UNIVERSITY OF CAPE COAST

SUPPORTING GEOMETRY LESSONS WITH MUSIC: INVESTIGATING THE EFFECTS ON ATTITUDE AND ACHIEVEMENT OF BASIC EIGHT STUDENTS

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BY

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Thesis submitted to the Department of Mathematics and ICT Education, Faculty of Science and Technology Education, College of Education Studies, University of Cape Coast, in partial fulfilment of the requirements for the award of Master of Philosophy in Mathematics Education

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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 in this University or elsewhere.

Candidate's Signature …………………………… Date …………………

Candidate's Name: Stephen Atepor

Supervisor's Declaration

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

Supervisor's Signature ……………………………… Date ………………….

Supervisor's Name: Mr. Benjamin Yao Sokpe

ABSTRACT

The purpose of the study was to investigate the effect of participation in geometry lesson supported with music on the attitudes and achievements of Basic Eight students in geometry. To guide the study, two research questions and four hypotheses were developed. The research design used was the pre-test-post-test non-equivalent control group. Eighty-eight (88) Basic Eight students from a Conveniently selected school participated in the study. The major findings were: students conceived geometry as being difficult and formula related; geometry lessons supported with music motivate students towards geometry and the gain in geometry achievement of students in the experimental group was much higher than that of the control class. After testing the hypothesis "There is no significant difference between achievement of students taught Geometry without music and with music" using ANCOVA, it was concluded that geometry songs used creatively to support geometry instructions have positive influence on students' attitude towards geometry; and that students are likely to make greater achievements in geometry when taught with music as a support. It was recommended that teachers are educated on the effects of music integration on students' attitudes and achievements using teacher platforms, mathematics teachers' workshops and conferences.

ACKNOWLEDGEMENTS

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Finally, I appreciate my closest companion and lovely wife, Esenam, who offered me the conducive physical, emotional and psychological environments with the right motivation to stay focused through the entire work.

DEDICATION

To my trio sons, Elorm, Dela, Enam and my sister in-law, Makafui

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LIST OF ABBREVIATIONS

BECE	Basic Education Certificate Examination
CRDD	Curriculum Research and Development Division
GES	Ghana Education Service
JHS	Junior High School
NCTM	National Counsel for Teachers of Mathematics
NMAP	National Mathematics Advisory Panel

CHAPTER ONE

INTRODUCTION

Mathematics teachers, the world over, agree that underachieving students at the pre-tertiary level need remedial teaching on most mathematics concepts that have already been taught just because they have forgotten the mathematics facts. Students are considered underachieving when they are unable to exhibit certain minimum mathematical abilities (Yee & Ee, 2016). Helping students to build such mastery has always been the concern for mathematics educators. Approaches such as the integration of ICT (Eickelmann, Gerick, & Koop, 2016), have been empirically proven to be helpful.

In spite of such approaches in the teaching of mathematics, the challenge continues to linger. An alternate means of teaching mathematics through music has been found to be helpful. Songs have been used extensively to teach mathematics at the primary level. However, research on music integration in mathematics at the Junior High School level remains a grey area. This study seeks to investigate the effects of supporting Geometry lessons with music on the attitudes and achievements of Basic 8 students.

Background to the Study

Success in mathematics is important for the citizenry of every nation. This is so because mathematics gives students school and career options, thus, increasing students' prospects for future income (NMAP, 2008). In spite of this reality, nations across the globe continue to express worry over the poor achievements of their students in mathematics. In one of its reports, the National Mathematics Advisory Panel lamented over the non-performance of

American students in spite of America's reputation as an international leader (NMAP, 2008). The report appears to reflect the condition in most nations across the globe. Personal encounter with most underachievers in mathematics reveal their weaknesses in the basic type of knowledge (i.e., factual knowledge) required to learn mathematics.

Willingham (2009) submitted that the National Mathematics Advisory Panel reported that factual, procedural and conceptual knowledge were the three types of knowledge required to learn mathematics. Of these three knowledge types however, mastery over factual knowledge happens to be the lowest, and yet, still very difficult for underachievers to attain. Willingham (2009) opined that factual knowledge in mathematics referred to the learner's ability to readily have in memory mathematics facts and formulae that would enable the learner to perform specified mathematical activities. Thus, students had to familiarize themselves with mathematics axioms and facts, through constant practice, so as to be able to retrieve those facts with ease, whenever they were needed to perform mathematics activities. For such retrievals to be effective, they must be automatic and virtually attention free.

According to Willingham (2009), 'this automatic retrieval of basic mathematical facts is critical to solving complex problems because complex problems have simpler problems embedded in them' (p. 15). For instance, in a typical Geometry question involving composite geometric figures, students who are able to automatically retrieve geometric facts about the properties of a rhombus, for instance, keep their working memory (i.e., the mental "space" in which thought occurs) free to focus on the more complex and mentally exerting problems. The significance of memorization of mathematics facts has earned supports by several sources of evidences.

In the first place, answers drawn spontaneously from memory lessen the strain on the memory. Also, calculation is more prone to error than memory retrieval. Thirdly, knowledge of mathematics facts is associated with better performance on more complex mathematics tasks. It has been observed that when children have difficulty learning mathematics, it is often due, in part, to difficulty in learning or retrieving basic mathematics facts (Willingham, 2009). It was against this backdrop that Yee (1999) opines that teaching underachieving students who still struggle to remember and recall factual knowledge is the most demanding aspect of teaching mathematics.

Aside factual knowledge which is needed to build on other forms of complex knowledge, the procedural and conceptual knowledge types are also considered necessary by the National Mathematics Advisory Panel. Mathematical procedure refers to a sequence of steps by which a frequently encountered mathematical problem may be solved. Conceptual knowledge on the other hand refers to an understanding of the meaning of procedures that lead to correct answers. Knowing that multiplying two negative numbers produces a positive result is not the same as understanding why it is true. Thus, knowledge of procedure is no guarantee of conceptual understanding. That explains why most children can execute a procedure to divide fractions without understanding why the procedure works.

One of the main implications of the three types of knowledge is that, when teachers of mathematics ensure that students gain mastery in the factual and procedural knowledge of mathematics, their ability to solve complex problems would be enhanced (Willingham, 2009). Although mathematics curricular of most nations from primary school onwards are advocating for problem solving and higher order thinking skills, it is an undeniable fact that such levels are unattainable without a firm grip of factual knowledge.

In a bid to support underachievers to develop firm grip on all types of knowledge in mathematics, a number of interventions have been proposed. With the mixed-ability nature of today's mathematics classrooms coupled with the large class sizes, mathematics teachers are faced with the challenge to employ workable strategies that would yield positive results. Research has advocated for the need to integrate ICT in mathematics instructions as the panacea for mathematical anxiety, conceptual knowledge construction and good retention of knowledge (Eickelmann *et al.*, 2016).

The commendable benefits of ICT integration in recent times for example leaves no one in doubt as to the possibilities of ICT as far as positive attitudes and achievements in mathematics are concerned. For instance, recent studies have found positive effects of computer use on student achievement in mathematics (Eickelmann *et al.*,2016). While some researchers caution that improved results are not completely due to the influence of ICT alone, but are dependent on an environment conducive to the use of this technology, others argue that, teacher pedagogy must radically transform from the traditional teacher-centred approach to a student-centred approach (Corbett, 2014). Notwithstanding the consensus reached by many researchers that ICT integration is an option worth embracing to assist underachieving students, the fact, particularly with most developing nations, remains whether a number of schools, and basic schools for that matter, have access to functional ICT resources.

When previous instructional methodologies have been practically difficult to implement or use due to peculiar contextual issues, alternative instructional approaches and learning strategies become necessary to increase the learning of those students who have not been successful. Considering the reports of the National Mathematics Advisory Panel (NMAP),

> “Mathematics performance and learning of groups that have traditionally been underrepresented in mathematics fields can be improved by interventions that address social, affective, and motivational factors. Recent research documents that social and intellectual support from peers and teachers is associated with higher mathematics performance for all students, and that such support is especially important for many African-American and Hispanic students. There is an urgent need to conduct Experimental evaluations of the effectiveness of support-focused interventions both small and large-scale, because they are promising means for reducing the mathematics achievement gaps that are prevalent in U.S. society” (NMAP, 2008, p.16).

Thus, knowledge of the nature of learners, their likes and dislikes could serve as a clue to mathematics educators in the designing of mathematics lessons. Adolescents are known to have high attraction for music. Literature is replete with findings from research on adolescent brain developments and preference for music. Drawing on these insights to the advantage of the mathematics educator could serve as an alternative means to assist underachieving students as far as their affective domains and development of factual knowledge is concerned. Miranda as cited by Thomas (2016) opined that music has very influential effects on the development of adolescents, with arears such as socialization, emotion regulation, personality, and motivation.

Also, Thomas (2016) posits that adolescents sometimes opt for music because of its inherent benefits of fulfilling emotional needs or providing emotional outlets for them. Such evidence of effects of music on the affective parts of students creates the avenue for music integration in mathematics lessons. That explains why Yoho (2011) suggested that, there was the need to find ways to enhance mathematics retention. Drawing from literature, Lock as cited in Yoho found that music strengthens connections among neurons because it is processed in both hemispheres of the brain and it stimulates cognitive functioning. If music has the tendency of stimulating cognitive functioning, then mathematics teachers could employ it to support their instructions to enhance the acquisition of factual knowledge.

According to Moreno as cited in Yoho (2011), scientists have found that music can change the brain physically and how it performs, thus, earning itself a place in the mathematics classroom. The effects of music on the adolescents' affective and cognitive aspects lends itself to the Multiple Intelligence theory. The theory is used to develop instructions that suit student learning styles and embrace student diversity. The utilization of only one or two intelligences in teaching disadvantaged the students whose strengths were in other intelligences. The learning needs of all students in the classroom and the utilization of approaches, which enabled diversification, needed to be addressed by the teacher.

This study sought to draw on the knowledge of adolescents as revealed by literature (Lock, 2006; Miranda, 2013; Moreno, 2009; Thomas, 2016) coupled with the effects of music on attitudes and academic achievements of children as asserted by the body of literature (An, Tillman, Boren, & Wang, 2014; Holmes & Hallam, 2017; Kocabaş, 2009; Yoho, 2011) to investigate the effects of supporting Geometry lessons with songs on the attitudes and academic achievements of Basic 8 students of Great Winners School complex in the Hohoe Municipality.

Statement of the Problem

According to Willingham (2009), spontaneous retrieval of basic mathematics facts is critical to solving complex mathematics problems because, complex problems have simpler problems embedded in them. Thus, if students receive good tuition that equips them for Geometry problem solving skills and they are able to retrieve relevant Geometry facts, they should, without much difficulty, be able to tackle Geometry problems. Knowledge of Geometry facts is associated with good achievement on more complex Geometry tasks. Thus, when students have difficulty learning mathematics (Geometry), it is often due, in part, to difficulty in retrieving basic facts (Willingham, 2009).

If one's competence in factual knowledge is closely related to one's competence in procedural and conceptual knowledge, then one would expect, according to Willingham (2009) that, interventions that are aimed at improving automatic retrieval of facts would, as well, improve proficiency in more complex concepts. Evidence on this direct link is positive but limited. Drawing from literature that bothers on music integration in the mathematics classrooms, a number of studies have been conducted to investigate the effects of integrating music in mathematics lessons on learners' attitudes and academic performance in education and specifically mathematics (An, *et al*., 2014; Holmes & Hallam , 2017; Kocabaş, 2009; Yoho, 2011).

For instance, studies show that music is being employed as a tool for learning, enjoyment and retention of information. 'Music can be integrated with reading, mathematics, science, and social studies curricula to enhance skills in each of these academic areas' (Civil, 2007, p. 1). Also, Hetland and Vaughn as cited in Civil (2007) established that there was a high correlation between songs and spatial-temporal reasoning skills. Along the same vein, Erickson as cited by An, Capraro, and Tillman (2013) identified the benefits of teaching through the arts as: the transformation of learning environments; reaching students who may not easily be reached; promotion of learner-centred environments; connecting in-school learning to the real world and curbing of anxiety.

Mathematics education theorists have attempted to associate the musical arts with mathematics instruction as an interdisciplinary approach to improving students mathematics achievements (Tillman, 2014). However, much remains to be understood about the impact of such interdisciplinary pedagogy and development of robust correlating curriculum theory. Although the impacts of such interdisciplinary pedagogy has not been fully understood as asserted by Tillman (2014), Press (2016) insists that the linking of mathematics and art via creativity has its most persuasive force in the change of attitude toward axiomatic foundations. Notwithstanding the number of research that has been conducted in the area of music integration, there still exists a significant amount of grey areas yet to be researched.

For instance, although Halperin (2011) explored the relationship between participation on mathematics scores and High school retention, the focus was not on any specific mathematics content. Besides, it was focused on the impact on Mathematics scores and school retention. Secondly, Trinick, Ledger, Major, and Perger (2016) focused on the experiences of three mathematics educators in their music-mathematics integrated instructions, paying no attention to the experiences of the learners themselves. On their part, An *et. al.* (2014) focused on comparing two groups of third graders: those who participated in the 'traditional' lessons, and the Experimental group comprising those who participated in the music-mathematics integrated lessons.

Fagan and Fisher (2011) extended their study to include English and Arts with focus on fourth graders. Mathematics skill acquisition and retention of fourth graders was the focus of the study conducted by Yoho (2011). Still with no specific content area in view, Kocabaş (2009) focused on fourth graders but with a slight difference in his analysis. Kocabaş used time series to analyse an aspect of the data. Duma and Silverstein (2014), on their part, made three studies on a decade of art integration outcome for students, teachers and schools.

In most of these studies in the body of literature, focus is mostly on primary school pupils. On a very few occasions, teachers who practised music-mathematics integrated lessons were the focus. Also, most studies are not mathematics content specific. Again, in most music integrated lessons, the lyrics of the songs used are not directly based on specific content. Aside the fact that such researches are rare in Ghana, and Africa for that matter, no study of this nature has focused on specific content area such as Geometry. More so, most of such related studies target low graders such as kindergarten or primary pupils. The gaps provide the focus for this study: to investigate the effect of supporting Geometry lessons with music on the attitudes and achievement of Basic 8 students of Great Winners School in the Hohoe Municipality.

Purpose of the Study

This study sought to investigate the effect on higher grade students' attitudes and achievement when songs with Geometry facts and formulae as lyrics are used creatively to support Geometry lessons in Basic 8 of Great Winners school in the Hohoe Municipality.

Research Objectives

This research aims at achieving two main objectives. That is, to investigate the effects of participating in Geometry lessons supported with music on:

1. the attitudes of Basic 8 students towards Geometry
2. the achievements of Basic 8 students in Geometry

Research Questions

Research questions were formulated to guide the study

1. What is the attitude of Basic 8 students toward Geometry?
2. How does participation in Geometry lessons supported with music affect the attitudes of Basic 8 students toward Geometry?

Research Hypotheses

To achieve research objective two, four hypotheses were formulated as follows:

1. H_0: There is no significant difference between the pre-test mean Geometry achievement test scores of students taught Geometry lessons without music and those taught Geometry lessons with music.
2. H_0: There is no significant difference between achievement of students before and after being taught Geometry lessons without music.
3. H_0: There is no significant difference between achievement of students before and after being taught Geometry lessons with music.
4. H_0: There is no significant difference between achievement of students taught Geometry without music and with music.

Significance of the Study

The participating students would be the foremost beneficiaries of the innovation. They would know and be able to keep the songs used during the research for their personal usage even after the study. Since the mathematics syllabus is spiral in nature, the Geometry songs become useful to the participating students even at their higher level of education. Besides, some of them could develop the interest and begin to implement similar approaches to enhance their learning in mathematics and other subjects. Also, mathematics teachers, school administrators, educators and curriculum developers/reviewers could introduce the innovation to enhance the mathematics curriculum.

Delimitation of the Study

The study focussed on only two Geometry topics: Surface Area and Volume of solid figures as presented in the Junior High School syllabus for Basic 8 (CRDD, 2012). The study limited itself to these two Basic 8 Geometry topics for the following reasons: Surface Area and Volume of solid figures were the two Geometry topics captured in the second term scheme of work for the school; the Geometry songs composed were specifically meant for these topics; and the time constraints for the study could not allow for more than the two topics.

Limitation of the Study

The use of Convenience sampling poses a limitation on the study. Thus, the results from this study cannot be generalized over all students learning Surface Areas and Volumes of solid figures in Geometry, but to Basic eight students in Great Winners School Complex in the Hohoe Municipality.

Definition of Terms

Attitude toward Geometry: An aggregate measure of like or dislike for Geometry; tendency to engage in or avoid Geometry related activities; a belief that one is good or bad in Geometry; and a belief that Geometry is useful or useless (Ma & Kishor)

Achievement in Geometry: Ability to retain, remember, recall, retrieve and use Geometry facts and formulae to solve Geometry problems.

Organisation of the Study

This study is organized as follows: Chapter One begins by establishing the background to this study and states the problem. It provides the purpose for the study. It further outlines the research objectives, questions and hypotheses that guided the entire research. The chapter finally provides the significance, scope and specific limitation of this study. Chapter Two presents a detailed review of the theoretical and conceptual frameworks underpinning the study; the major concepts within the conceptual frameworks, Geometry as a content area in mathematics, adolescents and music, as well as four major related works. Chapter Three presents and explains how the research was conducted. It comprises the research approach and design, the variables being studied, population, sample and sampling technique used, data collection procedure, instruments and data analysis. Chapter Four covers the results from the analysis of data. It also includes the discussion of the results. Chapter Five covers the summary of the entire study, major findings, conclusions on the findings, recommendations of the study and some suggestions on areas for further studies.

CHAPTER TWO

LITERATURE REVIEW

In this chapter, literature is reviewed along the following themes: theoretical framework, conceptual framework, concepts underpinning the study and related studies

Theoretical Framework

Multiple Intelligence Theory (MI)

Until Howard Gardener's contribution to the concept of intelligence, the common notion was that, intelligence was conceptualized as a single construct which was inbred and thus difficult, if not impossible, to change. Gardner's assertion was that humans learnt using eight different types of intelligence (Gardner, 1995). These include linguistic intelligence, logical-mathematical intelligence, spatial intelligence, musical intelligence, bodily-kinesthetic intelligence, naturalistic intelligence, interpersonal intelligence, and intrapersonal intelligence.

It is worth noting that, although Gardner (1995) never intended for his original work to be aimed at education, he still provided few guidelines for the implementation of his theory in the classroom. The diverse, and contradictory conclusions about possible educational implementations of the theory, as drawn by different educators the world over were surprising to Gardner himself. Educators who saw the place of the Multiple Intelligence theory in the classroom begun to debate along questions such as: Should teachers teach with strengths or weaknesses of students in view? Should teachers train all eight intelligences or teach a given subject in eight different ways? Is the creation of eight different tests the way out or a complete abolition of test from the classrooms?

Responses to such questions and many more made educational practitioners to repeatedly cite MI theory to buttress all kinds of classroom practices which aligned to their personal philosophies and for implementing changes that they considered desirable (Gardner, 1995). Such scholarly debates led Gardner, his friends and some onlookers to begin the exploration of the educational implications of the MI theory. Gardner (1993) as cited by Gardner (1995) described how they launched their own pilot and model programs in curriculum, instruction and assessment. The result of the surveys and experiments led Gardner to put up a number of educational implications as offshoots of the MI theory.

Gardner's theory of Multiple Intelligence, when situated in the classroom setting, has implications for teaching during instructions and to an extent, assessment. Guides, Gardner, Intelligences, Digest, York, and Books, (1989) posit that teachers should recognize and teach to a broader range of talents, skills and abilities. Secondly, teachers should organize subject contents in such a style that encourage most, if not all, of the intelligences. Thus, the same contents are presented in a variety of ways to facilitate deeper understanding. Also, teachers could show students how to use their more developed intelligences to assist in the understanding of a subject which normally employs their weaker intelligences.

With the obvious goal to develop a sense of accomplishment and self-confidence, Gardner's theory of Multiple Intelligences provides a theoretical basis for recognizing the different abilities and talents of students (Guides *et* *al*., 1989, p. 3). Guides *et al.* (1989, p. 3) concludes that, 'Multiple Intelligence theory acknowledges that while all students may not be verbally or mathematically gifted, children may have an expertise in other areas such as music, spatial relations, or interpersonal knowledge." Thus, whenever learning is approached and assessed in the above manner, most students, if not all, successfully participate in classroom learning irrespective of the subject involved.

Multiple Intelligence Theory: Situated in this Study

Gardner's eight intelligences found their places during Geometry lesson delivery in this study: Visual-spatial intelligence being the ability to perceive the visual spatial world with significant precision was developed by having students open up solid figures like cylindrical milk tins to enable them to visualize how the nets of solids are arrived at and also to guide students in the appreciation of the determination of the total surface area of a given solids.

The ability to produce and appreciate rhythm, pitch and make meaning of different patterns of sound (Musical intelligence) was extensively seen in the lesson delivery. Geometry facts and formulae were used as the lyrics of the songs in supporting the Geometry lesson. The use of the Geometry songs gave students with musical intelligence the opportunity to express their abilities and talents in ways that would make them active participants and learners of Geometry. Thus, the application of the MI theory in this research came in the form of making use of instructional techniques (use of Geometry songs) to cater for the needs of learners whose intelligence is aligned toward music.

Linguistic intelligent students were not left out in the MI theory based Geometry lesson designed and delivered by the researcher. With their natural flare to excel in language proficiency, the researcher incorporated aspects in the lesson where individual students shared ideas and explained concepts to their peers with the researcher's guidance. Students perceived to be linguistic intelligent took advantage of such opportunities and made good use of them. The lesson, by such design, made room for such linguistic students to exploit their potentials.

Logical-mathematical intelligent learners have the upper hand in number and logic related problems. They were not left out in the Geometry lesson either. The researcher offered students a number of opportunity to make logical arguments in favour of certain choices they made as far as given formulae were to be used in solving specific problems. Other students, with the researcher's guidance, acted as judges to accept or debunk their colleagues' arguments. The properties of geometric figures were basically used in making arguments that led to choices that were made by students.

Bodily-kinesthetic intelligence refers to the ability to control physical motion. In the event of convincing peers about decisions to be made, students faced criticisms by their colleagues. The Geometry lessons offered students the opportunity to control their emotions and to tolerate others' views. Situated in such environment of mathematical discourse was the opportunities for interpersonal intelligent students, who have the ability to recognize and understand other people's moods, desires, feelings and motivations, to build on their strengths too. While achieving such great feats, students who are aligned toward intrapersonal intelligence developed their ability to understand their own emotions, ideas, motivations and self-reflection.

The entire lesson was therefore designed and carried out to make use of students' talents in the same way at the same time. According to Denig (2004) as cited in Douglas, Burton, and Durham (2008), since students learn differently, each of them reinforces and retains concepts through varying perceptual strengths. Thus, the researcher, in most of the lessons, took care of the mixed ability students although the musical intelligent students were the primary targets of the researcher.

Theories of Attitude Formation and Change

This section sought to delve into the definitions and components of attitude, how attitudes are formed, why we hold them, what implications they have for our behaviour, and how attitudes change.

Attitude: Definition

Issues on attitude date back to the 19th century and are traceable to Fishbein and Ajzen in the 1970s (Briñol, Petty, & Guyer, 2019). Since then, many psychologists have built on the concept of attitude. Different psychologists define attitude differently. Fishbein and Ajzen (1993), consider attitude as "an individual's disposition to react with a certain degree of favourableness or unfavourableness to an object, behaviour, person, institution, event or to any other discriminable aspect of the individual's world." This definition suggests, within the context of the study that, one's attitude toward Geometry refers to his/her disposition to react with a certain degree of favourableness toward Geometry.

Crisp and Turner (2007) see attitude as a set of beliefs that one holds in relation to an attitude object. Geometry is considered in this study as the attitude object. The definition by Crisp and Turner refers to the views held by students regarding Geometry as a mathematics content area. Such views or beliefs may result from previous experiences, teacher factor, nature of the topic in question or other factors. Aside these, Allport (1935) as cited by Leder (1985) defined attitude as a 'mental or neural state of readiness, organized through experience, exerting a directive or dynamic influence on the individual's response to all objects and situations to which it is related'. It is worth noting that, Allport's definition highlights spontaneous action towards related situations. These spontaneous reactions come as a result of experiences. Considering the current study, Allport seem to be arguing that, one's attitude toward Geometry is simply that spontaneous reaction from a student as a result of the views and beliefs he/she has held about Geometry.

This study aligned itself to the definition of attitude propounded by Ma and Kishor (1997), as cited in Leder (1985) as, an aggregate measure of liking or disliking for Geometry; tendency to engage in or avoid Geometry related activities; a belief that one is good or bad in Geometry; and a belief that Geometry is useful or useless. A simpler definition of attitude is a mind set or a tendency to act in a particular way due to both an individual's experience and temperament. Typically, when we refer to a person's attitudes, we are trying to explain his or her behaviour. Attitude, according to Thurstone as cited in Leder (1985) denotes 'the sum total of a man's inclinations and feelings, prejudice or bias, preconceived notions, ideas, fears, threats, and convictions about any specific topic'. Such comprehensive description of an individual explains so much about the individual's attitude.

Attitude: Components

Fishbein and Ajzen (1993) posit that the widely accepted hierarchical model of attitude sees three components (Figure 1) making up the attitude construct. First is the C*ognitive*, which refers to one's thoughts, beliefs, and ideas about something. In this case, the cognitive component refers to students' thoughts, beliefs and ideas about Geometry as a mathematics content area. The second is the *Affective*, which considers the feelings or emotions that something evokes. Hence, the Affective component refers to the feelings or emotions that Geometry evokes in students. The third component is the *Conative, or behavioural*. This refers to the tendency or disposition to act in certain ways toward something. In this perspective, Conative deals with the behaviour that is exhibited by students when they are to learn or when they are learning Geometry as a subject.

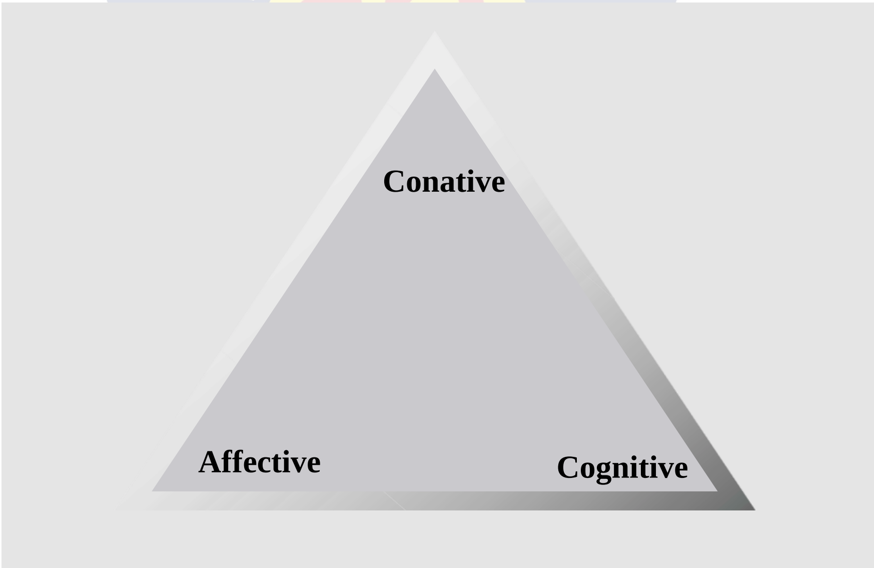

Figure 1: The tripartite model of attitude

Source: Fishbein and Ajzen (1993)

Attitude: Formation and Change

Crisp and Turner (2007) have identified four distinct ways in which attitude toward a subject or an event can result. Ranking from the least in terms of psychological complexity, Crisp and Turner identified: Mere Exposure, Associative learning, Self-perception and Functional reasons to be the four ways by which attitudes are formed. The current study aligns itself to Mere Exposure as the approach underlying attitude change. Briñol, Petty and Guyer (2019) stated that, previous or repeated exposure to stimuli can increase the ease with which those stimuli are processed, thus enhancing liking for the stimuli because increased processing fluency is misattributed to the stimulus, at least when fluency is perceived as good.

Zajonc as cited in Crisp and Turner (2007) describes Mere Exposure effect as the ability to develop more positive feelings toward a subject or concept and individuals as the frequency of exposure to those objects are increased. Thus, attitude change in the study was brought about as a result of the introduction of music (with Geometry facts and formulae as lyrics) to induce more positive feelings toward Geometry as students sing the songs over and over. It is worth noting however that, attitude transformation takes time, effort, and determination, but it can be done. It is important not to expect to change a person's attitudes quickly. Teachers need to understand that attitude change takes time and should not set unrealistic expectations for rapid change (Moore & Vanneman, 2003)

Theory of Performance

Six related basic concepts, developed into a framework to explain performance and improvements in performances was named Theory of Performance (ToP) by Don Elger of the University of Idaho. According to Elger (1962), one has performed if one has produced results that are valued. The current study conceptualizes performance as achievement. If a student therefore achieves, it means he/she has produced results that can be scored. Elger (1962) sees the performer here as either an individual or a group involved in a collective effort. The performer in this study, refers to each participating student, identified with codes such as C-01, C-02, C-03 etc. and E-01, E-02, E-03 etc. respectively. The letter 'C' represents 'Control group' while 'E' denotes 'Experimental group' as used throughout the report.

Elger (1962) further describes performance as a journey and not a destination, with the location in the given journey being labelled as the level of performance. Each level, according to Elger (1962), describes the effectiveness or quality of the performance. It is worthy of note that performance could be dynamic. It advances from a lower level to a higher one. The reverse could also be the case anyway. The performance influencing factors can be broadly classified into two: those that are fixed, and those that can be manipulated by the performer or by others.

The factors that can be manipulated can further be categorized into three: Performer's Mind set includes but not limited to actions that engage positive emotions. Examples include setting challenging but interesting goals, using previous failures as a natural booster for enhancing high performance, and the provision of conditions in which the performer feels an appropriate degree of safety. The performer here, is the researcher. Immersion is the creation of a physical, social, and intellectual environment to boost up performance and stimulate personal as well as professional development. Geometry supported with music serves as the social and intellectual environment used in the study to boost performance or Geometry achievement.

Reflective Practice is the inclusion of actions that help people to pay attention to and learn from experiences. This was achieved by allowing students to go over the songs with close observation to the lyrics. Examples include observing the present level of performance, noting accomplishments, analysing strengths and areas for improvements, analysing and developing identity, and improving levels of knowledge. Thus, the performance influencing factors that can be manipulated have been situated in the Geometry lessons and their effects measured. The theory of performance challenges educators and teachers for that matter to understand that improvement in students' performance does not happen by chance. Instead, it takes a conscious effort on a continual basis to attain positive results. Elger (1962, p.4) concludes that

> "the conditions for optimal performance and improvements in performance can be reduced to three axioms: ***Axiom 1***—engage the performer (student) in an optimal emotional state (*performer's mind set*). ***Axiom 2***—*immerse* the performer in an enriching environment (Geometry with music lesson). ***Axiom 3***—engage the performer in *reflective practice*" (give students time to reflectively rehearse the song while noting the lyrics).

Conceptual Framework

The framework shown in Figure 2, gives a pictorial view of the variables at play in the study.

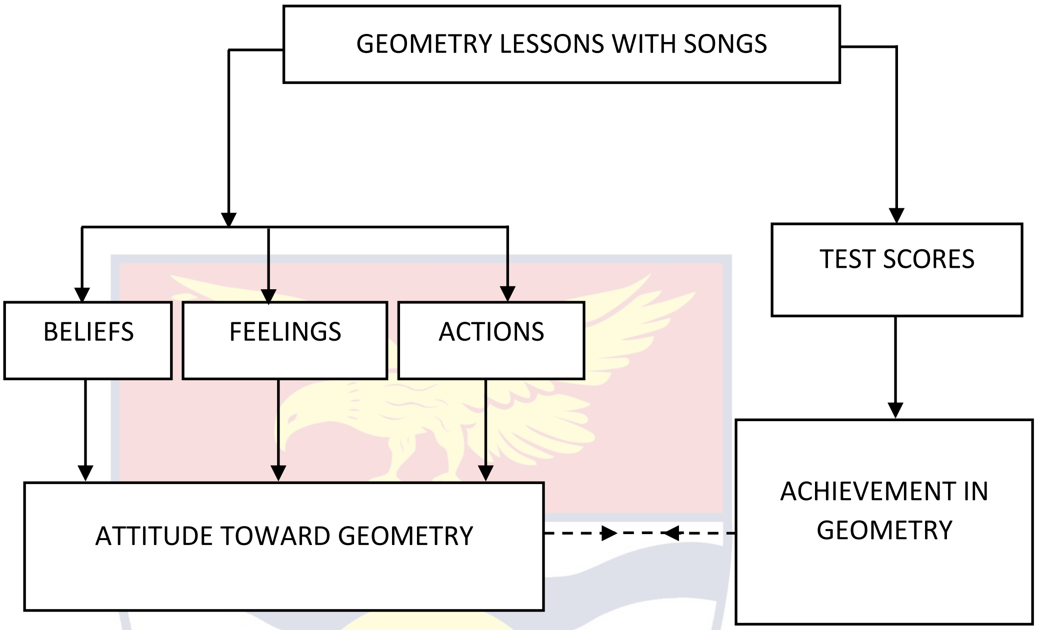

Figure 2: Conceptual Framework

Source: Author's own construct (2020)

The framework in Figure 2 shows the interplay of the independent variable: Geometry lessons supported with music, and the two dependent variables- attitude toward Geometry and achievement in Geometry. The intervention is implemented for a period of time and its effect on students' attitude toward Geometry and their achievement measured. Prior to the implementation of the intervention, the two dependent variables are measured for the respondents. After the two-week long intervention, the dependent variables are again measured to find out whether or not there has been some change.

Students' Attitudes Toward Mathematics

Matematica (2014) indicates that, research in the mathematics education fields has pointed out the relevance of affect's role in mathematics learning. The general assertion that ones' attitude towards mathematics is closely related to his/her performance in the subject makes many mathematics educators to advocate for the promotion of positive attitude toward the subject. Such assertions are supported by the outcome of recent studies that seek to point to a positive correlation between student attitudes towards mathematics and their academic achievement (Mata, Monteiro, & Peixoto, 2012). This assertion is further supported by Pavlovicova and Zahorska (2015) who agree that positive attitude toward mathematics is a direct function to success in mathematics. Hence, their call for mathematics pedagogies that enhance positive attitude.

Mathematics educators and researchers who advocate for the promotion of positive attitude towards mathematics among learners do so with the idea that, a positive attitude is connected to success (Matematica, 2014). Although this is not true in all cases, it could be true in some cases. For instance, Ma and Kishor as cited by Matematica (2014), after analysing the correlation between attitude and achievement in 113 studies, underlined that this correlation is not statistically significant.

Outcome of many other studies show that, it is not enough to tie mathematical abilities to positive attitudes. Kushwaha, Education, College and Hathras (2014) support the fact that, students sometimes deviate from that assertion-getting good scores in spite of clear exhibition of negative attitude towards mathematics. Such contradictory outcomes simply indicate that positive attitude towards mathematics may not automatically result in corresponding high achievement. Academic achievement in itself is determined by several factors and so, may not always be as a result of just one or a few determining factors.

A clear understanding of the effects of students' attitude toward mathematics achievement is required of mathematics teachers to plan appropriate interventions to improve students' attitudes towards mathematics, and hence further improve their achievement. In other words, attitudes towards mathematics must be accentuated in teaching and learning processes if higher mathematics achievement is to be realized (Ayob & Yasin, 2017). In spite of some deviations, Ayob and Yasin insist that "attitudes towards mathematics has notably been recognised as one of the determinants of an individual's success". Ayob and Yasin (2017, p. 1106) buttressed their argument with the quote "The winner's edge is not in a gifted birth, a high IQ, or in talent. The winner's edge is all in the attitude, not aptitude. Attitude is the criterion for success"- Denis Waitley, The Winners Edge (1989).

Measurement of Attitude Toward Mathematics

The measurement of attitude towards mathematics dates back to Thurstone's method for attitude assessment in 1929 (Leder,1985). Thereafter, a number of different instruments have been employed by mathematics education researchers. Leder (1985) opines that, in order for one to understand why such variety of instruments to measure attitude to mathematics have been developed, it is essential to consider the components within the definition of attitude. In an attempt to discuss various attitude toward mathematics measurement instruments Leder (1985) identified quantitative approaches such as Thurstone's scales, summated rating scales (Likert-type scales) and semantic differential scales. Other qualitative approaches include: interviews, observations, interest inventories and check lists, preference ranking, projective techniques, enrolment data and other forms of data such as clinical and anthropological methods.

Considering the calibre of participating students in the study: students from low socio-economic status who have some level of difficulty comprehending write ups in English as well as expressing themselves entirely in English, the researcher employed the qualitative approach for the measurement of students' attitude toward Geometry (Cohen, Manion, & Morrison, 2012). The qualitative approach has a number of advantages, making it suitable for this study. Its advantages include maintenance of the natural setting; the researcher being the key instrument; possibility of multiple sources of data; inductive and deductive data analysis; ensuring participant's meaning etc. (Creswell & Creswell, 2018). This study made use of written and oral interview to collect data on the attitude of students towards Geometry. Also, the attitude of students who participated in the Geometry lessons supported with music was also measured using interviews.

With interviews, the researcher works inductively and deductively. Inductively, the researcher builds patterns, categories and themes in a bottom up manner, organizing data in more abstract units of information (Creswell & Creswell, 2018). The inductive process is usually characterized by the back and forth movement between the themes and the database until comprehensive set of themes are arrived at. The deductive process occurs when the researcher looks back to the data from the themes to determine if more evidence could be gotten to support each theme or to gather more information. Thus, both inductive and deductive data analysis goes on complementarily. Interviews also help the researcher to keep focus on the participant's meaning that they hold about the research problem. It does not focus on the meaning that the researcher brings to the study nor the meaning expressed by the body of literature (Creswell & Creswell, 2018)

Students' Achievements in Mathematics

It is generally known that students' performance in mathematics at all levels is becoming an issue of concern to all and sundry. Regarding the reasons assigned to such low-achievement of students, Kushwaha, Education, College, & Hathras (2014) argue that mathematics achievement is determined by various variables that are psychological, social, cognitive entry behaviour, instructional and many more. Literature has enough data to buttress the relationship between the afore listed variables and achievement in mathematics. For instance, Yeh, Cheng, Chen, Liao, and Chan (2019) opine that the dominance of the teacher-centred approach in mathematics classrooms accounts for the significant percentage of low-achievement of students in mathematics. This opinion may be questionable in situations where students' achievements are low in spite of teachers' use of child- centred teaching methods. These variations simply suggest that the factors that lead to low achievement in mathematics are varied.

Besides, cognitive entry behaviour refers to the pre-learning required to learn specific content matter has been considered as key indicator of the level of learning attainable by students at any given level (Çalişkan, 2016). Çalişkan points out how significantly cognitive entry behaviour explains the extent of achievements in learners. Yunt as cited in Çalişkan (2016) posits that cognitive entry variables have a much stronger effect on achievement level than those of an affective nature. This assertion by Yunt may have to be subjected to more tests to ascertain its validity anyway. Holding achievement motivation (an affective entry characteristic) constant, Yunt concluded that the achievement levels of students with high cognitive entry behaviours were higher than those of the other students. Simply put, Yunt concluded that when the effect of cognitive entry behaviours was kept constant, achievement motivation did not have a significant effect on learning level.

Aside cognitive entry behaviour being a determining variable as far as achievement in mathematics is concerned, the heterogeneous nature of a typical mathematics classroom accounts partly to the level of achievement. Each mathematics classroom is characterized by mixed ability learners. Hence, students' demonstration of different levels of achievement, although they are taught by the same teacher under the same conditions (Yeh, Cheng, Chen, Liao & Chan, 2019). The low achieving students are left with the option of receiving knowledge passively. It is against this backdrop that Barr and Tagg (1995) as cited in Yeh *et al*. (2019) posit that it has become very necessary to create more opportunities for low-achieving students to learn in school.

The literature is replete with a number of teaching approaches in mathematics education that have been advocated for as alternative to the conventional methods. ICT integration, one of the effective approaches known from research has been embraced across the globe (Corbett, 2014; Skryabin, Zhang, Liu, & Zhang, 2015; and Eickelmann, Gerick, & Koop, 2016). Some have questioned the feasibility of some ICT resources due to difficulty of access by some communities, thus, limiting its use within some contexts. This limitation makes room for the use of mathematical games as an alternative teaching approach (Yeh *et al.*, 2019). The fact remains that, even some mathematical games need ICT to implement.

Arts integration (An, *et al.*, 2014; Buxton, 2017; Civil, 2007; Holmes & Hallam, 2017; Still, 2014; Yoho, 2011; An, Capraro, & Tillman, 2013; Duma & Silverstein, 2014; Press, 2016; Trinick, Ledger, Major, & Perger, 2016), presents another suitable alternative when access to modern technological approaches become problematic. The integration of arts as teaching strategies has proven to be useful in virtually all contexts. This study seeks to beef up empirical evidence in this regard.

In consonance with most researchers, attitude toward mathematics remains a significant determinant of mathematics achievement (Kushwaha *et al*., 2014). Thus, giving the same learning environment, teachers, text books, home conditions, etc., different students will achieve differently due to different attitudes toward the subject-mathematics. The general observation is that, students who demonstrate positive attitude towards mathematics end up with high scores when compared with their counterparts who exhibit negative attitude towards mathematics.

A close study of mathematics achievements of students in Ghana indicates a gloomy picture. A nine-year trend analysis capturing WASSCE examination for the years 2007 to 2016 makes the case for low achievement clearer (Abreh, Owusu, & Amedahe, 2018). Also, Mereku (2012) as cited in Mills and Mereku (2016) reports that, students' low performance in mathematics has been confirmed by various reports from national large scale assessments such as the BECE and WASSCE. On the international stage, the story became more glaring, just as Anamuah-Mensah *et al.*, as cited in Mills and Mereku (2016) revealed.

With such unsatisfactory performance year after year, Mills and Mereku (2016) argue that the Ghanaian students' inability to reach the higher benchmarks nationally and internationally demands proactive curative measure. To them, students should, as a matter of urgency, be assisted to build a sound foundation in the mastery of fundamental knowledge and skills required to solve more cognitively demanding problems. The practicality of such measures calls for all stakeholders to play active roles in curbing the situation to an appreciable level. The assertion of Mills and Mereku (2016) simply implies that, mathematics teachers have no business bothering students on cognitive demanding mathematical problems if students have not mastered the fundamental facts (Willingham, 2009).

Measurement of Students' Achievement in Mathematics

Achievement or performance of students in mathematics can be measured by one of two possible ways. One of such ways is to employ qualitative methods such us, observation of mathematics instructions and interviewing of students who had participated in an instruction (Vos, 2005). Aside the use of qualitative methods to describe lessons and collate students' views, perceptions and experiences, educators may opt for quantitative methods. Vos opines that quantitative methods are characterized by the counting and measurement of phenomena so that, numbers represent verbal descriptions. Although quantitative studies sacrifice some degree of details and depth, they accrue some width. This study adopted the two major approaches in measuring students' achievement in mathematics-qualitative (e.g., interviews) and quantitative (achievement tests). That way, details, depth and width are all catered for during the measurement procedure.

Geometry as a Mathematics Content

Lining up the various content areas in mathematics, the area which is full of interesting problems, having a long history tied to the development of mathematics, and with its integral part closely linked with the development of mathematics is Geometry (Jones, 2014). The wealth of gains from the learning of Geometry makes it a demanding topic to teach well. One major mathematics content that must be learned in schools is Geometry (CRDD, 2012). It is not surprising it is encountered by students at all levels. Kartono as cited in Dewi and Harahap (2016) defines Geometry as "the presentation of abstraction of visual and spatial experiences, for example, the area, patterns, measurement, and mapping". This description for Geometry makes it problematic when it is taught by the conventional method. Its nature means that students appreciate it more when it is taught from the concrete to the abstract. Utami, Mardiyana, and Pramudya (2017) posit that developing the cognitive abilities of students is not the sole importance of studying Geometry, but assisting memory formation from concrete into the abstract. Geometry empowers students to analyse and interpret the world they live in as well as equip them with tools they can apply in other areas of mathematics (Funny, Ghofur, Oktiningrum, & Nuraini, 2019).

Idris as cited in Utami *et al*. (2017) opine that students often get discouraged because of lack of understanding in the learning of Geometry.

Idris explained further that Geometry vocabulary, visualization abilities, and ineffective Geometry instruction account for students' difficulties in achieving in Geometry. Personal experience with many students regarding their frustrations in Geometry also indicate that a number of the students have little or no mastery in the basic geometric facts, thus, making them handicapped when it comes to more complex Geometry problems.

The mathematics syllabus (CRDD, 2012) outlines the aims for teaching Geometry as follows: to develop spatial awareness, geometrical intuition and the ability to visualize; to provide a breadth of geometrical experiences in; to develop knowledge and understanding of and the ability to use geometrical properties and theorems; to encourage the development and use of conjecture, deductive reasoning and proof; to develop skills of applying Geometry through modelling and problem solving in real world contexts; to develop useful ICT skills in specifically geometrical contexts; to engender a positive attitude to mathematics; and to develop an awareness of the historical and cultural heritage of Geometry in society, and of the contemporary applications of Geometry.

Having established a working definition for Geometry and the general aims of teaching it, Jones (2014) establishes the basis for the inclusion of Geometry in the school curriculum as follows: the study of Geometry helps students to develop the skills of visualization, critical thinking, intuition, problem solving, perspective, conjecturing, deductive reasoning, logical argument and proof; geometric presentations helps students make sense of other areas of mathematics etc. According to Jones (2014), Geometry should be presented in ways that stimulate curiosity and encourage exploration to beef up students' learning and general attitudes towards Geometry and mathematics in general. This explains why the study adopted the discovery teaching method for the lessons.

Another reason for the inclusion of Geometry is because our cultural life is significantly visual (Jones, 2014). Aesthetic appreciation of the Arts, architecture, music and many cultural artefacts involve geometric principles such as symmetry, perspective, scale, orientation and so on. It is common knowledge that scientific principles and technological phenomena make extensive use of the knowledge of Geometry. The dependence of many current applications of mathematics on Geometry cannot be overemphasized.

Music and Adolescents

Many teenagers as well as their parents, families and teachers experience emotional turbulence most often. Thomas (2016) opines that music has a key role in the adolescent's transitional period in life because, they shape adolescents' personal and social identities. According to Thomas, to determine the best ways music can be presented to teenagers in the classroom, one would have to start by examining how the adolescent brain processes information. That way, educators will not focus on what adolescents perceive as school music but what they consider as their music. Generally, children are born with the flare for music. They develop their consciousness towards their culture's music through daily experiences.

Literature has sufficient evidence to support the general assertion that music, for the adolescent is an effective tool to employ as the panacea for low affective domains that have links with academic attainments. For instance, Miranda as cited in Matematica (2014) purported that music enhances socialization, emotion regulation, personality, motivation and general positive adolescent development. Music enhances socialization in the sense that, many teenagers with similar music preference naturally form social cliques based on common musical preferences. Many adolescents use music to relieve themselves of academic and social pressures of school life. That probably explains why some high school students prefer to learn with music at the background. On the implications for music education, Thomas (2016) suggests that, educators should factor their students' musical preferences when designing lessons with music.

Research has indicated that, adolescents spend more than three hours daily on the average listening to music by themselves. They use gadgets such as radios, CD's, MP3 players, TV's and other sources (Rideout, Foehr, & Roberts, 2010). More precisely, Schwartz and Fouts as cited in Weiss, Abeles, and Powell (2017) asserted that, adolescent spend about 4.5 hours daily listening to music, an amount of time similar to that spent in class by the time they graduate from high school. With these sterling evidences about the possibilities of music in the classroom, educators might consider incorporating familiar music into the classroom. Such familiar music may include popular songs, but also classical music that students have experienced in movies and on television (Todd & Mishra as cited in Macrides & Angeli, 2018).

Todd and Mishra as cited in Macrides & Angeli (2018) suggested that students are most likely to be motivated to learn school music when teachers include some popular music in their lessons, as well as incorporate active modes of listening. Thomas (2016) opined that music educators could select music that shares similar elements as popular music, such as a fast tempo, or present music that has a familiar style. Again, Thomas suggested that, when introducing music selections to students initially, they might feel more motivated to learn to and perform music that has a personal appeal, as opposed to music that is strange and foreign to them.

Thomas (2016) noted "When students are allowed to choose the music they want to learn, and then are given the opportunity to learn and perform the music in a small group setting, they are able to take ownership in the learning process" (p. 5). This is supported by (Green, 2006) who stated,

> "By allowing learners the personal autonomy to explore authentically that aspect of musical autonomy, we could open their ears to the possibility of imbuing music with a much wider variety of delineations than children and young people usually realize are available." (p. 115)

To sum it up, adolescence has been established to be plagued with much emotional and psychological difficulties. Thomas (2016) offered some explanations that account for such difficulties. Adolescence is a period when emotions surge and the desire for reckless activities abound. These behaviours take forms such as arrogance, moody and emotional behaviours.

Review of Related Works

Kocabaş' (2009)**,** research titled 'Using songs in mathematics instruction: results from pilot application' aimed at examining the effects of mathematics courses that are supported by using songs on students' attitudes, achievements and Multiple Intelligences. This has two major similarities and five key differences when compared with the current study. In terms of similarities, both Kocabaş' work and the current study used achievement tests that were developed from contents in their respective grades as outlined in the mathematics curricular. Besides, the specific mathematics contents were taught with the songs which were composed for each instructional objective.

Regarding the five key differences, the number of dependent variables studied in the research conducted by Kocabaş (2009) was one more than in the current study. Kocabaş' research had an extra dependent variable- Multiple Intelligences. Also, whereas Kocabaş' work drew his sample from third graders the current study focused on eighth graders. In terms of the design used, Kocabaş, adopted a Pre-test-Post-test Experimental design with Control group and time series designs, while the current study aligned itself toward the pre-test-post-test non-equivalent Control group design. Kocabaş, used precisely four Experimental and four Control groups which were randomly selected from the socioeconomic schools and the low-level elementary schools. The current study used one Experimental and one Control group which were naturally available in the Conveniencely selected school. Finally, while Kocabaş paid no attention to any specific mathematics content area, the current study focussed on Surface areas and Volumes of solid figures.

Kocabaş (2009) concluded that the developed mathematical songs decreased mathematics anxiety and increased positive attitude towards mathematics which resulted in an increase in students' achievement. The findings, according to gender indicated that, male students' attitudes were higher than female students' in the Experimental groups. Kocabaş, recommended that the developed songs for mathematics course should be used in primary schools due to the spiral structure of the mathematics syllabus. Also, that class teachers should be trained on how to use songs to support mathematics instructions.

Yoho (2011), conducted an action research with the aim of answering the question 'Would using music improve math skill acquisition and retention?'. The quest to answer such a question resulted from the desire of mathematics teachers to help students retain mathematical facts and information for easy recall and use. Unlike Kocabaş (2009) who used third (3^{rd}) graders, Yoho used fourth (4^{th}) graders. In all, Yoho used 18 fourth graders, with various learning difficulties. For each content unit that was prepared for instruction, a few key concepts, facts and/or formulae were chosen to be developed into a short melodic song that was taught to the students. The songs were taught to the students right after the concept was taught. Students were then encouraged to practise the songs regularly. Thereafter, the respective unit tests followed the learning of the songs.

The current study differs from the research conducted by Yoho (2011) in a number of ways. In the first place, while Yoho used fourth (4^{th}) graders, the current study used eighth (8^{th}) graders. Secondly, while Yoho's work employed two teachers- one teaching the Experimental group (with music) and the other teaching the Control group (without music), the current study engaged only one teacher to teach both the Experimental and the Control groups. Although the two teachers who taught in Yoho's research did their best to use the same methodology and style, their individual differences still had some bearing on the entire lesson. This difference was catered for in the current study by ensuring that one teacher taught both groups. The lessons were spread over a period of three teaching weeks to cater for teacher tiredness and exhaustion.

After the unit test conducted, Yoho (2011) found that the 18 students in the study increased their assessment scores from an average of 21% on the unit pre-test to an average of 81% on the unit test. This showed an average increase of 57.7%. The comparison class scored an average of 40% on the pre-test and an average of 87% on the unit test, showing an increase of 47%. The gain of the students in the Experimental group was 10.7 % points higher than the comparison class. Yoho concluded that the use of music in mathematics lessons produces relatively higher gains than instructions without music. Yoho admitted that her results were inconclusive, to some extent, because of the teacher difference. She recommended that another research be conducted with instructions by one teacher so that one could determine, more distinctly, if it was success factor, or the music that was used to support the lessons. This recommendation was what the current study sought to address.

An, Tillman, Boren, and Wang (2014) in a bid to improve elementary teachers' pedagogy and students' mathematics performance and general disposition conducted the study titled "Fostering Elementary Students' Mathematics Disposition through Music-Mathematics Integrated Lessons." Their research aimed at investigating the effects of teaching mathematics though interdisciplinary approaches on students' dispositions. The sample was drawn from two groups of third (3^{rd}) graders with 28 students each, one of which was assigned to participate as the Experimental group and the other group was made the comparison group.

The research conducted by An *et al.* (2014) is similar to the current study in some respect. In both cases, a pre-test was administered to students in both groups to assess their mathematics dispositions before the intervention.

Intervention procedures were similar for both studies. Thus, the Control groups had the mathematics lessons without songs supporting the lessons while the Experimental groups had their lessons supported by the songs.

Aside the slight similarity between the study conducted by An *et al.* (2014) and the current study, a number of remarkable differences exist between the two studies. While their study took nine teaching weeks, the current study took three teaching weeks. Also, while An *et al.* selected their respondents (pupils) randomly, the current study used an intact group for both the Experimental and Control groups. Furthermore, whereas the current study focuses on 8th graders, the study by An *et al.* targeted lower graders (3rd). Moreover, while their study employed two female elementary teachers to handle the two groups (one taught the Experimental group while the other taught the Control group), the current study, in an attempt to cater for individual differences, made use of one teacher for both groups. Finally, An *et al.* adapted the Fennema Sherman Mathematics Attitude Scales for data collection while the current study adopted interview guides for data collection on student attitude toward Geometry.

An *et al.* (2014) concluded by providing evidence that music does not only contain aesthetic value as a form of art, but also serves as an educational resource for mathematics instruction. The outcome of the study has presented an alternative model for mathematics teachers to develop their pedagogical content knowledge. They opined that their study was limited by the possible threats to internal validity posed by the Hawthorne effect.

On their part, Sylwia Holmes and Susan Hallam from UCL Institute of Education, University College, London, based their research work on what music psychologists had established, that some forms of musical activities have the ability to improve intellectual performance, spatial-temporal reasoning and other learning enhancing related skills. Holmes and Hallam (2017) researched into the potential of active music-making for improving pupils' achievement in spatial-temporal reasoning. Besides, the study aimed at exploring if learning music might have some effect on pupils' achievement in mathematics.

Very much like the current study is the fact that, Holmes and Hallam (2017) adopted a quasi-Experimental design. The disparities however result from a number of issues. For instance, while the current study focusses on eighth graders whose age brackets average 14 years, Holmes and Hallam targeted children aged 4 to 7 years as the participants in the study. Regarding duration of study, Holmes & Hallam conducted their study over a period of two years. The current study could last for only three teaching weeks. Holmes & Hallam found in their study that, music instruction had impact on the development of spatial-temporal skills.

It is quite clear that the current study remains unique due to a number of reasons. The level of respondents (eighth graders); study area (Ghanaian context); and the mathematics content area (Geometry) remain the key aspects that mark out the current study as unique in comparison with all such research in the body of literature. Unlike the other studies which target lower level learners such as 1st to 6th graders in elementary schools, the current study focusses on relatively higher levels such as 8th graders (Junior High school students).

Chapter Summary

This chapter entailed aspects of related literature reviewed from the body of literature. Literature was reviewed on the theories that underpinned the study, the conceptual framework with its accompanying concepts were discussed in detail. The attitude of students toward mathematics and measurement of attitude toward mathematics were extensively discussed as well. The achievement of students in mathematics, measurement of achievement in mathematics was reviewed. Geometry as a mathematics content area, adolescents and music as well as four major related studies were also reviewed.

CHAPTER THREE

RESEARCH METHODS

In this chapter, the research methods used in the study is discussed. The research approach and design, study area, population of the study, sample and sampling techniques are explained in this chapter. The chapter also includes information on instruments for data collection, data collection procedure, validity of instruments, data analysis process, and ethical considerations.

Research Design

The approach adopted in the study is the exploratory sequential mixed methods. Considering the research questions guiding the study, either of qualitative or quantitative approaches would be inadequate to exhaustively answer the research questions. Thus, to provide an appropriate understanding of the effects of the teaching approach, a mixed methods design which draws on the strengths of both quantitative and qualitative research (and its data) is employed. The exploratory sequential mixed methods design begins with qualitative data. The qualitative data is then followed by quantitative data on the same respondents. The qualitative data collected at the start of the study is aimed at exploring a given phenomenon. In this study, the qualitative data collected on students' attitude toward Geometry was done through written and oral interviews.

Participating students were given sheets of papers on which they were required to express their views, feelings and general behaviour toward Geometry related topics in mathematics. To ensure that what students had expressed were indeed the true reflection of how they saw and felt about

Geometry, the researcher followed up with an interview session to ascertain the written feedbacks given by students. Since the exploratory sequential mixed methods researcher has a sequence to data collection that involves first collecting qualitative data followed by quantitative data, this study proceeded with the three week-long Geometry lessons with music as support. Quantitative data in the form of achievement scores were generated through the tests conducted. The quantitative data collected (Geometry achievement scores) was intended to explain, support or query the initial qualitative findings (Attitude toward Geometry).

According to Creswell (2012), one advantage of the exploratory sequential mixed method approach is that it allows the researcher to identify measures actually grounded in the data obtained from study participants. The researcher can initially explore views by listening to participants, and then decide on whether to make modifications that could aid the entire process of addressing the research problem. The researcher is able to design or modify appropriate instruments for quantitative data based on initial qualitative data. However, it has the disadvantage of requiring extensive data collection. Also, the time required for this process is relatively longer.

Being an educational research where randomization was practically impossible (Creswell & Creswell, 2018), quasi-experimental design was adopted. In this study, intact groups were used for both the Experimental and Control groups since the two groups were already existing as the two streams A and B of the school. The specific research design used was the pre-test post-test non-equivalent Control group design. All participating students in both groups were interviewed and pretested on the Geometry test designed to find out their cognitive entry levels. Both groups were taught Geometry using the same lesson plan. While the Experimental group had music supporting their Geometry lessons, the Control group had no music supporting their lessons. After the lessons, both groups were tested again based on the lessons taught. Some students from the Experimental group were also interviewed to find out their attitude toward Geometry after participating in the Geometry lessons supported with music.

Two comparable Basic 8 classes were used: Basic 8A and 8B. The two classes were comparable in the sense that both were: of the same level (Basic 8); taught Mathematics by the same teacher; situated in the same school with similar teaching and learning conditions. Prior to the study, the researcher had decided to use the class with a lower pre-test mean score as the Experimental group. Basic 8B (which emerged with the lesser pre-test mean score of 57.59) was eventually chosen by the researcher to be the Experimental group while Basic 8A (with pre-test mean score of 64.53) was used as the Control group. In both cases, intact group was used. Also, the large class size of the Experimental and Control classes catered for the threat of mortality.

Furthermore, cross contamination of the two classes, otherwise referred to as diffusion of treatment, as a threat, was minimized by spacing the timing of the lessons and allowing the Control class (Basic 8A) to be ahead of their Experimental counterparts by two days. The researcher also dealt with the threat of resentful demoralization (compensatory) by informing the Control class, before the study, that he would make time after the study to teach them the Geometry songs. The researcher fulfilled his promise such that, by the end of the research, students in both classes knew how to sing and use the songs in their learning of Geometry. To minimize the threats to external validity, the findings are generalized over the 110 Basic 8 students only.

Study Area

The study was conducted in Great Winners School Complex, in the Hohoe Municipality of the Volta Region. Great Winners School Complex, Hohoe is a private basic school established in the year 2007. The school currently has a boarding facility that houses over three hundred (300) pupils. Its Junior High School department has two streams, A and B for all three forms. The school has so far produced ten (10) batches of students for the Basic Education Certificate Examination (BECE), and has been ranked mostly among the best three in the Ghana Education Service (GES) ranking of Basic schools in the Hohoe Municipality. In spite of its high academic achievement over the years, Mathematics continues to be a challenge for most of the students. This remains a concern for the school management in the last couple of years.

Great Winners school was selected as the research site because it met two key criteria which were pre-determined by the researcher before the study. These criteria were: readiness to release its Basic 8 classes for the three-week long study and Basic 8 students having the pre-requisite knowledge for the Geometry lessons on Surface area and volume of solid figures. The related pre-requisite knowledge required were perimeter and areas of plane figures as well as properties of quadrilaterals. Great Winners school complex Basic 8 students met the afore stated criteria, and hence, their selection for the study.

Population

The school's Basic 8A and 8B were used as the Control and treatment groups respectively. Basic 8A had 54 students while Basic 8B had 56 students. In all the population was 110 Basic 8 students of Great Winners School, Hohoe. However, due to absenteeism, only 88 took part in the study.

Sampling Procedure

Convenience sampling was used to select the school because, the school met certain criteria that were pre-determined by the researcher (Cohen, Manion & Morrison, 2012). Purposive sampling technique was used to choose Basic 8 students of the school. Availability of the Basic 8 classes for participation in the three-week long study; a class size of not less than thirty (30) as well as the completion of the pre-requisite content areas (Geometry contents in Basic 7 and Basic 8 first term) were the criteria for the choice of Great Winners School as the research site. In all, the treatment group comprised 41 students while the Control group comprised 47 students, making the sample size for the study to be 88.

Data Collection Instruments

Two instruments were basically used to collect data for the study. These were the Teacher-made Geometry Achievement Test and the semi-structured interview guides. While the Teacher-made Geometry Achievement Tests were used to collect quantitative data, the semi structured interview guides were used to collect qualitative data.

Teacher-made Geometry Achievement Tests

Three separate self-developed objective tests developed from Geometry contents of lower grades (Basic 8 first term and below) were used for the pre-test. The lower grade Geometry contents served as the pre-requisites for Surface area and Volume of solid figures as the content area of interest. The test items were formulated with the syllabus as a guide and expert's input and supervision to ensure that the items were valid and reliable. As per the syllabus, the pre-test was drawn from Shape and Space, area of plane figures and properties of quadrilaterals as spelt out in the JHS syllabus (CRDD, 2012). Post-test questions were developed from the contents Surface Area and Volume of solid figures. In all, the post-test comprised two different Geometry Achievement Tests which were based on the specific instructional objectives (as stated in the syllabus) of the lesson (CRDD, 2012).

The pre-test comprised three separate sections: Tests 1, 2 and 3. Test 1 items were drawn from 'Plane figures'. There were 20 items covered in Test 1. Students were to answer all twenty items in thirty (30) minutes. Test 2 items were taken from 'Properties of Quadrilaterals'. Twenty (20) items in this section were to be answered in twenty (20) minutes. Finally, Test 3 items were drawn from 'Area of plane figures: triangles, trapezium, parallelogram and circles'. It comprised fifteen (15) items which were to be answered in twenty (20) minutes. In all, the pre-test comprised fifty-five (55) items, to be answered in seventy (70) minutes. All, except five (5) questions, were objective.

Two separate Geometry Achievement Tests constituted the post-test. Test 1, based on the volume of prisms: rectangular (cuboid), square (cube) and circular (cylinder), comprised ten (10) objective questions. The duration for Test 1 was twenty (20) minutes. Test 2 tested students' ability to retain and recall formulae of the Area of plane surfaces and volume of solid figures. The questions were four (4), with each question having sub-questions under it. The duration for Test 2 was twenty (20) minutes. In all, the post-test comprised ten (10) objective questions and four (4) main open questions with a duration of forty (40) minutes.

Vos (2005) refers to written test as the classical instrument for measuring achievement. Mathematics education researchers agree that mathematics achievement should be measured quantitatively with marks or scores being their outcomes. According to Vos, although the arguments that the reduction of all the complexities of achievement into a mere score is tantamount to concealing vital information, the scores still have the advantage of being a more convenient shorthand, particularly when reports on students as well as comparison of students are to be made for decision sake. He further points out that, achievement tests have been disadvantaged by their inbred limitations: they require reading; rarely demand discussion; no allowance for group discussions; written tests focus on measuring only what students cannot do, instead of allowing students to demonstrate what they can; they encourage rote learning.

In spite of these limitations, educators still have to consider written test because of its numerous advantages such as: they can be administered uniformly irrespective of the number of students involved; they are time-effective; within a limited time- frame, they can test a broad range of competencies; they are known for good reliabilities, especially when the items have a closed format. These advantages of efficiency have made written tests a favourite instrument for measuring mathematics achievement in the classroom and educational research for that matter (Vos, 2005).

Vos (2005) argues that, researchers start the development of written tests by first considering the objectives of their research. For instance, a test may either be developed to reflect a curriculum document which spells out certain minimum standards attainable at a level. Tests may be developed to test specific curriculum content descriptions and then scrutinized on face validity by the curriculum experts Standardized tests by international bodies (WASSCE, SAT, GRE etc.) or those developed from textbook-based items may as well be considered. Vos further explained that tests satisfy the curricular validity when they test appropriate content; and they meet the face-validity criteria when they appear good.

Regarding the design of valid tests, Vos (2005), in his recommendation argued that the classical methods for developing tests may result in valid and reliable instruments for research in the developed nations. However, same tests usually turn out to be invalid with respect to response processor. Thus, testing for mathematical skills are usually sacrificed for students' perseverance, language proficiency, guessing skills, and probably some other skills not directly related to mathematics skills. On the need to improve test design, Dunne *et al.* as cited in Vos suggest that a significant number of items from lower grades than the target population should be included in the design of the test items. In the same vain, Rogan & Hattingh as cited in Vos suggested for the creation of a trial version of the test and have it pilot tested, then very difficult items eliminated as well as very easy ones.

Interview Guide

Tuckman (as cited in Cohen, Manion, & Morrison, 2012) describes interview as a distinctive technique in research. According to Tuckman, interviews provide access to what is hidden in an individual. Interviews make it possible to access what an individual knows, his/her likes and dislikes (values and preferences) as well as what he/she thinks (attitudes and beliefs). In view of these, the researcher included specific questions regarding the experiences and perceptions of the respondents in the interview guide. Three interview guides were developed: the written interview guide, the oral interview guides 1 and 2 (Appendices A, B, & C). Responses from the interviews were to be used to explain further the achievement scores.

The collection of data by interviews has a number of advantages: the interviewer is able to probe into partially answered questions (Robson, 1993 as cited in Cohen, Manion, & Morrison, 2012); interviews are very much useful when respondents have challenges as far as reading, comprehension and writing are concerned; privacy and general control of the interview environments can easily be ensured or controlled by the interviewer. Cohen, Manion, and Morrison (2012) opine that interviews can guarantee that it is the respondent alone who is responding to the items. This may not always be the case in postal surveys.

In spite of the many advantages of using interviews in collecting data, they are still prone to the following limitations: interviews may be affected by the specific characteristics of the target respondents (e.g. social status, sex, outfits, personality, age, etc.); the personality, approach and skills used by the interviewer; the physical environment where the interview is taking place.

Cohen, Manion, and Morrison (2012) pointed out peculiar challenges associated with interviewing children. They outlined: avoiding the assumption that children 'know the answers'; overcoming the challenge of inarticulate children; wording of questions to the level of comprehension of children; avoiding of children seeing the interviewer as a spy, etc. These challenges can simply be curbed considerably or avoided when interviewers act professionally.

To overcome these challenges, interviews were conducted under a quiet environment where interviewees were not distracted. Also, only volunteering students were interviewed. The interviewer used clear and simple language during the interview session. In some instances, the interviewer used the local language to ease understanding by the interviewees. Interviewees were encouraged to use their preferred language in answering any or all questions. To avoid tension, interviewer adopted the strategy of walking around with each interviewee while conducting the interview. This was to ease off any formality and create a friendly atmosphere to allow interviewees to relax while responding to the items.

The written interview had one open-ended item which aimed at eliciting a natural flow of each student's view, feelings and behaviour toward Geometry related topics. Students were given thirty (30) minutes to express themselves in the spaces provided below the open-ended item (Appendix A). The item was as follows:

> *"Geometry is one of the major areas in mathematics. You have been learning Geometry since your kindergarten days. For instance, you learnt about shapes such as squares, circles,*

triangles and rectangles at the kindergarten and primary school levels. You later learnt about other shapes such as trapezium, parallelogram, kite and rhombus. Again, you learnt about perimeter of shapes as well as the areas of plane figures. All these make up the major area we call Geometry in mathematics.

Now, write down all your experiences about Geometry (in the spaces provided below) as a major topic in mathematics. Your experiences may include your views, feelings, problems and how you behave when you meet Geometry questions in any test or examination as well as what happens to you when the mathematics teacher enters your class to teach the Geometry related topics".

The oral interview guides came in two folds. Oral interview guide 1 (Appendix B) comprised three sections: beliefs about Geometry related topics; feelings toward Geometry related topics; and behaviour toward Geometry related topics and activities. The three sections constitute the components of attitude as used in this study. Oral interview guide 2 (Appendix C) was open ended, and unstructured, though guided somehow by three main items. The guide sought to give participants in the Experimental group the opportunity to share their experiences after participating in the Geometry lessons supported by the music.

Validity and Reliability of Instruments

The researcher made the interview guide items available for peer review and expert scrutiny to ensure validity (Cohen *et al.*, 2012). In line with Silverman (1993) as cited in Cohen *et al*., the reliability was controlled by structuring the interview items such that, the format and word sequencing as well as questions for each participating student was the same. Wording, according to Oppenheim (1992: p. 147) as cited in Cohen *et al*., is a critical factor when dealing with attitudinal items. He opines that reliability is tampered with when wordings, context and emphasis are not the same. This is so because, the questions cease to be the same for all respondents. The researcher ensured reliability by subjecting students to the same questions for both oral and written interviews. Also, the researcher conducted all oral interviews for the sake of uniformity.

Considering the suggestions put forward by Silverman (1993) as cited in Cohen *et al.* (2012), that: interview guides should be pre-tested, and should include lots of closed questions, the researcher satisfied these demands. Also, the researcher factored open ended interviews to enable students to demonstrate their unique views, feelings and perceptions. Such variations in the questioning were aimed at enhancing validity as well as the reliability of the interview questions.

Pre-testing of Instruments

The written interview guide as well as the achievement test (diagnostic test) were pretested at Methodist JHS, Hohoe to ascertain their reliability.

Geometry Songs

The two-stanza Geometry song, named G-Song by the researcher, was developed creatively by inserting some Geometry formulae into the tune of the first stanza of the song ‘Nkosi Sikelel’ iAfrika’, the first segment of the South

Africa national anthem. 'Nkosi Sikelel' iAfrika' was composed by a Methodist school teacher by name Enoch Mankayi Sontonga in 1897. It was first sung as a church hymn but later became an act of political defiance against the apartheid regime. 'Nkosi Sikelel' iAfrika', translated in English as 'Lord, bless Africa', went through some metamorphosis as far as the lyrics is concerned, to become the first half of the National anthem of South Africa since 1994. With its powerful historical origin, implication of its lyrics to Africa as a whole, appealing tune for most adolescents and suitability of its tune to be sung as a marching song which most students sing often in school, the researcher adopted this tune for the Geometry song.

The researcher used the formulae for the area of some plane figures coupled with the formulae for the volume of some solids to form the lyrics of the popular tune. The researcher took into consideration, the context of the students as well as familiar tune to compose the song. This was to enhance the learning of the song. Students could sing it as marching song, during play time, by the school choir or special school academic programmes to enhance learning under very relaxed conditions. The lyrics of the song is as follows:

G-SONG: Area of some plane figures

Area of a triangle $\frac{1}{2}$ *bh,* Area of a square is *length x length*

Area of a circle πr^2**,** Rectangle is *length x breadth*, Trapezium, $\frac{1}{2}\ h\ (a+b)$

Parallelo-gram is *bh***,** Area of a sector $\frac{\theta}{360}\ \pi r^2$

G-SONG: Volume of some solids and length of an arc

Volume of a cuboid, *length* $\times$ *breadth* $\times$ *height*

Volume of cube is, *[length]*^{3}

Cone is $\frac{\pi r^2 x\, h}{3}$

Cy-linder, $\pi r^2\ x\ h$

Sphere $\frac{4}{3}\ \pi r^3$

Hemisphere $\frac{2}{3}\pi r^3$

The length of an Arc is $\frac{\theta}{360}\ 2\pi r$

Data Collection Procedure

Data was collected within two teaching weeks by the researcher and two other mathematics teachers in the school. Having sought the consent of the Headmistress of Winners School as well as the participating students with an introductory letter obtained from the Department of Mathematics and ICT Education, University of Cape Coast, the researcher briefed the teachers on their roles during the study period. With a thorough explanation of the details of the entire research to the participating students, the researcher sought for their consent in writing. This was to meet all possible ethical considerations. The researcher finally spelt out the various phases of the study as: interview, pre-testing, lessons followed by songs based on the lesson, post-interview and finally post-test. The students were excited hearing that they were going to be taught with songs.

Researcher coded each participating student with students in the treatment or Experimental group (Basic 8B) bearing codes such as E-01, E-02, E-03, E-04, etc. while students in the Control group (Basic 8A) bearing codes such as C-01, C-02, C-03, C-04, etc. Students in both classes or groups were given the written interviews to respond to. This lasted for twenty minutes. The responses of students from each class were collated, read through and based on the degree of negative attitude expressed towards Geometry by the students, the researcher selected twelve (12) students from the Experimental group and eighteen (18) students from the Control group. Interviews (oral) were actually conducted for some of the selected students until data saturation was reached.

The researcher ordered the instructional periods of the two classes (Basic 8A and 8B) such that, the Control group took the lead in the coverage of the lesson objectives. The Experimental group was intentionally delayed by two days. That was to prevent students in the Control group from learning the Geometry songs at an earlier time thereby, interfering with the study. The researcher taught both classes using the same lesson plan. The teaching method used by the researcher was the learner centred approach since that was the proposed teaching method by the syllabus (CRDD, 2012). The Experimental group had their lesson supported or followed up immediately with the Geometry songs. Table 1 shows the scheme of work for the period.

Table 1: Scheme of Work

Day	Lesson	CONTROL GROUP
1		Introduction, Coding of Students & Informed Consent
2		Written Interview & PRE-TEST
3	1	Introduction to solid figures- prisms, pyramids and spheres
4	2	Nets of solid figures-prisms and pyramids
5	3	Surface areas of solid figures (square prisms and pyramids; rectangular prisms and pyramids) ***Group assignment***
6	4	Surface areas of solid figures (circular prisms and pyramids) ***Home work***
7		***Class Exercise***
8	5	Volume of solids-prisms
9	6	Volume of solids-prisms ***Class exercise***
10	7	Volume of solids-pyramids ***Home Work***
11		POST-TEST
12		Closure
13		
14		Teaching and Learning of Songs as promised
Day	**Lesson**	**EXPERIMENTAL GROUP**
1		Introduction, Coding of Students & Informed Consent
2		Written Interview & PRE-TEST
3		
4		
5	1	Introduction to solid figures- prisms, pyramids and spheres
6	2	Nets of solid figures-prisms and pyramids
7	3	Surface areas of solid figures (square prisms and pyramids; rectangular prisms and pyramids) ***Group assignment***
8	4	Surface areas of solid figures (circular prisms and pyramids) ***Home work***
9		***Class Exercise***
10	5	Volume of solids-prisms
11	6	Volume of solids-prisms ***Class exercise***
12	7	Volume of solids-pyramids ***Home Work***
13		Songs on Geometry + Post lessons INTERVIEW
14		POST-TEST + Closure

Source: Author's own construct (2020)

Data Processing and Analysis

Quantitative Data Processing

After scoring and expressing all Geometry achievement scores in percentages, both descriptive and inferential statistics were employed. Scores of students who could not take both tests (pre-test or post-test) were excluded before the actual analysis was done. The general achievement of students in the pre-test and post-tests of the Control and Experimental groups were described using descriptive statistics such as mean scores and standard deviations displayed in tables. Bar graphs were used to show the graphical presentations of the pre-test and post-test achievements of individual students in each of the two groups, Control and Experimental. Box plots were used to show whether or not outliers were present in any of the four different data sets.

Test of Assumption of the Test Tools Used

The achievement scores (pre-test and post-test) within each group (Control and Experimental) were analysed using the paired sample t-test while the two groups were compared using the independent sample t-test. To employ the t-test, four major assumptions had to be met (Field, 2005; Pallant, 2005). To ensure normality, the Kolmogorov-Smirnov test was run. The result of the test is displayed in Table 2.

Table 2: Kolmogorov-Smirnov Test of Normality

Test	Group	Statistic	df	Sig.
Pre-test	Experimental	.104	41	.200
	Control	.108	47	.200
Post-test	Experimental	.119	41	.157
	Control	.110	47	.200

Source: Field data (2020)

According to Pallant (2005), a non-significant result (significant value greater than 0.05) indicates normality. Considering the significance column of Table 2, it is clear that the significant value of each of the four data sets is greater than 0.05. This shows a non-significant result for each data set: pre-test and post-test of the Control and Experimental groups. Since non-significant results indicate normality (Pallant, 2005), it means that each of the four data sets is normal. Hence, normality assumption was satisfied.

To satisfy the assumption of independence, the observations (achievement test scores) must either be taken from respondents in two separate groups or from specified respondents at different times (Morgan, Leech, Gloeckner, & Barrett, 2004). In the current study, each group (Control and Experimental) had its students contributing achievement scores at different times/days. Also, scores were collected from students who happened to be in two separate groups (Control and Experimental). Thus, the study met the assumption of independence (Pallant, 2005).

Homogeneity of variances, is the next assumption to be satisfied. Table 3 and 4, give the results of Levene's test for equality of variances. Pallant (2005) opines that Levene's test for equality of variances tests whether the variation of achievement scores for two groups (Control and Experimental) is the same.

Table 3: Levene's Test of Equality of Variances (Pre-Test Scores)

F	df	Sig.
.041	86	.840

Source: Field data (2020)

According to Pallant (2005), a significant value greater than 0.05 indicates that the assumption of equal variances is not violated. From Table 3, the significant value of 0.840 is greater than the cut-off of 0.05. Hence, it can be concluded that the assumption of equal variances is not violated and thus, the independent sample t-test can be run to compare the means of the Pre-test scores of students in the Control and Experimental groups.

Table 4: Levene's Test of Equality of Variances (Post-Test Scores)

F	df	Sig.
.137	86	.712

Source: Field data (2020)

According to Pallant (2005), a significant value greater than 0.05 indicates that the assumption of equal variances is not violated. From Table 4, the significant value of .712 is greater than the cut-off of 0.05. Hence, it can be concluded that the assumption of equal variances is not violated and thus, the independent sample t-test can be run to compare the means of the Post-test scores of students in the Control and Experimental groups.

Qualitative Data Processing and Analysis

Responses from the interviews were basically read through, coded and analysed thematically. The written interviews were first analysed thematically with the constructs or themes being: *beliefs* about mathematics (Geometry), *feelings* toward mathematics (Geometry) and *behaviour* toward mathematics (Geometry). Students' written responses, captured under the three constructs or themes were used to proffer descriptions that served as the response to the research questions: Research question 1: What is the attitude of Basic 8 students toward Geometry? Research question 2: Does participation in

Geometry lessons supported with music affect the attitude of Basic 8 students toward Geometry?

The oral interviews were transcribed, coded and analysed appropriately using themes or constructs (belief about Geometry, feelings towards Geometry and behaviour toward Geometry) that constitute attitude toward Geometry, as a dependent variable in the study.

Chapter Summary

The chapter explained how the research was conducted. It gave detailed description of the research methods used in the study. The approach used was the exploratory sequential mixed methods. The specific design was the pre-test-post-test non-equivalent control group. The school used was Conveniently selected. Intact group was used. Teacher-made Geometry Achievement test, written and oral interview guides were the instruments used for data collection. The Geometry achievement test scores (quantitative data) were analysed using the paired sample t-test and independent sample t-tests while the qualitative data was analysed thematically.

CHAPTER FOUR

RESULTS AND DISCUSSION

This chapter presents the results from the analysis of data as well as discussion of the results. The objective of this study was to explore the effect of participation in Geometry lesson supported with music on the attitudes of Basic 8 students toward Geometry and the achievements of Basic students in Geometry. To achieve these research objectives, both qualitative and quantitative data were collected from 88 Basic 8 students of Winners School Complex. The presentation of results is ordered as follows: results of the research questions followed by the results of the hypotheses.

Participation in Geometry Lessons Supported with Music: Effects on the Attitude of Basic 8 Students Toward Geometry

Two research questions were developed to answer this objective.

What is the Attitude of Basic 8 Students Toward Geometry?

The purpose of this research question was to gather information about how students themselves view or perceive Geometry, what their feelings toward Geometry are and how they behave or act toward Geometry as a topic or Geometry related lessons and questions. Data was collected in two phases to answer research question 1. Phase one was through the written interview while phase 2 was an oral interview.

Phase 1: Written interview

The written interview aimed at eliciting students' personal responses that reflected their attitude toward Geometry. Students had twenty (20) minutes to present, by writing in either English or the local language (Ewe), their responses. Before students were allowed to write down their responses, the researcher read through the questions with explanation to ensure clarity of the question. Students' written responses were collated, sorted, coded with themes that were analysed and reported as follows:

Beliefs (Cognitive component of Attitude)

Generally, students' view about Geometry was that of difficulty, full of formulae and simply based on one's ability to remember facts and formulae. The following written comments from some of the students indicated their views about Geometry:

C-31: If we talk about Geometry, the thing that makes it very simple is when you know the formulae off-head. In this class, the thing that makes Geometry to be difficult for some of us is that we fail to learn our formulae.

C-32: Geometry is easy, just that, I mostly forget the formulae

E-36: My friends and I have realized that, when one knows the formulae, one will be able to solve most, if not all, of the questions in Geometry

E-01: Geometry is one topic I like so much. For me, it is easy to understand but also easy to forget its formulae

C-18: Geometry, for me, is an easy topic. Many of my friends see it as difficult but if you know the formulae, you will solve Geometry questions without any problem.

As recounted from the shared views of the students, Geometry, in their opinion is simply based on a number of formulae. One's ability to memorize such formulae and retrieve them appropriately determines one's performance in Geometry.

Feelings (Affective component of Attitude)

Regarding their feelings or emotions concerning Geometry and its related questions, many students agree that the feelings have not been positive. The following are a few of the written comments noted:

E-03: Anytime I am able to solve Geometry related questions, I become happy. Whenever I am unable to solve them successfully, I become sad.

E-13: I fear calculations in Geometry related questions

E-45: When it is time for Geometry, I feel like I am hungry and I become very weak. Sometimes, I feel like sleeping when we have Geometry related questions

E-29: I usually get angry and confused when solving Geometry questions

E-25: And sometimes, the reason why I don't like Geometry is that, sometimes when I am given Geometry questions to solve I get confused in the process. This makes me unable to continue. So, I really need help to develop interest for Geometry.

C-29: Geometry was my favourite topic as far back as my primary school days. As time went on and I got to the Junior High School level, I could no longer retain formulae. That was the beginning of my problems. By the time I entered Basic 8, I had given up on Geometry. Now, I am regretting I gave up, but I don't know who can help me. I need help as far as the way I feel about Geometry is concerned.

C-04: Anytime it is time for Geometry lessons and I hear "go and call the teacher", I either start feeling cold or sleepy. Sometimes, it *appears I understand what is taught but when I take a test or exercise, I perform poorly. It makes me angry.*

The responses of students suggest that, their feelings toward Geometry is not pleasant enough. Some even wish their negative emotions should be replaced with more positive ones. Their only challenge is that they feel they do not know how?

Behaviour (Conative or Actions)

How students act on seeing Geometry questions, as well as their behaviour toward Geometry lessons was also needed to assess their attitude toward the topic. Students' written responses regarding their behaviour toward Geometry were transcribed and reported as follows:

C-29: I no more pay attention during Geometry lessons

E-13: Geometry is everywhere but for some of us, it is not in our field, so we avoid it as much as possible.

E-45: Sometimes, I feel like getting out from the classroom when it is time for Geometry lessons.

Drawing from the written responses of eighty-eight (88) students regarding their views, feelings and behaviour toward Geometry related contents, sixty-five (65) of the students (representing 73%) saw Geometry as being difficult, formulae related, performance tied to one's ability to recall formulae toward Geometry usually exhibit feelings of dislike, anger, fear, hatred and mix-feelings toward Geometry. As the students expressed, the natural reaction or behaviour traits of teenagers who manifest such views and feelings toward a topic would be avoidance of the topic.

Phase 2: Oral Interview

With informed consent of few volunteering participating students, the oral interview was conducted by the researcher to augment the written interview. The interview took a semi-structured form to allow the researcher to gather the true responses of the students. Students were allowed to express themselves in ways they could communicate their responses best while the responses were recorded. The recorded interviews were transcribed and coded. The data was analysed and reported thematically as follows:

Beliefs about Geometry (Cognitive component of Attitude)

Students believe that Geometry is very important and should not be taken out of the mathematics syllabus. However, they admit it is difficult to understand, basically full of formulae and favours those who are able to commit such formulae into memory and are able to retrieve them for use when asked to do so. The following responses buttress such beliefs:

> ***E-25:*** *I see Geometry as difficult and mainly based on formula work. If I know the appropriate formula to use, I have high chances of getting my solutions right. Geometry is useful because it is found in every mathematics exam I write. Apart from passing exam, I think Geometry is useful in everyday life because most of the stuff I sell in my mother's shop at home have shapes of geometric figures. Knowledge of Geometry helps me to identify them by their shapes. Even the buildings around come in geometrical shape forms. I'm not really doing well in Geometry related questions. I wish I score higher than 50% when I take Geometry tests. For now, my previous scores are usually less than half the total mark (50%).*

***E**-36: I have no problem with my mathematics teacher. Geometry is my problem. I know Geometry is useful anyway. I am not doing well in Geometry.*

***E**-21: Geometry is very important as far as my mathematics is concerned. However, I don't easily understand Geometry. I need to be given extra help to catch up with the formulae*

Feelings toward Geometry (Affective component of Attitude)

Generally, students have negative feelings toward Geometry. The feelings toward Geometry include dislike, anger, fear and hatred for that matter. Some of the responses in this regard include but not limited to these:

***E-25:** I sometimes feel bored while I feel happy some other times. I feel bored when solving questions on topics like ratio and proportion, Geometry and vectors. I feel bored particularly when I am finding it difficult to understand. I will not be happy if Geometry is cancelled from the mathematics syllabus because I know how important Geometry is all around us.*

***E-36**: I feel afraid when I meet Geometry questions. I feel happy whenever my mathematics teacher is absent from school, especially when the topic to be treated is Geometry. cancellation of Geometry from the syllabus will be good and bad news for me. Good news because, I will be free from learning Geometry while it will be bad news because I know I will miss out on a lot since I know Geometry is needed in every field*

***E**-21: I fear Geometry particularly because my teacher shouts at me when I forget the formulae she considers fundamental*

Behaviour toward Geometry (Conative or Actions)

Regarding their behaviour toward Geometry as a topic, Geometry lesson or questions, the students admit they will, as a matter of fact, avoid Geometry related issues. The following attest to that fact:

E-25: *I avoid Geometry, because formulae are too many and confusing*

E-36: *I won't study Geometry at all. In fact, the subject won't even be mathematics*

Participating students' responses in written and verbal forms naturally confirmed the tripartite components that make up attitude (Fishbein & Ajzen, 1993). Students' views and beliefs about Geometry were basically derived from their personal previous experiences, teacher factor, nature of the topic and other factors. The source of their beliefs: personal experiences, teacher factor etc. confirmed the assertion made by Crisp and Turner (2007). Key among their beliefs about Geometry was the fact that, most of them reduced Geometry to formulae work. This view was seen in responses given by C-31, C-32 and E-36.

The view held by Basic 8 students, that Geometry was all about formula work contradicts the very essence of Geometry as posited by Utami, Mardiyana, and Pramudya (2017). Thus, Geometry is not only taught to develop the cognitive abilities of students, but also assisting memory formation from concrete into abstract. According to (Funny et al., 2019), Geometry empowers students to analyse and interpret the world they live in as well as equip them with tools they can apply in other areas of mathematics. Therefore, holding the view that Geometry is simply based on formulae and that one's performance is determined by one's ability to recall such facts and formulae would nullify one of the fundamental essence of Geometry as a mathematics content as stated by Funny *et al.* and the mathematics curriculum (CRDD, 2012). Students' view of Geometry being based on formulae could explain the negative feelings they expressed about it, since most of the Geometry related questions demand more than recall of facts and formulae.

Idris (2006) as cited in Utami *et al.* (2017) opines that students often get discouraged because of lack of understanding in the learning of Geometry. When confronted with Geometry problems that require higher order thinking skills, students with only formulae in their memories without understanding would certainly get frustrated and discouraged. Students with a bunch of formulae without conceptual understanding will have feelings such as the ones expressed by E-25, C-29 and E-29.

Drawing from the responses of twenty-three (23) (representing 77%) Basic 8 students, it is quite clear that their attitude toward Geometry is not different from their general attitude toward the subject mathematics as a whole. Generally, Basic 8 students of Winners school view Geometry as a difficult topic in mathematics, full of formulae and thus, easy only for those who have the ability to memorize formulae and retrieve them for calculations when needed. Those who are unable to memorize are usually handicapped and frustrated whenever they come across Geometry problems. Students agree that Geometry is important but its difficult nature as well as it being full of formulae makes its learning challenging. This assertion must have its roots in the dominant teaching method used by their teachers particularly during Geometry related topics.

How does Participation in Geometry Lessons Supported with music affect the Attitude of Basic 8 Students toward Geometry?

This research question targeted students who were taught Geometry with music. The purpose of the research question was to gather information about how students who participated in the Geometry lessons supported with music, viewed Geometry. The research question also aimed at collecting data about how the participating students felt about Geometry and their expected behaviour toward Geometry after their experiences. Their predictions about how the music would affect their achievements in any given Geometry test was also explored. The following responses from students reveal their personal experiences after participating in the Geometry supported with music lessons:

> ***E-40:*** *……….Also, songs make facts to stick in our minds. That way, recall of facts and Geometry formulae for use in any test or exam becomes easier. Sir. I am sure I am moving from below average to average.*
>
> ***E-25:*** *The song is good. I liked it. During the test, I simply sang the song and it helped me to remember some of the formulae. So, the song is good Geometry is interesting!*
>
> ***E-36:*** *The song was very interesting to me, so, I really got involved in what we were doing in the class. Immediately after school, I saw myself teaching other colleagues who were not in school that day. About the test we wrote too, although I didn't talk, I just sang the song quietly in my mind and that helped my recall of the formulae to answer my questions joyfully. I am*

very sure that I shall, for once, score almost everything correct.

E-36: *With these songs, I now know that, I can get every related question correct*

***E-**13: My interest begun when we were learning the song. During the test, I just sang the song and got all the formulae required to answer all the questions. I even told a friend that I was sure I was going to score 100%. I think we'd do better in mathematics if we are taught with music than the usual ways we have always been taught.*

***E-28: T**he song was nice. It really helped us in the test. With the song, we were able to remember some of the Geometry formulae and we did very well in the test*

E-12: *The simple thing I can say about this song is that, it helps in remembering Geometry formulae. That's it!*

It is quite clear from the responses of nine (9) out of twelve (12) students (representing 75%) that the Geometry songs had significant influence on the affective aspects of the participating students, aside helping in the retrieval of the Geometry formulae which most of them agreed was a challenge for them in the past.

Exploration of Quantitative Data

This section reports on the features of all four data sets: pre-test and post-test scores of the Control and Experimental groups. The Control group here refers to Basic 8A class that took Geometry lessons by the child-centred approach but without music while the Experimental group refers to Basic 8B class that took Geometry lessons by the child-centred approach and with music as support. The section presents descriptive statistics, presence of outliers through box plots, and pictorial comparison of pre-tests and post-tests of students in the Control and Experimental groups. Table 4 presents the output on descriptive statistics for the Control group (the class taught Geometry without music).

Table 5: Descriptive Statistics for the Control Group

Test	N	Minimum	Maximum	Mean	Std. Deviation
Pre-test	47	36	91	64.53	13.989
Post-test	47	30	92	70.62	13.472

Source: Field data (2020)

From Table 5, the number of students who took each of the tests was 47. The pre-test scores range from 36 to 91 percent, with a mean score of 64.53 and standard deviation of 13.989. The Control group is a class above average. The post-test scores ranged from 30 to 92 after the students were taught Geometry with the child-centred approach to teaching. A cursory look at the mean scores for both pre-test (64.53%) and post-test (70.62%) indicate some level of improvement. However, more information would be required to make more detailed inference.

Table 6 gives the output of the descriptive statistics for the Experimental group (the class taught Geometry with music).

Table 6: Descriptive Statistics for the Experimental Group

Test	N	Minimum	Maximum	Mean	Std. Deviation
Pre-test	41	29	91	57.59	14.632
Post-test	41	32	95	75.83	15.451

Source: Field data (2020)

Table 6 shows that, 41 students participated in the Geometry lesson that was supported with music. The pre-test scores range from 29% to 91% with a mean score of 57.59%, suggesting a relatively weaker performance than the Control group (whose pre-test mean score was 64.53%). The standard deviation of the pre-test scores was 14.632. The post-test scores showed some improvement; with the least score 32% and the highest score 95%. The standard deviation of the post-test scores was 15.451. The post-test scores for the Experimental group were more spread than those of the Control group.

Figure 3 presents a box plot for the pre-test scores of the Control group. The Box plot indicates clearly that there is no outlier in the data set. A close look at the box plot also suggests that the scores are normally distributed about the mean. Thus, variation in the scores are not wide.

Figure 6: Post-test of Geometry lessons with music group (Experimental Group)

Source: Field data (2020)

Pictorial Comparison of pre-test-post-test scores of Individual Students in both Control and Experimental Groups

The graphs present pictorial representation of the pre-test and post-test scores of each student who participated in the Geometry lesson with or without music. Besides, each graph gives a quick summary of the differences between the pre-test and post-test of each student, i.e. whether the student's achievement score improved, declined or remained the same. Finally, with the graphs of the two groups- Control and Experimental, it is easy to compare the two groups pictorially and find out which is achieving better than the other.

Figure 7 shows the pre-test and post-test scores of participating students in the Control group. Aside C-06, C-24, C-31, C-38, C-40, C-42, C-43, C-44, C-47, and C-48, all other 37 students representing 79% of the entire Control group saw slight improvements in their achievement scores. That means that, 21% of the students in the Control group saw no improvement in their Geometry achievement by the end of the three-week long intervention.

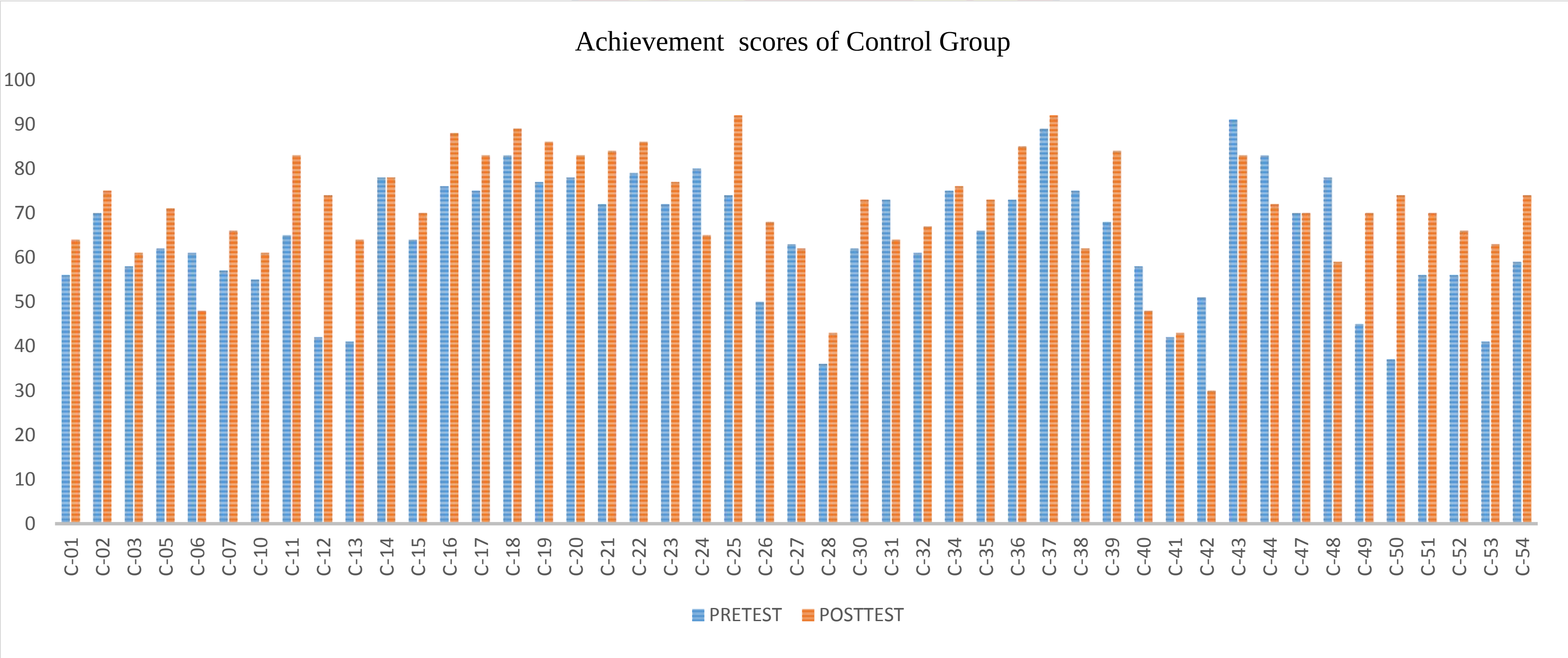

Figure 7: Achievement scores of Control Group

Source: Field Data (2020)

Figure 8 presents a bar chart that shows the pre-test and post-test scores of each participating student in the Experimental group (those taught Geometry with music). Only four participants (E-02, E-14, E-22 and E-23) saw some level of decline in their achievement scores. Thus, 37 students representing 88% of the Experimental group had some level of achievement in their Geometry achievement scores. It can be observed that the students in the Experimental group are achieving better than their counterparts in the Control group. This is worth noting because, the Control group was found to be relatively stronger at the start of the study (as per the mean score of the pre-test administered).

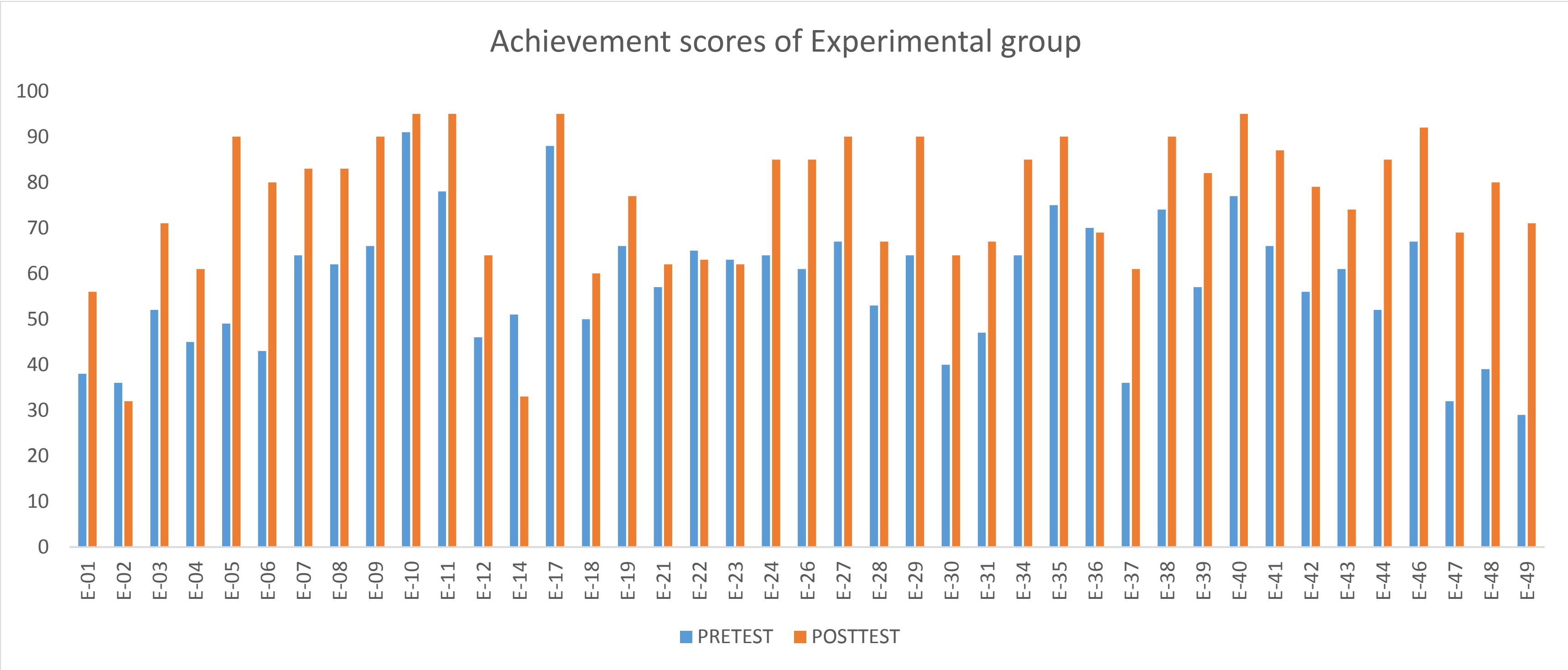

Figure 8: Achievement scores of Experimental Group

Source: Field Data (2020)

Data on student attitudes after participation in the Geometry lesson supported with music indicated that the students' feelings and views about Geometry were positively enhanced. For instance, when asked [by the researcher], "Now, with the song, how do you think it has affected your feelings toward Geometry and mathematics in general?", a participating student responded as follows: ***E-40:*** *"exciting! Sir. I am sure I am moving from below average to average".* This clearly indicates motivation for improvement in achievement. It confirms one of the functions of music to adolescents as purported by Thomas (2016).

According to Thomas (2016), when introducing music selections to students initially, they tend to feel motivated. Similar motivational indications were seen in the response provided by E-02, E-13, E-36 and E-25. For some students, like E-25, the experience of having the lyrics of a song being the same formulae they have struggled with brought some thrills and excitement to them. This confirmed the conclusion made by Kocabaş, (2009)**,** that "the developed mathematical songs decreased mathematics anxiety and increased positive attitude towards mathematics which resulted in an increase in students' achievement". To sum up, the attitudes of students who participated in the Geometry lesson supported with the music saw an obvious improvement.

Participating in Geometry Lessons supported with music: Effects on the Achievements of Basic 8 Students in Geometry

Four hypotheses were developed to answer the second research objective: to explore the effect of participation in Geometry lessons supported with music on the achievement of Basic 8 students in Geometry.

Hypothesis 1:

H_0: *There is no significant difference between the pre-test mean Geometry achievement scores of students taught Geometry lessons without music and those taught Geometry lessons with music.*

This hypothesis was aimed at determining the cognitive entry level of students before the study. The independent sample t-test was run to compare the mean achievement scores of the pre-test scores of the Control and Experimental groups. The hypothesis was tested at a 5% level of significance. The achievement of students in the pre-test is shown in the Table 7.

Table 7: Descriptive Statistics of Pre-test Scores of both groups

Test	Group	N	Mean	Std. Deviation
Pre-test	Experimental	41	57.59	14.632
	Control	47	64.53	13.989

Source: Field Data (2020)

Table 7 indicates that, the pre-test scores of the Control (with M = 64.53 with SD = 13.989) is relatively higher than that of the Experimental group (M = 57.53 with SD = 14.632). From the table, the Control group had a relatively higher cognitive entry level than the Experimental group. This actually confirms earlier claims by the mathematics teacher for the two groups, that the class considered as the Control has, on a number of occasions turned out to be stronger in terms of monthly tests organised by the school.

In Table 8, the significance. Value is 0.025, which is not greater than 0.05. Thus, there is a significant difference between the pre-test scores of the Control and the Experimental groups. It can therefore be concluded that, the

Control group significantly outperformed the Experimental group in the pre-test.

Table 8: Independent Samples Test

Test	Group	Mean	Std Deviation	t	df	Sig. (2-tailed)
Pre-test	Experimental	57.59	14.632	-2.274	86	.025
	Control	64.53	13.989			

Source: Field Data (2020)

The results of the test on the comparison of the two groups involved in the study revealed a difference in their mean pre-test scores. The output displayed in Table 7 confirms the Control group to be the more achieving class with a mean pre-test score of 64.53 as against the Experimental group with a mean pre-test score of 57.53. It means that, the group selected to be the Experimental has the weaker cognitive entry behaviour (Çalişkan, 2016).

Considering the claims of Yunt (1978) as cited in Çalişkan, that the achievement levels of students with high cognitive entry behaviours are higher than those of the other students, the results of this study contradicted Yunt's claims. This is because, although the affective entry characteristics (attitude toward geometry) was relatively same for both groups, the achievement levels of students with high cognitive entry behaviours (Control group) were not higher than that of those in the Experimental group. Students in the Experimental group made greater gains in achievement than their counterparts in the Control group.

Hypothesis 2

H_0: There is no significant difference between the achievement of students before and after being taught Geometry lessons without music.

Prior to the testing of Hypothesis 2, the mean score for the pre-test and post-test of the control group were compared. In Table 8, the mean score for the post-test (70.62 %) is higher than that of the pre-test (64.53%). Hypothesis 2 was tested to determine the significance of the observed difference between the Geometry achievement of students before and after being taught Geometry without music. Being the same group with each student having a pair of scores generated at two different times during the study, the paired sample t-test was run to compare the mean Geometry achievement scores of the pre-test and post-test of the same group (Control group). The hypothesis was tested at a 5% level of significance.

Table 9: Paired Samples Statistics for the Control Group

Test	N	Mean	Std. Dev	t	df	Sig.
Post-test	47	70.62	13.472	3.362	46	0.002
Pre-test	47	64.53	13.989			

Source: Field data (2020)

Summary statistics for the paired sample test are displayed in Table 9. Since the significance value (.002) is less than 0.05, it implies there is a significant difference between the pre-test and the post-test of the Control group. A comparison of the mean scores of the pre-test (M = 64.53) and post-test scores (M = 70.62) of the control group indicates that the post-test scores were higher. The conclusion drawn from this is that there is statistically significant difference between the achievement of students before and after being taught Geometry lessons without music. Thus, the post-test scores are significantly higher than the pre-test scores.

Hypothesis 3

H_0: There is no significant difference between the achievement of students before and after being taught Geometry lessons with music.

This hypothesis was tested to establish the significance of any differences observed between the Geometry achievement of students before and after being taught Geometry with music. The paired sample t-test was run to compare the mean Geometry achievement scores of the pre-test and post-test of the Experimental group. The summary statistics are displayed in Table 9.

Table 10: Paired Samples Statistics for the Experimental Group

Test	N	Mean	Std. Dev	t	df	Sig.
Post-test	41	75.83	15.451	9.129	40	0.000
Pre-test	41	57.59	14.632			

Source: Field data (2020)

Comparing the mean scores of the pre-test and post-test in Table 10, it can be deduced that the post-test scores (M = 75.83 %) are higher than the pre-test scores (M = 57.59%). The hypothesis 3 was tested at a 5% level of significance. From Table 10, the significance value of 0.000, which is less than 0.05 results in the conclusion that there is a significant difference between the pre-test and post-test achievement scores of the Experimental group.

There is a significant difference between the achievements of students before and after they were taught Geometry with music. It can therefore be concluded that, there is significant improvement on the pre-test scores indicating that, supporting Geometry lessons with music has a remarkable effect on students' achievement. A very large effect size of 0.68 was found. This means that, 68% of the variance in Geometry achievement is explained by the music. In conclusion, there was a statistically significant difference in students' Geometry achievement.

Juxtaposing the Geometry achievement levels of students from the two research groups, i.e. Basic 8 students who took Geometry lessons with music and their counterparts who took the same lessons but without music, a number of differences could be pointed out. Although there was statistically significant difference between the pre-test and post-test scores of both the Control and Experimental groups, 38 students, representing 93% of the Experimental group saw various degrees of improvements in their Geometry achievements, while 36 students representing 79% of the Control group had gains in their Geometry achievements.

Secondly, the margin of difference between the means of the pre-test and post-test scores of the Control and Experimental groups adds to the difference. While the margin of difference for the Control group was 6.09 (i.e. 70.62 – 64.53), that of the Experimental group stood at 18.24 (i.e. 75.83 – 57.59). The larger difference from the Experimental group further supports their greater attainments. Although the students in the Experimental group seem to have made higher gains as indicated by their general percentage gains as well as margin of difference, it must however be noted that, these same students were weaker in terms of cognitive entry behaviour. If cognitive entry behaviours significantly explain the extent of achievements in learners as (Çalişkan, 2016) puts it, then a different variable must have accounted for such gains in the achievements of students with relatively weaker cognitive entry behaviour.

Aside the overall percentage improvements and margin of difference in the Control and Experimental groups, the effect size, as indicated by eta squared value, makes the picture clearer. Whereas 20% of the improvement in the overall achievement of students in the Control group resulted from the teaching approach used in delivering Geometry lessons, 68% of the variance in Geometry achievement of students in the Experimental group is explained by child-centred approach supported by the music. Again, the assertion of Yunt as cited in Çalişkan (2016) that cognitive entry variables have a much stronger effect on achievement level than those of an affective nature, is strongly violated. In this study, music, which had effect on students' affective domain accounted to a large extent for the effect on Geometry achievement.

This outcome of increased students' achievement through the inclusion of developed Geometry songs agrees with the findings of Kocabaş (2009), who researched into 'Using songs in mathematics instruction: results from pilot application'. Although Kocabaş, drew his sample from third grade primary pupils, the current study sampled higher graders (8^{th} grade students), suggesting that, regardless the level of the learners, music, when integrated with the appropriate teaching methods has the tendency to increase achievement.

It is noteworthy also that, students from this same class, who were interviewed made some significant comments that indicated the role of the music on their cognitive parts as well. For instance, from responses such as:

*E-40***:** *...Also, songs make facts to stick in our minds. That way, recall of facts and Geometry formulae for use in any test or exam becomes easier;*

E-45: just sang the song to recall all my Geometry formulae! Simple! And

*E-25***:** *the song is good. I liked it. During the test, I simply sang the song and it helped me to remember some of the formulae. So, the song is good*

it is a fact that the songs helped them to recall Geometry facts and formulae which were indeed factual knowledge required to solve more complex problems.

The participating students' experiences of being able to remember and use these formulae only confirm the assertion made by Willingham (2009) that, 'this automatic retrieval of basic mathematical facts is critical to solving complex problems, since complex problems themselves have simpler problems embedded in them' (p. 15). To further explain his claim, Willingham (2009) opined that factual knowledge in mathematics referred to the learner's ability to readily have in memory mathematics facts and formulae that would enable the learner to perform specified mathematical activities. Thus, students had to familiarize themselves with mathematics axioms and facts, through constant practice, so as to be able to retrieve those facts with ease, whenever they were needed to perform mathematics activities. For such retrievals to be effective, they must be automatic and virtually attention free.

This was what the music with Geometry lyrics sought to do for these participating students: enabling students to retain the needed facts and retrieve them automatically and virtually attention free. The music-with geometric lyrics aided their retention of factual knowledge while the child-centred approach of teaching enhanced their conceptual knowledge. The result was the overall significant improvement in their Geometry achievement. This outcome is similar to that of Yoho (2011), who, in an attempt to use music to increase Math skill retention found that the 18 students in his study increased their assessment scores from an average of 21% on the unit pre-test to an average of 81% on the unit test, resulting in a 57.7% average increment, thereby, concluding that the use of music in mathematics lessons produces relatively higher gains than instructions without music.

Hypothesis 4

H_0: There is no significant difference between the achievement of students taught Geometry without music and students taught Geometry with music.

Prior to the testing of Hypothesis 4, a close analysis of the entries in Table 8 indicates a statistically significant difference between the Pre-test Geometry achievement test scores of students in the Experimental and Control groups. With students in the Control Group (Mean = 64.53, SD = 13.989) achieving more in Geometry than their counterparts in the Experimental Group (Mean = 57.59, SD = 14.632) before the intervention, One- way analysis of covariance (ANCOVA) was used to investigate the effect of supporting Geometry lessons with music on the post-test scores of students, while controlling for pre-test scores. Prior to the running of ANCOVA, preliminary checks were conducted to ensure that there was no violation of the assumptions of normality, linearity, homogeneity of variances, homogeneity of regression slopes, and reliable measurement of the covariate (Pallant, 2005).

Table 11: Test of Between-Subjects Effects

Test	Sig	Partial Eta squared
Pretest	.000	.379
Post-test	.000	.144

Source: Field data (2020)

Table 11 shows the main ANCOVA results. To know whether the Experimental and Control groups are significantly different in terms of their post-test scores, the significance value in the table is compared with an alternative alpha level, 0.05, set by the researcher. If the Sig value is less than 0.05, it suggests that the groups differ significantly (Pallant , 2005). In Table 11, the significance value is .000, which is *less* than .05; therefore, the result is significant. There is a significant difference between the Geometry achievement post-test scores of students in the Experimental group and that of those in the control group after supporting Geometry lessons with music.

Again, from Table 11, the effect size of the dependent variables (post-test scores), as indicated by the corresponding partial eta squared value is .144. Values for eta squared can range from 0 to 1. To interpret the strength of eta squared values the following guidelines can be used (from Cohen, 1988):

..01= small effect; .06 = moderate effect; and .14 = large effect. The value in this case is .144 (a large effect size according to Cohen's 1988 guidelines). This value also indicates how much of the variance in the Geometry achievement post-test scores is explained by the Geometry lessons supported with music teaching strategy. In this case, we are able to explain only 14.4 per cent of the variance.

Regarding the influence of the covariate (Pre-test scores), Table 11 shows a significant value of .000. This indicates whether there is a significant relationship between the covariate and the dependent variable, while controlling for the independent variable (group). According to Pallant (2005), the significant value of .000 (which actually means less than .0005) indicates that the covariate is significant. In fact, it explained 37.9 per cent of the variance in the dependent variable (partial eta squared of .379 multiplied by 100).

The final table in the ANCOVA output provides the adjusted means on the dependent variable for each of the groups. 'Adjusted' refers to the fact that the effect of the covariate has been statistically removed. Table 12 shows the Estimated marginal means

Table 12: Estimated Marginal Means

Group	Mean	Std. Error
Experimental	78.135[a]	1.814
Control	68.606[a]	1.691

Source: Field data (2020)

The result from Table 11 indicates that there is a significant difference between the Geometry achievement post-test scores of students in the Experimental group and that of those in the control group after supporting Geometry lessons with music. Further enquiry by the comparison of the mean achievement scores of the post-tests of both the Experimental group (M = 75.83) and the Control group (M =70.62) indicates that the Experimental group made a relatively higher gains than the control group. Also, the large effect size of 14.4 percent further shows that the Geometry lessons supported with music teaching strategy influenced the achievement of students. This value also indicates how much of the variance in the Geometry achievement post-test scores is explained by the Geometry lessons supported with music teaching strategy. In this case, we are able to explain only 14.4 per cent of the variance.

In a comparative analysis of the achievement levels of students in the two groups, it could be seen that, 93% of the students in the Experimental group made various levels of gains in achievement while 79% of the students in the Control group made gains in their achievement. Also, from the effect size point of view, 20% of the variance in Geometry achievement of students in the Control group being explained by the teaching approach used as against 68% of the variance in the Geometry achievement of students in the Experimental group being explained by the teaching approach used. These show that in comparison, students in the Experimental group had improved more in their Geometry achievement than their counterparts in the Control group although they began with relatively weaker cognitive entry behaviour.

The results do not contradict the bulk of literature in this regard. The effect of increased achievement in Geometry has confirmed the assertion that some forms of musical activities have the ability to improve intellectual performance, spatial-temporal reasoning and other learning enhancing related skills (Holmes & Hallam, 2017). Although Holmes and Hallam targeted children aged 4 to 7 years as the participants in their study; conducted their research over a period of two years; had two Experimental and two Control groups; and researched into the potential of active music-making for improving pupils' achievement in spatial-temporal reasoning, the outcome of the current study supports theirs. The outcomes of the current study also agree with that of An *et al.*, (2014), Yoho (2011) and Kocabaş, (2009).

The overt effects the music integrated Geometry lesson had on the attitudes of students toward Geometry as well as their achievement in Geometry were not by chance. Gardner's Multiple Intelligence theory (Gardner, 1995) underpinned the entire lesson structure. For instance, Guides *et al.*, (1989) posit that teachers should recognize and teach to a broader range of talents, skills and abilities. Thus, the researcher adopted different strategies such us group assignment, individual presentations as well as inclusion of music into the lessons to broaden the range of talents, skills and abilities etc. such as musical, linguistic etc.

Chapter Summary

This chapter highlighted the findings of the study. The study revealed that Basic Eight students of Great Winners School Complex, Hohoe, had misconceptions about Geometry as a Mathematics content area. To most of them, Geometry could best be reduced to formulae work. This view affected their general attitude toward Geometry related activities, thereby leading to avoidance of Geometry related activities. When Geometry formulae were used as lyrics of songs whose tunes students were familiar with, students' attitude toward Geometry related topics was enhanced so much that, their views about Geometry as well as feelings were changed positively. Beyond the positive effect such songs had on students' general attitude, the Geometry songs enhanced their achievement in the Geometry tests administered. The gains for participants of Geometry lessons supported with music was more than that for students who took part in Geometry lessons without the integration of music.

CHAPTER FIVE

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

This chapter presents the summary of the findings resulting from the analysis of data, the conclusions drawn from the analysis and the recommendations for future research work.

Summary

The purpose of the study was to explore the effect of participation in Geometry lessons supported with music, on the attitudes and achievements of Basic 8 students in Geometry. Two research questions and four hypotheses were developed to guide the study. The two research questions aimed at addressing the first research objective, while the four hypotheses aimed at addressing the second research objective.

The study employed the exploratory sequential mixed methods approach. This was because, either of qualitative or quantitative approaches would be inadequate to exhaustively answer the research questions and to test the hypotheses. To provide an appropriate understanding of the effects of the teaching approach on students' attitude and achievement, a mixed methods design which draws on the strengths of both quantitative and qualitative research is employed. Quasi-experimental design, specifically, the pre-test-post-test non-equivalent control group was adopted.

Convenience sampling technique was used to select Winners School Complex for the study. In all, 41 and 47 Basic 8 students each were used for the Experimental and Control groups respectively. For data collection, teacher made Geometry achievement tests (pre-test and post-test) were used for the quantitative data. Also, written and oral interview guides were used for the qualitative data. Scores from the Geometry achievement tests were expressed as percentages, processed and analysed using SPSS software.

Descriptive statistics such as mean scores and standard deviations were used to describe each of the data sets. Paired sample t-test was used to analyse the achievement levels within the Control and Experimental groups. Independent sample t-test was used to compare the mean scores of students in the Geometry achievement test of the Control and Experimental groups before the innovative teaching approach was employed. Finally, independent sample t-test was used to find out if there were differences in the mean scores of the Control and Experimental groups.

Findings

1. (a) Basic 8 students of Winners School have reduced Geometry to mere formula work and have negative feelings toward Geometry. They would therefore want to avoid Geometry related activities as much as possible.

   (b) Participation in Geometry lessons supported with music motivated Basic 8 students toward Geometry. Hence, Geometry songs used creatively to support Geometry instructions have positive influence on students' attitude towards Geometry.

2. Geometry lessons supported with music produce relatively higher achievements than lessons without music even among Basic 8 students.

Conclusion

1. (a) Basic 8 students have negative attitude toward Geometry largely because, they reduced Geometry to formula work. Hence, they made little or no progress when solving Geometry problems whenever they were not able to recall basic Geometry facts and formulae.

   (b) Since the songs influenced the feelings and perception of Basic 8 students toward Geometry, their general attitudes toward Geometry were affected. This implies that, Basic 8 students' participation in Geometry lessons supported with music affect their attitudes toward Geometry.

2. Teaching strategies that target the affective domains of Basic 8 students have higher chances of enhancing positive attitudes that could result in achievements irrespective of how underachieving the students may be.

The findings of the study provide empirical evidence for the provision made by the JHS mathematics syllabus, thus, 'since the aim of mental drills is to give practice and increase children's confidence in recalling their basic number facts, teachers should use variety of teaching strategies including games, music and physical activities as well as rewards to motivate children to practice and increase their confidence in recalling their basic number facts'.

Recommendations

From the findings of this study, the following recommendations are made for teachers, school authorities, curriculum developers and reviewers and future researchers.

1. In-service training sessions on how to identify and handle students' misconceptions about Geometry should be organised by Mathematics, Science and ICT coordinators at the circuit and district levels for teachers of mathematics at the JHS level.
2. Mathematics teachers should be educated on the effects of teaching Geometry with songs. Such education could be done by facilitators during teachers' in-service training sessions, mathematics teachers' associations and through mathematics teachers' workshops and conferences.

Suggestions for Further Studies

This study was targeted at Basic 8 students. The study aimed at exploring the effect of participation in Geometry lesson supported with music on the attitudes and achievements of Basic 8 students in Geometry. It is recommended that:

1. New research, targeted at Senior High school students, could be conducted to find out if the findings will differ.
2. Further research could look into whether the gains in achievement was caused by the improved attitude mainly or directly by the teaching strategy.

Since it appeared that the teaching method used could have accounted partly for the small gains in Geometry achievement of students in the Control group, further studies could consider three research groups: conventional, child-centred approach without music and child-centred approach with music. That way, the contribution made by the teaching method alone could be determined and then, the real effect of the songs alone could as well be determined. Further research could as well explore the same variables based on: gender differences and students' learning styles. Finally, further studies could consider music integration in mathematics teacher professional development. The effects on teacher performance could be measured and its implication for mathematics education practice assessed accordingly.

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APPENDICES

APPENDIX A

UNIVERSITY OF CAPE COAST

COLLEGE OF EDUCATION STUDIES

FACULTY OF SCIENCE AND TECHNOLOGY EDUCATION

DEPARTMENT OF MATHEMATICS AND ICT EDUCATION

RESEARCH TOPIC:

SUPPORTING GEOMETRY LESSONS WITH MUSIC: EFFECT ON THE ATTITUDE AND ACHIEVEMENT OF BASIC 8 STUDENTS OF GREAT WINNERS SCHOOL

INTERVIEW GUIDE 1 (WRITTEN)

RESEARCH QUESTION 1:

What is the attitude of Basic 8 students toward Geometry?

Code [ ]

Geometry is one of the major areas in mathematics. You have been learning geometry since your kindergarten days. For instance, you learnt about shapes such as Squares, Circles, triangles and rectangles in the kindergarten and primary school levels. You later learnt about other shapes such as trapezium, parallelogram, kite and rhombus. Again, you learnt about perimeter of shapes as well as the areas of plane figures. All these make up the major area we call geometry in mathematics.

Now, write down all your experiences about geometry (in the spaces provided below) as a major topic in mathematics. Your experiences may include your views, feelings, problems and how you behave when you meet geometry questions in any test or exams as well as what happens to

you when the mathematics teacher enters your class to teach the topic geometry.

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THANK YOU

APPENDIX B

UNIVERSITY OF CAPE COAST

COLLEGE OF EDUCATION STUDIES

FACULTY OF SCIENCE AND TECHNOLOGY EDUCATION

DEPARTMENT OF MATHEMATICS AND ICT EDUCATION

RESEARCH TOPIC:

SUPPORTING GEOMETRY LESSONS WITH MUSIC: EFFECTS ON THE ATTITUDE AND ACHIEVEMENT OF BASIC 8 STUDENTS OF GREAT WINNERS SCHOOL

INTERVIEW GUIDE 1 (ORAL)

RESEARCH QUESTION 1:

What is the attitude of Basic 8 students toward Geometry?

Beliefs

1. How do you see geometry as a topic?
2. Is geometry useful to you? Explain
3. Apart from passing your test and examination do you think geometry has any other use? Explain
4. Do you do well in geometry as a topic?
    a) If YES, why do you think you are doing well in geometry?
    b) If NO, why do you think you are not doing well in geometry?

Feelings

5. How do you feel when you meet a question in geometry?
6. How do you feel when you have geometry and your mathematics teacher is absent from school?

7. How would you feel when geometry is cancelled out from the mathematics syllabus?

Behaviour

8. If you were to study a topic in mathematics every day, would it be geometry?
9. Questions on what topic in mathematics would you avoid if you had the choice? Why?

THANK YOU

APPENDIX C

UNIVERSITY OF CAPE COAST

COLLEGE OF EDUCATION STUDIES

FACULTY OF SCIENCE AND TECHNOLOGY EDUCATION

DEPARTMENT OF MATHEMATICS AND ICT EDUCATION

RESEARCH TOPIC:

SUPPORTING GEOMETRY LESSONS WITH MUSIC: EFFECTS ON THE ATTITUDE AND ACHIEVEMENT OF BASIC 8 STUDENTS OF GREAT WINNERS SCHOOL

INTERVIEW GUIDE 2 (ORAL)

RESEARCH QUESTION 2:

Does participation in Geometry lessons supported with music affect the attitude of Basic 8 students toward Geometry?

1. Were you in class when the song was taught?
2. How was the experience/feelings like? Could you please share with me, what the song did to you?
3. How did you use the song when you were writing the test earlier today?

THANK YOU

APPENDIX D

CODE: [ ]

PRETEST 1

<u>INSTRUCTION</u>

Time Allowed: 30 minutes

*Answer **all** questions. From the options lettered **a** to **d**, choose the **best** option by **circling** the letter that represents it*

1. Squares, rectangles, kites, trapezia and parallelograms are collectively known as ……
   a) Triangles
   b) Quadrilaterals
   c) Polygons
   d) Plane figures
2. What is the name of the Figure 1.0 below?
   a) Square
   b) Rectangle
   c) Trapezium
   d) Rhombus

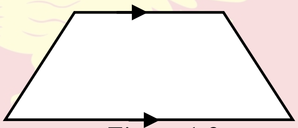


Figure 1.0

3. What are you measuring in the space covered by a two-dimensional figure such as square, rectangle or triangle?
   a) Length
   b) Perimeter
   c) Volume
   d) Area
4. What angle is shown in the Figure 2.0 below?
   a) 45^0
   b) 60^0
   c) 90^0
   d) 180^0

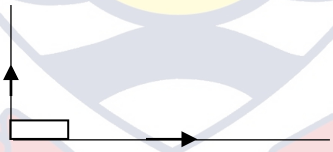


Figure 2.0

5. What is the **most appropriate** name for the triangle in Figure 3.0?
   a) right angled triangle
   b) acute angled triangle
   c) Isosceles triangle
   d) Isosceles right-angled triangle

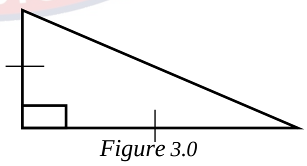


Figure 3.0

6. What is the proper way to label the area of a rectangle that has a length of 5cm and a width of 4cm?
   a) 20cm
   b) $20cm^2$
   c) 9cm
   d) $1cm^2$

7. If a square measures 3 cm on each side, what will be its area?
   a) 9cm
   b) $9cm^2$
   c) 12cm
   d) $6cm^2$
8. How many corners (vertices) does a circle have?
   a) 0
   b) 1
   c) 2
   d) 3
9. What are plane shapes in Mathematics?
   a) Any closed, flat, 2-dimensional shape
   b) Any open, flat, 2-dimensional shape
   c) Any closed, 3-dimensional shape
   d) All shapes
10. The Figure 4.0 below is made from two shapes. One of the shapes is a half-circle. What is the other shape?
   a) square
   b) rhombus
   c) rectangle
   d) semi-circle

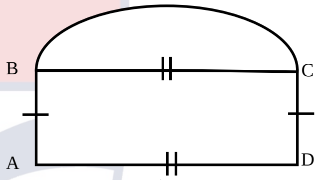
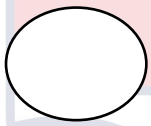
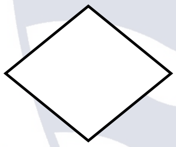
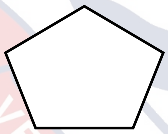
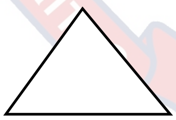
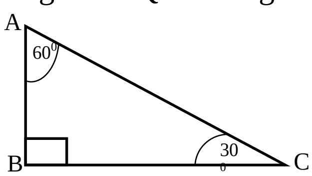


Figure 4.0

11. A square must have ……………………….
   a) four equal sides and four right angles
   b) exactly two right angles
   c) no parallel sides
   d) four acute angles
12. Which of the polygons below has four sides?
   a) triangle
   b) hexagon
   c) parallelogram
   d) circle
13. A plane shape with four equivalent sides and four right angles is called ……………
   a) kite
   b) rhombus
   c) square
   d) rectangle
14. A plane shape has four sides and four right angles. If its parallel sides are equivalent but all of its sides are not equal, the shape is best identified as ……………….
   a) rectangle
   b) square
   c) rhombus
   d) trapezium

15. A quadrilateral is a polygon with ……………….
    a) opposite sides and equal angles
    b) four sides and four angles
    c) all different sides and angles
    d) three sides and three angles
16. The area of a square is $16mm^2$, how long is one of the sides of the square?
    a) 16mm
    b) 8mm
    c) 4mm
    d) 2mm
17. How long is the base of the triangle, in the figure 5.0 below?
    a) 8cm
    b) 9cm
    c) 10cm
    d) 12cm
18. Which of the shapes below is a quadrilateral?
    a) 
    b) 
    c) 
    d) 
19. Which of the angles in triangle △PQR is a right angle?
    a. The angle at A
    b. The angle at B
    c. The angle at C
    d. None of the angles



20. The amount of space an object takes is known as ………………
    a. volume
    b. area
    c. length
    d. perimeter

THE END OF TEST

APPENDIX E

CODE: [ ]

PRETEST 2

(PROPERTIES OF QUADRILATERALS)

INSTRUCTION

Time Allowed: 20 minutes

*Answer **all** questions.*

*For questions **1 to 16,** choose the best option from the options lettered **a** to **d** **by Circling** the letter that represents it.*

1. The definition of a square is ……………….
   a) A quadrilateral with all sides equal
   b) A quadrilateral with all angles being 90^0
   c) A rectangle with a pair of adjacent sides equal
   d) A quadrilateral with two pairs of parallel sides
2. The sum of interior angles of a quadrilateral is ....
   a) 90 degrees
   b) 180 degrees
   c) 360 degrees
   d) 72 degrees
3. How many parallel sides has a kite?
   a) 0
   b) 1
   c) 2
   d) 3
4. How many lines of symmetry has a rectangle?
   a) 0
   b) 1
   c) 2
   d) 3
5. A rectangle is a quadrilateral because it has……………………
   a) 4 straight sides
   b) 4 right angles
   c) 2 pairs of parallel sides

d) 2 pairs of equal sides

6. Which of the following shapes has equal diagonals that bisect each other at right angles?
   a) Parallelogram
   b) Square
   c) Rectangle
   d) Rhombus
7. The diagonals of a rhombus are equal in length.
   a) TRUE
   b) FALSE
8. The opposite angles in a parallelogram are equal.
   a) TRUE
   b) FALSE
9. The diagonals of a parallelogram are equal
   a) TRUE
   b) FALSE
10. Which of the following polygons has four sides?
    a) kite
    b) triangle
    c) pentagon
    d) hexagon
11. Which of the following shapes has sides that are of the same length and angles that are **not** of the same size?
    a) rectangle
    b) rhombus
    c) square
    d) triangle
12. Which one of the following pairs of quadrilaterals has no line of symmetry?
    a) kite and trapezium
    b) kite and parallelogram
    c) kite and rhombus

d) parallelogram and trapezium

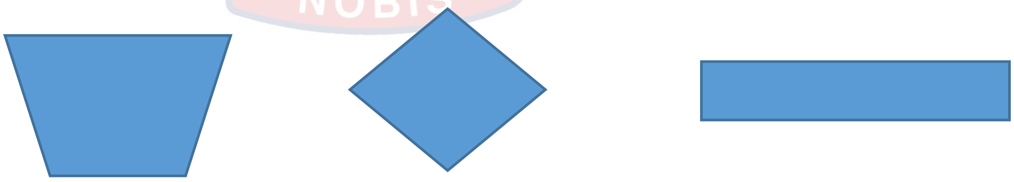
13. I am a quadrilateral with only one line of symmetry. Who am I?
    a) kite
    b) trapezium
    c) rhombus
    d) parallelogram

14. Which pair of quadrilaterals has all sides equal and all angles equal?
    a) square and rectangle
    b) square and trapezium
    c) square and parallelogram
    d) square and rhombus

15. Which pair of quadrilaterals has their diagonals equal in length?
    a) square and rectangle
    b) square and trapezium
    c) square and kite
    d) square and rhombus

16. Which pair of quadrilaterals has their diagonals intersecting each other at right angles?
    a) kite and square
    b) kite and rhombus
    c) kite and rectangle
    d) kite and parallelogram

17. Below are diagrams of some quadrilaterals. Write the name of each of them in the space below it



……………………… ………………… ………………………

……………………………… ………………………………

APPENDIX F

CODE: [ ]

PRETEST 3

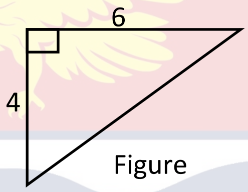
(AREA OF A TRIANGLE, TRAPEZIUM, PARALLELOGRAM & CIRCLE)

INSTRUCTION

Time Allowed: 20 minutes

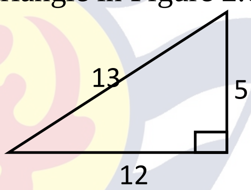
Answer all questions. From the options lettered a to d, choose the best option by circling the letter that represents

1. What is the area of a triangle with a base of length 3cm and height 4cm?
   a) 12cm
   b) $12cm^2$
   c) 6cm
   d) $6cm^2$
2. What is the area of the pictured triangle in Figure 1.0?
   a) 24 squared units
   b) 14 squared units
   c) 12 squared units
   d) 10 squared units



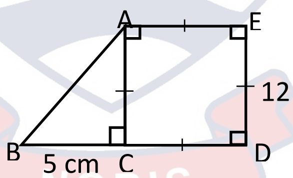
Figure

3. Calculate the area of the triangle in Figure 2.0 below
   a) 30 squared units
   b) 60 squared units
   c) 65 squared units
   d) 78 squared units

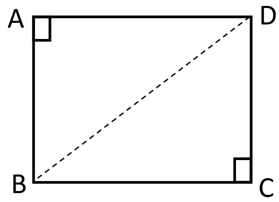


Figure

4. From the figure ABCDE, what is the area of the triangle ABC?
   a) $30cm^2$
   b) $60cm^2$
   c) $75cm^2$
   d) $144cm^2$



5. Consider the square ABCD. If its area is known to be 100 mm^2, calculate the area of triangle ABD
   a) $10,000mm^2$
   b) $100mm^2$
   c) $50mm^2$
   d) $40mm^2$



6. Figure 3.0 below comprises a triangle and half a circle. The total area of the figure is $55cm^2$. Calculate the area of the semi-circle
   a) $12.50cm^2$
   b) $40.00cm^2$
   c) $50.00cm^2$
   d) $42.50cm^2$

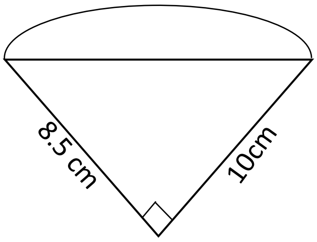
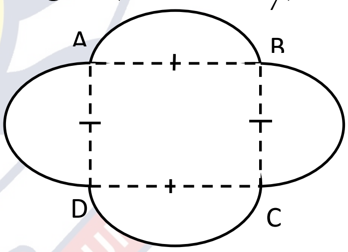


Figure 3.0

7. Calculate the area of a circle of radius 7cm ($Take\ \pi = \frac{22}{7}$)
   a) $44\ cm^2$
   b) $144\ cm^2$
   c) $154\ cm^2$
   d) $49\ cm^2$

8. The diameter of a circle is 7m long. Calculate its area
   a) $154.0m^2$
   b) $38.5m^2$
   c) $22.0m^2$
   d) $11.0m^2$

9. If the square ABCD in the diagram shown below has side length of 14cm, calculate the area of the entire figure ($Take\ \pi = \frac{22}{7}$)
   a) $38\ cm^2$
   b) $308\ cm^2$
   c) $3008cm^2$
   d) $30008cm^2$



10. Calculate the area of the circle in Figure 4.0 ($Take\ \pi = 3.14$)
   a) $3.14mm^2$
   b) $31.4mm^2$
   c) $314mm^2$
   d) $3140mm^2$

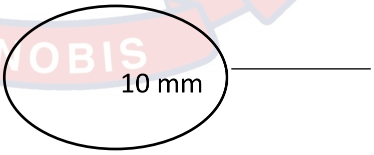


Figure 4.0

In Figure 5.0, line PQ is the diameter. Use the figure to answer questions 11 to 13.

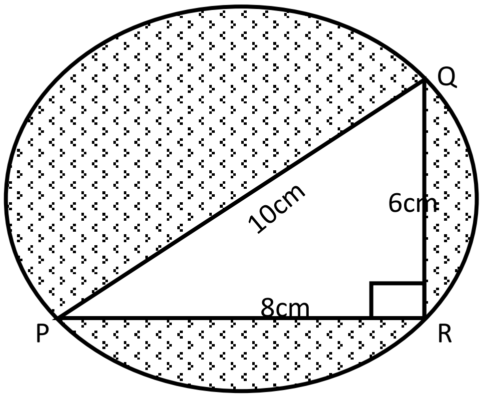


Figure 5.0

11. Calculate the area of the triangle PQR
    a) $40cm^2$
    b) $30cm^2$
    c) $24cm^2$
    d) $20cm^2$

12. Calculate the area of the circle **in terms of π**
    a) 10 π squared units
    b) 25 π squared units
    c) 100 π squared units
    d) 125 π squared units

13. Calculate the area of the shaded portion
    a) (25 π – 40) squared units
    b) (25 π – 24) squared units
    c) (25 π -30) squared units
    d) None of the above

14. The figure 6.0 shows a circle inscribed in a bigger one. If the radius of the smaller circle is 1cm and that of the bigger circle is 10cm, calculate the area of the shaded region
    (Take $\pi = 3.14$)
    a) 3.14 cm^2
    b) 314 cm^2
    c) 310.86 cm^2
    d) 300 cm^2

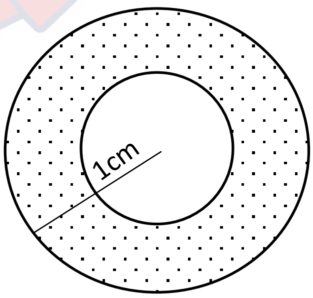


Figure 6.0

15. Which of the following is **not** the formula for the area of a circle?
    a) $\pi\left[\frac{d}{2}\right]^2$
    b) πr^2
    c) $\frac{\pi d}{2}$
    d) $2\pi r^2$

THANK YOU

APPENDIX G

CODE: [ ]

POSTTEST 1

(VOLUME OF CUBOID, CUBE AND CYLINDER)

INSTRUCTION

Time allowed: 20 minutes

*Answer **all** questions. For each question, C**ircle** the letter that represents the **best** option.*

1. One of the lengths of the sides of a cube is 1 cm. Calculate the volume of the cube.
   a) 1 cm
   b) 1 cm^2
   c) 1 cm^3
   d) 3 cm^3

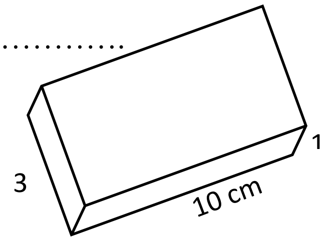
2. How much space will a box with dimension 4cm X 5cm X 2cm occupy?
   a) 11cm^3
   b) 14cm^3
   c) 20cm^3
   d) 40cm^3

3. The base radius of a right cylinder is 7cm. if the height of the cylinder is 100cm, calculate the volume of the cylinder $\{Take\ \pi = \frac{22}{7}\}$
   a) 15,400cm^3
   b) 15,000cm^3
   c) 2,200cm^3
   d) 2,000cm^3

4. The capacity of a cube is 27cm^3. How long is one of its sides?
   a) 27cm
   b) 9cm
   c) 3cm
   d) 1cm
   e)

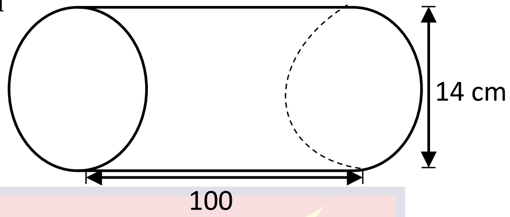
5. The area of the circular base of a cylinder is 0.10m^2. If the length of the cylinder is 10m, calculate the volume of the cylinder.
   a) 1.00m^3
   b) 10.0m^3
   c) 100m^3
   d) 1000m^3

6. The volume of the Figure 1.0 is …………
   a) $300cm^3$
   b) $30cm^3$
   c) $14cm^3$
   d) $10cm^3$



Figur

7. Given that $\pi = 3.14$, calculate the volume of Figure 2.0
   a) $15{,}386cm^3$
   b) $1{,}400cm^3$
   c) $314cm^3$
   d) $320cm^3$



Figure

8. Each of the length of a cube is 2mm. Its volume will be …………
   a) $2mm^3$
   b) $4mm^3$
   c) $8mm^3$
   d) $10mm^3$

9. A rectangular tank is 4m wide, 10m long and 5m high. How much maximum water can it hold?
   a) $19m^3$
   b) $20m^3$
   c) $50m^3$
   d) $200m^3$

10. Pick the odd one out
   a) mm^3
   b) cm^3
   c) litre
   d) m

APPENDIX H

POSTTEST 2
(Area of Plane figures & Volume of Solid figures)
INSTRUCTION

Time allowed: 20 minutes

*Answer **all** questions*

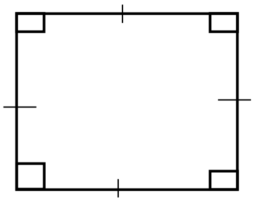
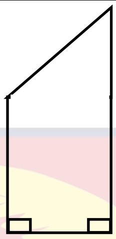
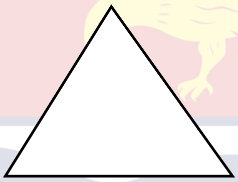
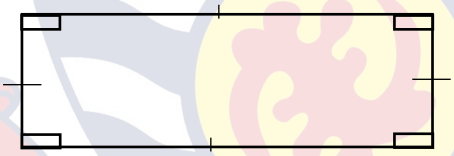
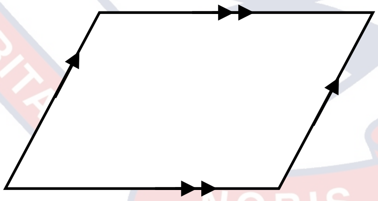
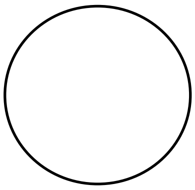
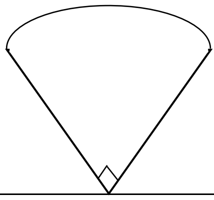
1. The table below shows some plane figures and the formula of their respective Areas. Complete the table

Plane figure	Formula for Area of a plane figure
Circle	
Square	
Trapezium	
Rectangle	
Parallelogram	
Sector	

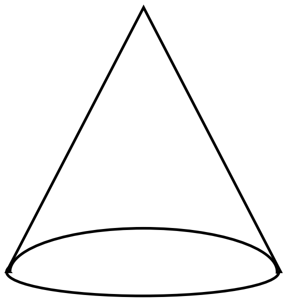
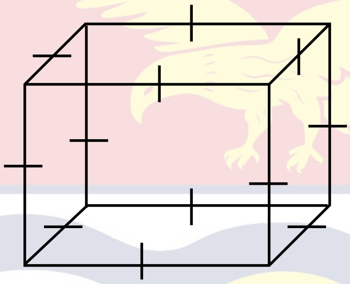
2. Write down the formula for the volume of each of the following solid figures

Solid figure	Formula for Volume of solid figure
Cylinder	
Cube	
Cuboid	
Cone	

3. Copy and complete the table below

Plane Figure	Name	Formula for its Area
		
		
		
		
		
		
		

4. Copy and complete the table below

Solid Figure	**Name**	**Formula for its Volume**
		
		
		
		

THANK YOU

APPENDIX I

UNIVERSITY OF CAPE COAST

COLLEGE OF EDUCATION STUDIES

FACULTY OF SCIENCE AND TECHNOLOGY EDUCATION

DEPARTMENT OF MATHEMATICS AND ICT EDUCATION

RESEARCH TOPIC:

SUPPORTING GEOMETRY LESSONS WITH MUSIC: EFFECTS ON THE ATTITUDES AND ACHIEVEMENTS OF BASIC 8 STUDENTS IN THE HOHOE MUNICIPALITY

LESSON PLAN 1

CLASS: Basic 2 A/B **TERM:** 2 **YEAR:** 2019/20

UNIT 2.13: L_1: Introduction to solid figures- prisms, pyramids and spheres

DURATION: 40 minutes

SPECIFIC OBJECTIVES

i. By the end of the lesson, the pupil will be able to identify:

ii. The cross-section of a regular solid; prisms, pyramids and spheres

RELATED PREVIOUS KNOWLEDGE (RPK)

The pupil can:

Identify plane shapes such as triangle, square, rectangle, circle etc.; the vertex of a solid shape

TEACHING AND LEARNING MATERIALS

Solids such as match box, chalk box, milk tin, soap carton, globe, orange, conical shapes

INTRODUCTION

In groups of five or six, teacher guides students to display all solid shapes (brought by teacher and students) on a desk for students to observe closely.

PROCEDURE

Activity 1

Teacher guides students to classify all shapes based on the following characteristics:

Solids whose edges slope into a common vertex

Solids with regular cross-section

Solids with only one surface without any vertex

Activity 2

Teacher names all solids whose edges slope into a common vertex, pyramids and then guides students to name the specific pyramids. Thus, triangular, square, circular, rectangular pyramid.

Teacher names all solids with regular cross-section prism and goes on to guide students to give specific names to specific prisms. Thus, triangular, square, circular, rectangular prisms.

Finally, teacher names solids with only one surface but without a vertex sphere

CLOSURE

Teacher asks each group to brainstorm and name a solid figure which fits the description of a prism, pyramid or sphere in everyday life.

APPENDIX J

UNIVERSITY OF CAPE COAST

COLLEGE OF EDUCATION STUDIES

FACULTY OF SCIENCE AND TECHNOLOGY EDUCATION

DEPARTMENT OF MATHEMATICS AND ICT EDUCATION

RESEARCH TOPIC:

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LESSON PLAN 2

CLASS: Basic 2 A/B **TERM:** 2 **YEAR:** 2019/20

UNIT 2.6.1 L_2: Nets of solid figures-prisms and pyramids

DURATION: 40 minutes

SPECIFIC OBJECTIVES

By the end of the lesson, the pupil will be able to:

i. Identify the nets of given prisms and pyramids

ii. Construct common solids from their nets

RELATED PREVIOUS KNOWLEDGE (RPK)

The pupil can dismantle common solids like milk tins, match box and chalk boxes

TEACHING AND LEARNING MATERIALS

Solids such as match box, chalk box, milk tin, soap carton, conical shapes built with papers

INTRODUCTION

In groups of five or six, teacher guides students to display all solid shapes (brought by teacher and students) on a desk for students to observe closely.

PROCEDURE

Activity 1

Teacher guides students to dismantle each solid along its edges. Then, draw the shape of the net seen on a sheet of paper. Teacher tells students that the shape drawn is called the net.

Activity 2

For the net of each solid dismantled, teacher guides each group to reverse the process. Thus, construct the solids from their respective nets.

CLOSURE

Teacher guides students to draw various prisms and pyramids with their respective nets on the chalk board. Teacher allows students to make copies of the solids and their respective nets in their jotters.

APPENDIX K

UNIVERSITY OF CAPE COAST

COLLEGE OF EDUCATION STUDIES

FACULTY OF SCIENCE AND TECHNOLOGY EDUCATION

DEPARTMENT OF MATHEMATICS AND ICT EDUCATION

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LESSON PLAN 3

CLASS: Basic 2 A/B **TERM:** 2 **YEAR:** 2019/20

UNIT 2.13.1 L_2: Surface areas of solid figures:

i. Square prisms
ii. Rectangular prism
iii. Square pyramids
iv. Rectangular pyramid

DURATION: 40 minutes

SPECIFIC OBJECTIVES

By the end of the lesson, the pupil will be able to calculate the total surface areas of:

i. Square prisms, Rectangular prisms, Square pyramids and Rectangular pyramids

RELATED PREVIOUS KNOWLEDGE (RPK)

The pupil can calculate the area of a: square, given the length of one of its sides; and rectangle, given its length and breadth.

TEACHING AND LEARNING MATERIALS

Chalk board illustration

INTRODUCTION

Teacher begins by drawing the diagram of a square prism (cube) with the length of one of its sides. Teacher invites a student to draw the net of the square prism drawn on the board.

PROCEDURE

Activity 1

Teacher guides the class by demonstrating how to calculate the area of the individual surfaces making up the entire net of the square prism. Teacher sums up the calculated area of all the six surfaces and informs the class that the result is the total surface area of the prism

Activity 2

Teacher draws a rectangular prism on the board and guides students to draw its net. Next, teacher invites a student to calculate the total surface area of the rectangular prism by involving his/her colleague. Teacher involves the entire class to go through the solution presented by their colleague. Teacher encourages the class to make constructive criticism while the procedure is discussed.

CLOSURE

Teacher presents the following on the chalk board as Group assignment to close the lesson

Draw a square and a rectangular pyramid. For each of the solids, draw its net, when dismantled. Given that the square pyramid has equal edges with each being 10cm, calculate its total surface area. Also, if the length of the rectangular base is 12cm and its breadth is 10cm, calculate the total surface area of the rectangular pyramid with slant edges of length 15cm **[20 marks]**

APPENDIX L

UNIVERSITY OF CAPE COAST

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FACULTY OF SCIENCE AND TECHNOLOGY EDUCATION

DEPARTMENT OF MATHEMATICS AND ICT EDUCATION

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LESSON PLAN 4

CLASS: Basic 2 A/B **TERM:** 2 **YEAR:** 2019/20

UNIT 2.13.1 L_4: Surface Areas of solid figures (Circular prisms)

DURATION: 80 minutes

SPECIFIC OBJECTIVES

By the end of the lesson, the student will be able to derive the formula for the total surface area of a circular prism which is (a) closed at both ends (b) opened at one end

RELATED PREVIOUS KNOWLEDGE

The student can: draw the net of a circular prism; calculate the area of a rectangle and circle

TEACHING AND LEARNING MATERIALS

A cylindrical milk tin and the dismantled milk tin (the net of the cylindrical milk tin)

INTRODUCTION

Teacher invites a student to make diagrams of a circular prism and its net on the chalk board

PROCEDURE

Activity 1

Teacher uses the cylindrical milk tin and its dismantled form (net) to illustrate how:

(a) The circumference **($2\pi r$)** of the circular base of the circular prism becomes the length **(l)** of the rectangular sheet after the tin was dismantled

(b) The height of the cylinder **(h)** eventually becomes the width **(w)** of the rectangular sheet after the tin was dismantled

Activity 2

(a) Teacher uses the fact in Activity 1 (a) to demonstrate that $2\pi r = l$

(b) Teacher uses the fact in Activity 1 (b) to demonstrate that h = w

Activity 3

With reference to the fact that the area of the rectangular metallic sheet (curved surface of the solid cylinder) is given by the length (l) x width (w), teacher demonstrates, through chalkboard illustrations that the Area of the cross-sectional surface is given by:

A = length (l) x width (w)

A = **$2\pi r$ x h**

A = $2\pi rh$, where r denotes the radius of the base of the cylinder , h denotes the height and A denotes the area of the curved surface, otherwise known as the curved surface area

Activity 4

With the net of the cylinder comprising of two equal sized circular surfaces, each with radius, r and a rectangular/ curved surface, teacher illustrates how the total surface area of the cylinder, closed at both ends could be derived.

Thus:

Total Surface Area of a solid cylinder (A_T) = Area of a circular face (A_1) + Area of the curved surface (A_C)+ Area of the other circular face (A_2)

$A_T = A_1 + A_C + A_2$, but $A_1 = A_2$

$A_T = \pi r^2 + \boldsymbol{2\pi rh} + \pi r^2$

$A_T = 2\,\pi r^2 + \boldsymbol{2\pi rh}$

$A_T = \boldsymbol{2\pi r}\ (\boldsymbol{r} + \boldsymbol{h})$

CLOSURE

Teacher closes the lesson by assigning students to:

(1) derive the formula for the total surface area of a cylinder opened at one end, using the one illustrated for the cylinder closed at both ends as a guide.

(2) Calculate the total surface area of a cylinder opened at one end if the radius of the cylinder is 20 cm and the height is 10 cm [Take $\pi = \frac{22}{7}$]

APPENDIX M

UNIVERSITY OF CAPE COAST

COLLEGE OF EDUCATION STUDIES

FACULTY OF SCIENCE AND TECHNOLOGY EDUCATION

DEPARTMENT OF MATHEMATICS AND ICT EDUCATION

RESEARCH TOPIC:

SUPPORTING GEOMETRY LESSONS WITH MUSIC: EFFECTS ON THE ATTITUDES AND ACHIEVEMENTS OF BASIC 8 STUDENTS IN THE HOHOE MUNICIPALITY

LESSON PLAN 5

CLASS: Basic 2 A/B **TERM:** 2 **YEAR:** 2019/20

UNIT 2.13.1 L_5: Volume of prisms

DURATION: 80 minutes

SPECIFIC OBJECTIVES

By the end of the lesson, the student will be able to calculate the volume of prisms: square, rectangular and circular prisms

RELATED PREVIOUS KNOWLEDGE

Students can: identify the cross-section of a right prism; and calculate the area of a square, circle and rectangle

TEACHING AND LEARNING MATERIALS

Square, circular and rectangular prisms made with paper cut outs

INTRODUCTION

Teacher displays each of the three prisms and asks students to identify the cross-section of each of the prisms. Teacher informs the class that the volume of a prism is given by the product of the cross-sectional area and the height/length of the prism. Thus,

Volume of prism = Area of the Cross-section X Height

PROCEDURE

Teacher asks students to pair up with their desk mates to perform each of the following

Activity 1

Teacher draws five different sizes of ***square*** prisms with their respective dimensions and students required to calculate the volume of each.

Activity 2

Teacher draws five different sizes of ***rectangular*** prisms with their respective dimensions and students required to calculate the volume of each.

Activity 3

Teacher draws five different sizes of ***circular*** prisms with their respective dimensions and students required to calculate the volume of each.

CLOSURE

Teacher closes the lesson with the following exercise