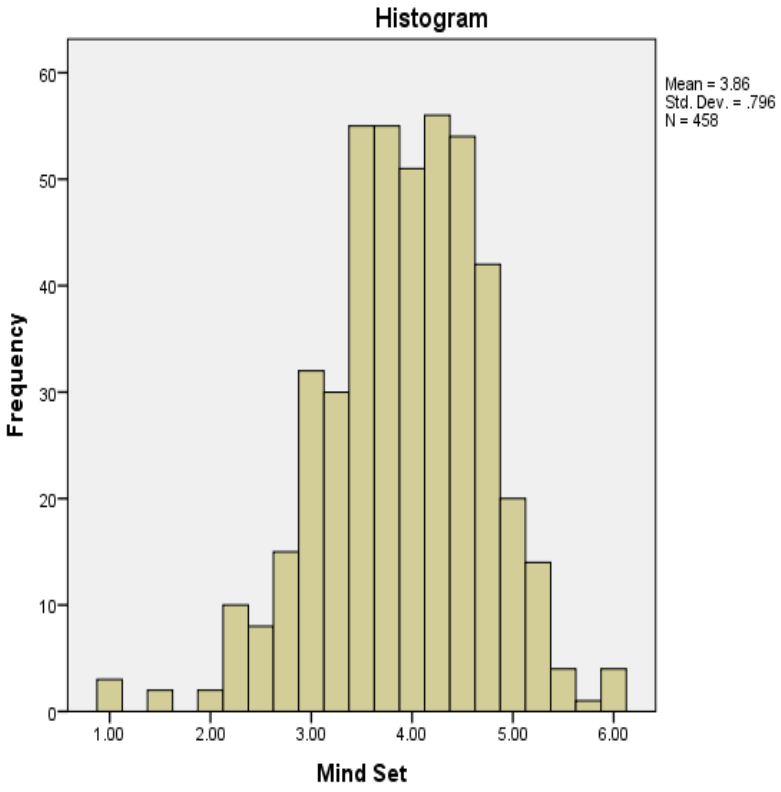


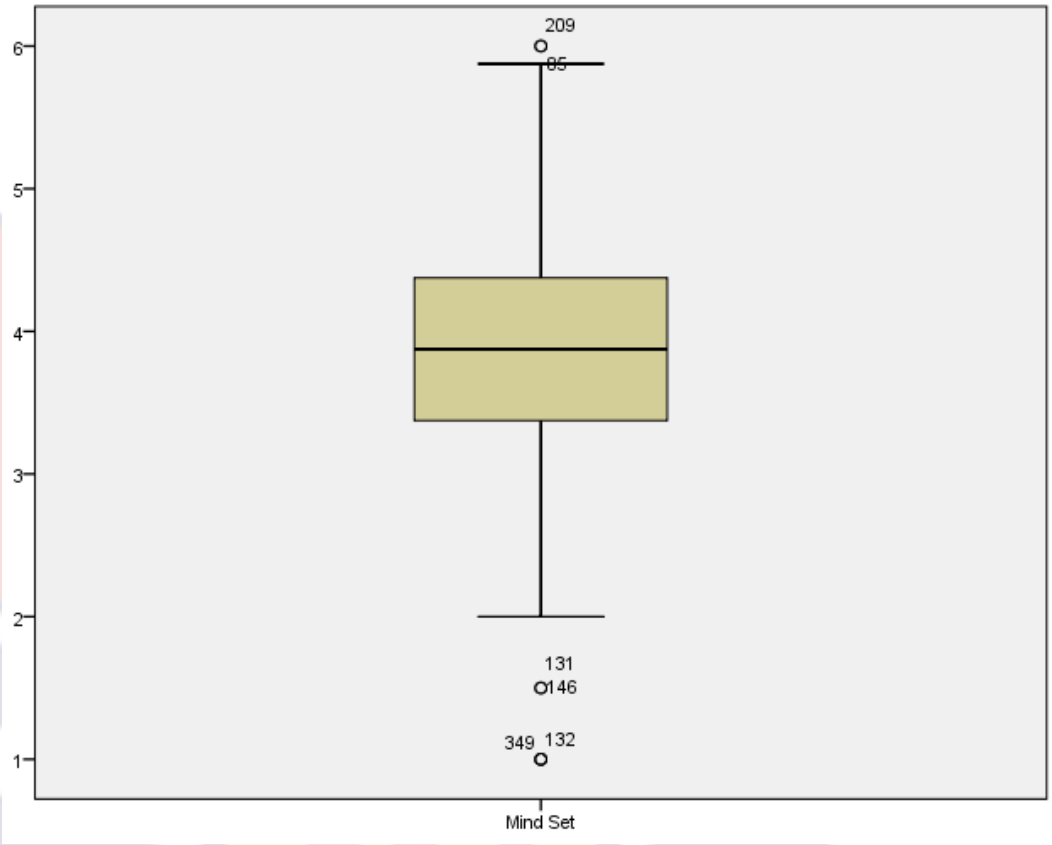


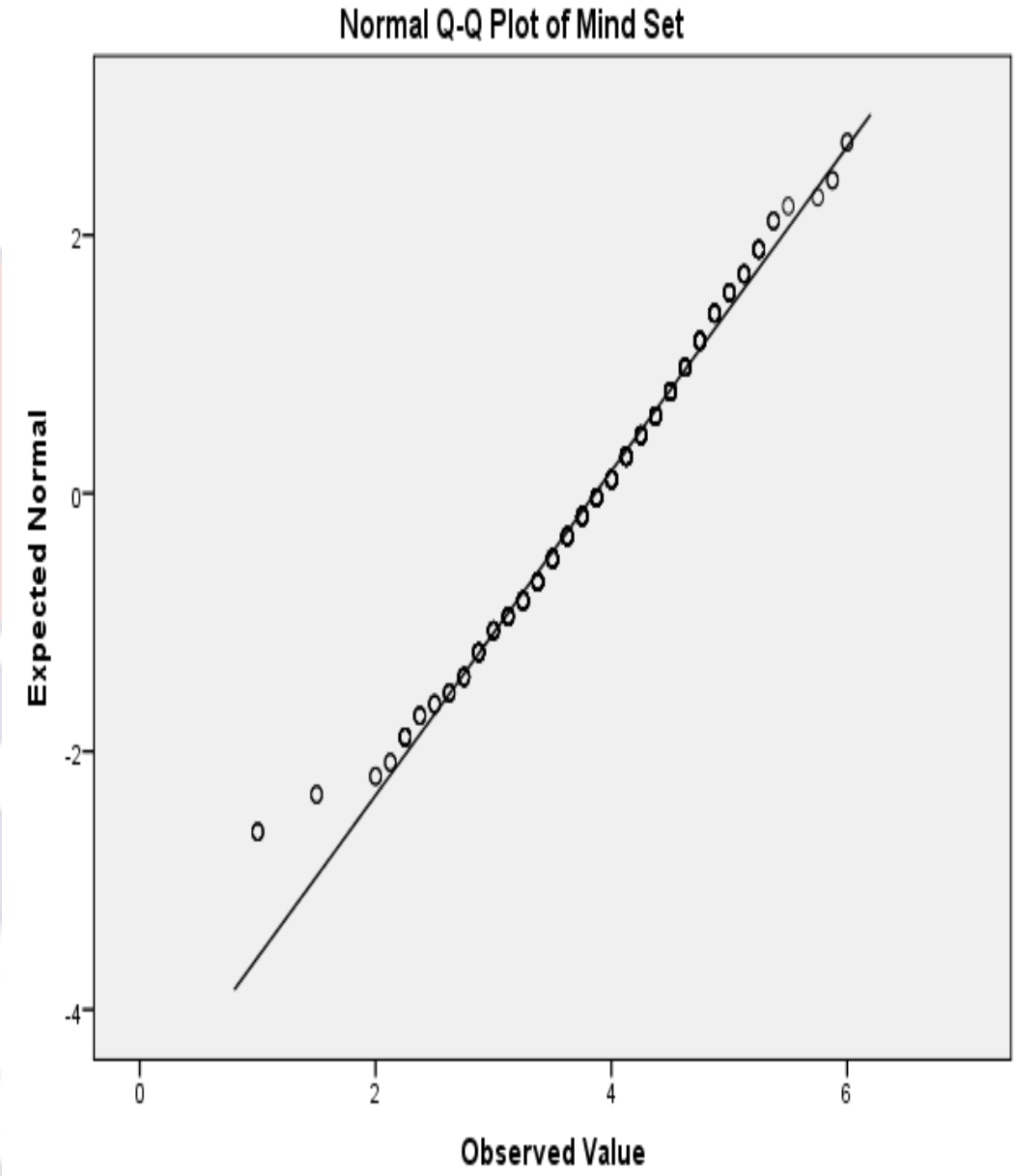




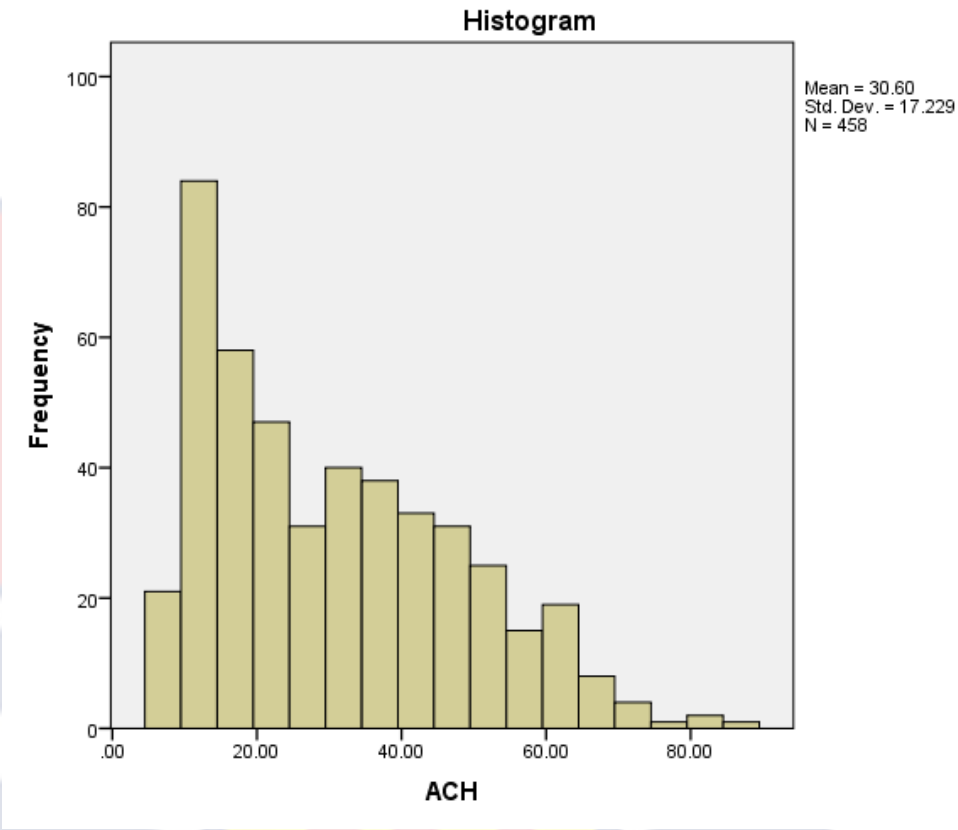
Mindset

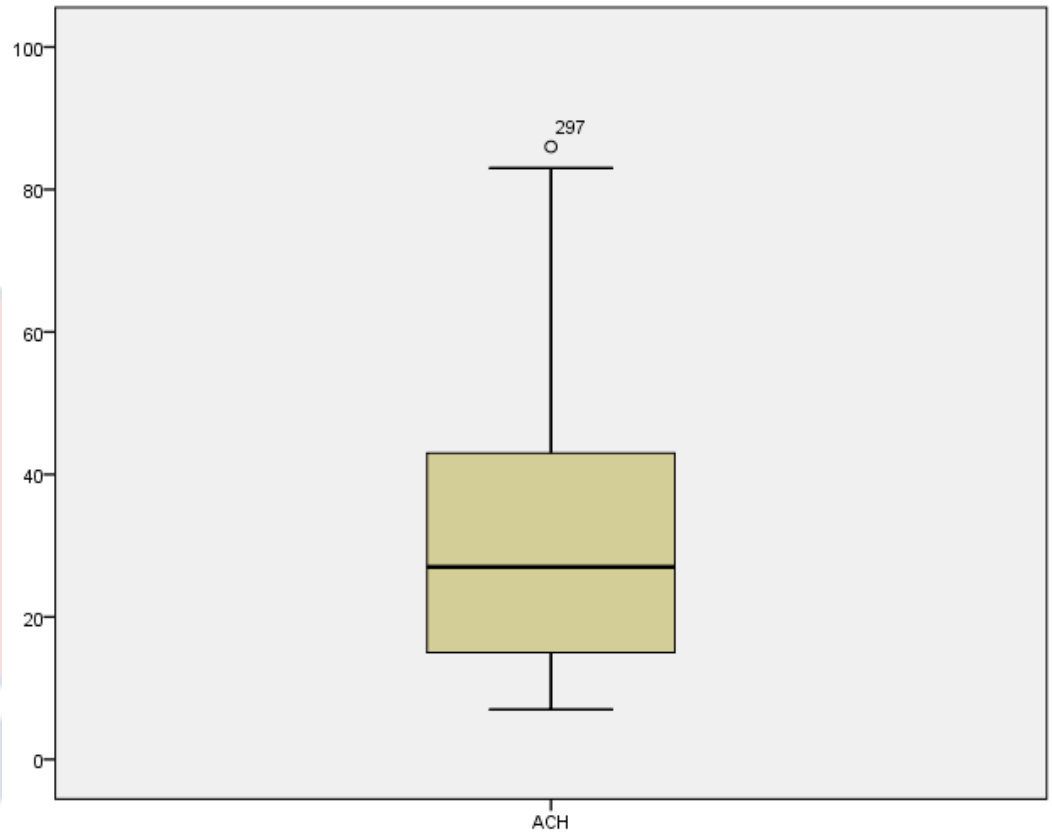


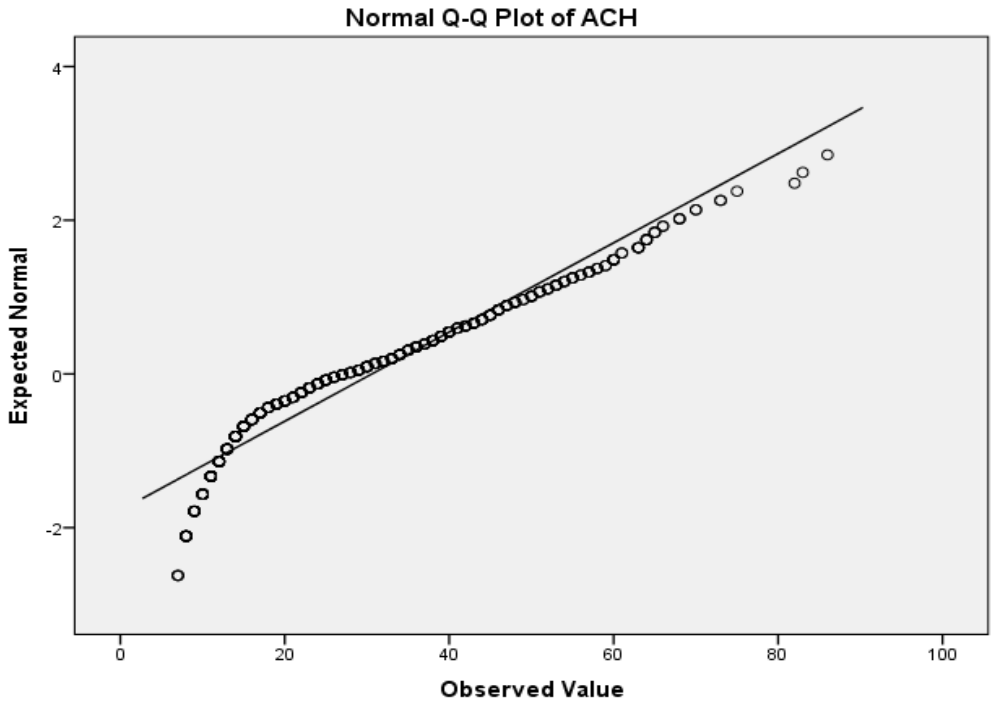


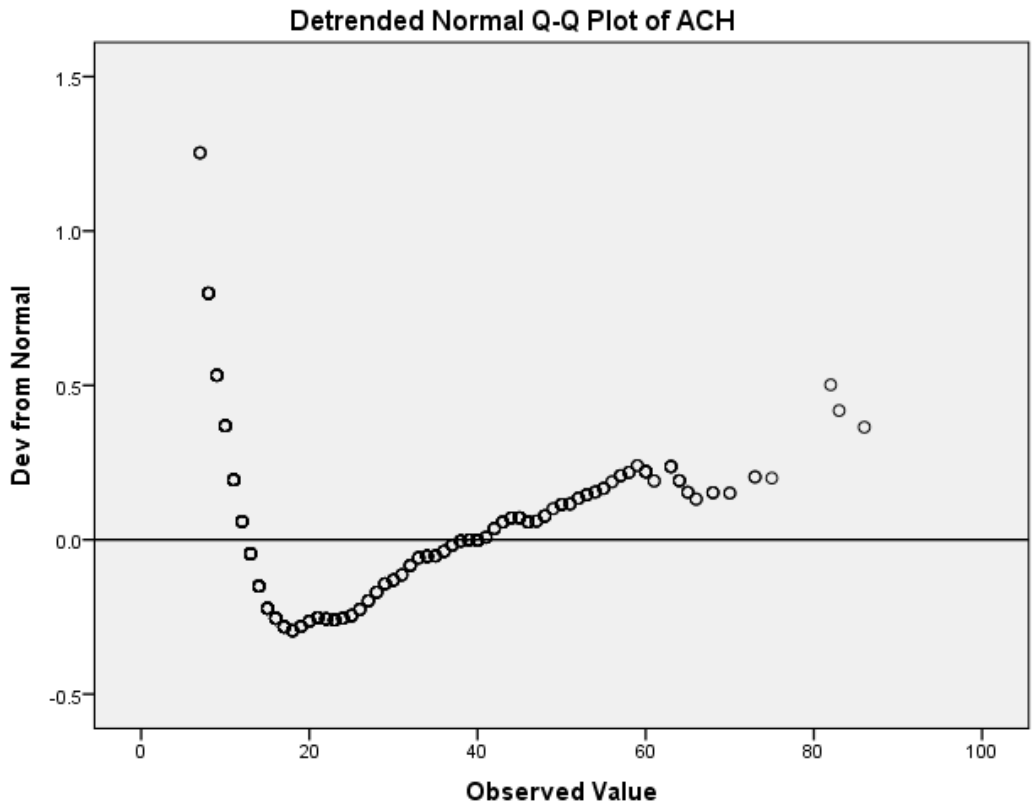


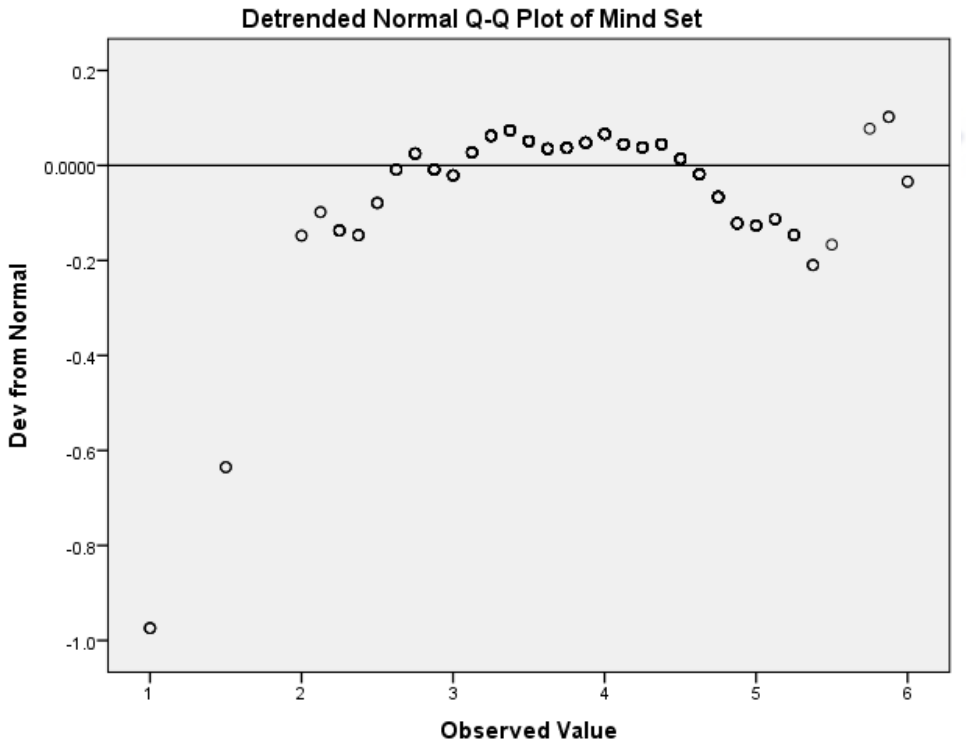
Academic Achievement











APPENDIX D: ETHICAL CLEARANCE LETTER

UNIVERSITY OF CAPE COAST
INSTITUTIONAL REVIEW BOARD SECRETARIAT
TEL: 0558093143 / 0508878209
E-MAIL: irb@ucc.edu.gh
OUR REF: UCCIRB/A/2016/1221
YOUR REF:
OMB NO: 0990-0279
IORG #: IORG0009096

20TH JANUARY, 2022

Mr. Aniah William Ayuure
Department of Mathematics and I.C.T Education
University of Cape Coast

Dear Mr. Ayuure,

ETHICAL CLEARANCE – ID (UCCIRB/CES/2021/ 112)

The University of Cape Coast Institutional Review Board (UCCIRB) has granted Provisional Approval for the implementation of your research titled **Investigating the Mathematical Mindset of Junior High School Students.** This approval is valid from 20th January, 2022 to 19th 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