UNIVERSITY OF CAPE COAST

EXPLORING VALUES IMPLICIT IN GHANAIAN SENIOR HIGH SCHOOL MATHEMATICS TEXTBOOKS

NICHOLAS ESSIEN

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BY

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DECLARATION

Candidate's Declaration

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

Candidate's Signature ..... Date .....

Name .....

Supervisor's Declaration

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

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

Name .....

ABSTRACT

Mathematics as a field of study is mostly seen to be value and culture free. This assertion has however been refuted since values are contained in mathematics as a discipline and in its pedagogy but are often taught implicitly. The purpose of this research was to explore values implicit in best-selling Ghanaian SHS 1 core mathematics textbooks, considering the fact that not many research studies have gone into valuing in Mathematics. Teachers' awareness level of values implicit in Mathematics as a discipline and its pedagogy were also explored. Four best-selling Ghanaian SHS 1 core mathematics textbooks as well as four Ghanaian SHS 1 core mathematics teachers were sampled purposively for the study. The data on values implicit in the four best-selling SHS 1 core mathematics textbooks were analysed using frequency distributions and percentages. Data collected from four SHS 1 Core Mathematics teachers considered for the study were also analysed. Findings from the data on the four best-selling Ghanaian SHS 1 Core Mathematics textbooks using checklist revealed that Objectism, Progress and Openness values were emphasised while Formalistic view, Theoretical knowledge, Instrumental learning, Accessibility, and Evaluation were also emphasised for Mathematical values and Mathematics Educational values respectively. How these values are conveyed were also presented. Teachers interviewed on the other hand were seen to have limited knowledge of values in mathematics as a discipline and in its pedagogies. Based on the findings, it is recommended that more research in Ghana should be centered on values in mathematics education. Workshops should be provided to mathematics educators to give them insight on values in mathematics.

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DEDICATION

This work is dedicated to my parents Mr. and Mrs. Essien.

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INTRODUCTION

Poor performance of students' in mathematics has always been topical globally. Researchers have continually highlighted contributing factors and other interventional packages to curb this canker, but the problem persist. This is perhaps due to the fact that much attention has not been paid to the role of values in mathematics education (Seah, 2019) and especially with emphasis on values conveyed in mathematics textbooks (Dede, 2006a; Dede 2006b; Seah & Bishop, 2000). Literature from different countries have established similarities and differences with regards to values emphasised in their mathematics textbooks (Dede 2006a; Dede, 2006b; Dollah &Widjaja, 2018; Seah & Bishop, 2000). No research has however been sighted on values conveyed in mathematics textbooks as well as teachers awareness of those values in the Ghanaian setting. This study therefore explored values implicit in best-selling Ghanaian SHS 1 Core Mathematics textbooks as well as mathematics teachers awareness of those values implicit in Mathematics as a discipline and in its pedagogies through various subheadings such as Background to the study, Statement of the Problem, purpose of the study, Research questions, Significance of the study, Limitation, Delimitation, and Organisation of the study.

Background to the Study

The world is fast becoming a convenient place to live due to the role Mathematics continues to play in technological advancement and in everyday life. Mathematics affects almost every facet of life, including Finance, Healthcare and general Socio-economic development (Ernest, 2015).

According to McCarron and Burstein (2017), mathematics provides a great foundation for the introduction of Financial Accounting to students and other mathematics related fields. Gupta (2016) corroborated this assertion by emphasising that the application of mathematics is much broader than what is known and may include areas of economics, education, technology healthcare and other sectors of our economy which is presumed to be the reason why countries like Ghana, Kenya among others have made the study of Mathematics compulsory in Senior High Schools (Curriculum Research and Development Division [CRDD], 2010; Yara & Otieno, 2010).

However, global concerns have been raised on students' phobia for and in effect poor performance in mathematics (Carnoy & Rothstein, 2013; Bethell, 2016; Mullis et al., 2012). According to Carnoy and Rothstein (2013), students in the United States of America have continuously performed poorly in mathematics, especially in international competitions as captured in Trends in International Mathematics and Science Study (TIMSS) 2011 report. This is not any different in sub-Saharan Africa as World Bank report on Mathematics and Science Education shows abysmal performance of students which is feared to impact negatively on the economic Progress of the region (Bethell, 2016).

The West African Senior Secondary Certificate Examinations (WASSCE) statistics shows that the performance of Ghanaian Senior High school leavers in core mathematics examination has basically been abysmal even though performance in 2019 and 2020 have shown some improvement (WAEC, 2016-2020). This is outlined in Table 1.

Table 1: WASSCE Statistics for Core Mathematics from 2016 - 2020

Year	WASSCE Performance (pass rate)
2016	32.83%
2017	42.73%
2018	38.33%
2019	65.31%
2020	65.71%

Source: (WAEC, 2016-2020)

The statistics from Table 1 above implies that on average, most of the students who wrote Mathematics for the past 5years will not be able to access tertiary education premised on the fact that it is a requirement for every student to get at least C6 before they are considered for admission into tertiary institutions. In international examinations, the TIMMS 2011 reports also revealed that Ghana's performance was the poorest as compared to other eight graders from participating countries (Mullis et al., 2012). Even though the focus of this work is on Senior High Schools, the report shows how widespread the canker is.

Several factors have been attributed to the global abysmal performance of students in Mathematics. While some are attributing the problem to methodology, others attribute it to inadequate teaching materials, perception of teachers and students, teacher competence among other personal, social and cultural related factors (Davis, Bishop & Tiong Seah 2010; Ganyaupfu, 2013; Ali & Jameel, 2016; Mbugua, Reche, & Riungu, 2012; Muema et al., 2018).

Plethora of researchers have therefore advanced research into diverse areas in Mathematics education. Some researchers are promulgating the use of technology in teaching Mathematics (Delyana et al., 2018; Zambak &

Tyminski, 2017), others concentrate on the use of culturally relevant Mathematics approaches (Davis, Bishop & Tiong Seah 2010; D'Ambrósio & Knijnik, 2020; Hartinah et al., 2019; Naresh, 2015), cognitive domain(Mavilidi et al., 2020; Dori, Mevarech & Baker, 2018; Presmeg, 2020) among others who have channeled their effort into other areas of Mathematics developments all in the quest to improve students' performances and interest in Mathematics.

However, a few of these researchers have actually focused on the affective domain. Even though Grootenboer and Marshman (2016), Davis et al. (2010) , Seah, Anderson and Clarkson (2016) and some other researchers in the affective domain have trumpeted the need to delve deep into the affective domain, their effort is still like a single voice in a cacophony of voices which is difficult to hear. Research has shown that students' beliefs, attitudes, emotions and other affective components have correlation with their academic performances (Grootenboer and Masherman, 2016). Seah et al. (2016) supported this by stating that value, as an affective construct for example, is used to determine what importance is placed on components of mathematics as a discipline and its pedagogies. They therefore placed the students' apathy on the study of mathematics at the doorsteps of pedagogy deployed in teaching mathematics and the inappropriate nature of values which are promoted implicitely.

Juxtaposing the importance of mathematics valuing in mathematics education with the attention given to it in and out of the mathematics classroom leaves much to be desired.

But whether teachers can improve their content knowledge and deploy appropriate pedagogy, whether students like or dislike Mathematics among other peripheral factors mostly depend on the textbooks available for use (Oates, 2014).

Teachers and students use a lot of teaching and learning materials in the instructional process. One of the key materials is textbooks which are used by both teachers and students. Seah and Bishop (2000) therefore described textbooks as 'invisible teachers' because they are the teachers of teachers and students. This is supported by Oates (2014) who further opine that textbooks give teachers some respite to refine their pedagogies. Implicit in these textbooks are mathematics values which are supposed to convey the aspirations of the nation through the syllabus. For example, the second general objective of the Ghanaian Core Mathematics syllabus states that by the end of the instructional period, students should be able to, "Recall, apply and interpret Mathematical knowledge in the context of everyday situations"(p. iii). This presupposes that the syllabus proposes Relational understanding and Relevance value as contained in mathematics educational values, and control value as contained in mathematical values by Bishop (1988). How are these values imbibed in students? It is definitely from teachers to students as many will suggest but textbooks are the weapons teachers use. It is therefore a course of concern that enough research has not gone into the kinds of values conveyed in mathematics textbooks.

Research by Taqiah and Bahari (2018) further suggest that teachers have no or little awareness of values implicit in mathematics as a discipline

and also in its pedagogy even though Seah (2012) opines that the extent to which a teacher is seen to be effective depends on his value awareness

It has therefore become important to consider which values are emphasized in the Ghanaian Core Mathematics Textbooks and how these values are emphasised in Ghanaian Core Mathematics textbook. The extent to which teachers are aware of those values also need to be explored.

Statement of the Problem

Ghana's performance in international examinations has not proven to be any better in the past years. This is evident as Ghana's participation in Trends in International Mathematics and Science study (TIMSS) in 2003, 2007, 2011 and 2015 has persistently produced abysmal results (Davis et al., 2019). According to Mullis et al. (2012), performance of eight graders from Ghana was the poorest as compared to the performance of eight graders from other participating countries like Korea, Singapore and China who took the first three spots as best participating countries in Mathematics. This trend of poor performance is not only limited to the Mathematics performance of Ghanaian students in international examinations but also in internal examinations. Even though the focus of this discussion is not on eight graders, the abysmal performance of students in TIMSS reflect what is the case in the Senior High Schools as evident in Table 1.

The introduction of the Secondary Education Improvement Project (SEIP) in 2014 (World Bank, 2018) which is expected to expire in November, 2021 as well as other government intervention programmes were aimed at impacting greatly on students' achievements in mathematics. However, (WAEC, 2016 - 2018) reports shows little impact of these interventions.

Researchers have tried to find the possible causes of what has become a national canker. Studies have cited students' phobia for mathematics among other factors relating to the nature of Mathematics, pedagogy, and classroom environments to be the contributing factors to their poor performance (Asan 2019 ; Daher & Abu Thabet , 2020; Nwoke et al., 2016; Sa'ad, Adamu & Sadiq, 2014). However, issues about Values are barely thought of (Bishop, 1991; Dede, 2006a: Dede 2006b; Seah & Bishop, 2000).

According to Bishop (1991), Valuing is one of the most important areas in Mathematics education which needs attention. Bishop (1988) is of the view that, "We must try to come to grips with the values of Mathematics if we are to understand them sufficiently to enculturate our children properly" (p.61). Even though it has been a general assertion that Mathematics is value free, research has refuted this claim (Albanese & Perales, 2015; Bishop, 1991; Davis et al., 2010). To Clarkson, teaching of values has been implied since the interpretation of a particular value may differ even in terms of viewpoints from different people. However, explicit teaching of values rather than its implicit nature will create a Mathematics for all classroom environments which in effect will promote classroom teaching and learning (Bishop, 1988).

Recent studies have therefore given considerable attention to the role of valuing in Mathematics education even though they are comparatively lower when compared to the cognitive domain (Bahari & Maat, 2018; Corey & Ninomiya, 2019; Davis, Carr & Ampadu, 2019; Dede, 2006a; Dollah et al, 2019; Nakawa, 2019; Seah, Davis & Carr, 2019). This attention has however focused mostly on what students, teachers, cultures, and societies put premium on (Bahari & Maat, 2018; Corey & Ninomiya, 2019; Davis Carr & Ampadu,

2019; Nakawa, 2019; Seah, Davis & Carr, 2019) at the expense of the values conveyed in various Mathematics textbooks. It is perhaps worth considering that we pay much attention to the role of values in Mathematics education (Dede, 2006a; Dede ,2006b; Seah & Bishop, 2000: Seah, 2019) especially on values conveyed in mathematics textbooks.

According to Asan (2019), some textbooks are just produced by certain writers with the aim of amassing wealth without being conscious of the contents of those books. Furthermore, Tshabalala and Ncube (2013) as cited in Sa' ad et al. (2014) opine that poor quality textbooks are the major cause of phobia of students and its associate impact on student's poor performance in Mathematics. It implies that poor quality textbooks have corresponding impact on students' performance. This assertion is corroborated by Daher and Thabit (2020) who explains further that writers of textbooks are not only conveying Mathematics contents but are mentors in transmitting several other ideas about the discipline which includes values. Textbooks are invisible teachers in which a lot of values are contained and transmitted (Daher & Thabit, 2020). This means textbooks are not only for students but also for teachers.

However, not enough research has gone into values conveyed in mathematics textbooks (Dede, 2006a; Dede, 2006b; Seah & Bishop, 2000). According to Barkatsas and Seah (2015), values can influence students learning preferences as well as preferred teaching pedagogies in the classroom setting which they argue that it is mostly defined by the culture of the students. Kalogeropoulos and Clarkson (2019) suggest the role of textbooks to include alignment of the values of teachers, students and the educational curriculum.

The Ghanaian jurisdiction has seen no research on values conveyed in Mathematics textbooks. With the influx of foreigners on our shores coupled with the Free Senior High School and computerised placement system placing students in different schools in different communities of different cultural and societal inclination, the Mathematics classroom becomes a basket of different cultures. Every culture has its own special way of doing mathematics, which makes textbooks critical tool in bridging cultural gaps as well as the gaps between Mathematics in the school and Mathematics in the real world. This is supported by Mullis and Martin (2017) who on TIMSS assessment framework emphasised that the curriculum of a school, whether formulated at the national level, community, or school level, defines and communicates the expectations of the country. They further stated that,

> In mathematics, countries differ in the degree of emphasis they place on acquiring basic skills, memorizing rules, procedures, facts, understanding mathematical concepts, applying Mathematics to "real life" situations, communication or reasoning Mathematically, and problem solving in everyday situation (p. 61).

Statements from Mullis and Martin (2017) affirm various convictions held by various Ethnomathematics scholars that mathematics is culturally and socially constructed.

Seah and Wong (2012) posit that the extent to which a teacher is seen to be effective depends on his value awareness. Bishop, Seah and Chin (2003) who on a report on Values in Mathematics Teaching (VIMT) established that the more teachers are aware of their own value position further support this, the more flexible they will be able to practice in the Mathematics classroom.

However, findings from a study by Taqiah and Bahari (2018) suggest that Mathematics teachers have little or no awareness on values conveyed in mathematics as a discipline and in its pedagogy. This implies that teachers may be conveying the wrong values to students. This becomes important especially in the Ghanaian jurisdiction as no research has been cited on teacher's awareness of values implicit in Mathematics as a discipline and in its pedagogy.

It is against this backdrop that this study was conducted to explore how the various Mathematical values as well as Mathematics educational values theorised by Bishop (1996) as cited in Bishop (1999) are conveyed in Ghanaian Core Mathematics textbooks for Senior High schools. It further explored Mathematics teachers' awareness of the values conveyed in Mathematics as a discipline and in its pedagogies.

Purpose of the Study

This study seek to explore which Mathematical values as well as Mathematics Educational Values are conveyed in Ghanaian Senior High School Mathematics textbooks. How the Mathematical values as well as Mathematics educational values theorized by Bishop (1996) as cited in Bishop (1999) identified are conveyed in best-selling Ghanaian SHS 1 Core Mathematics textbooks approved by Ghana Education Service (GES) and National Council for Curriculum and Assessment (NaCCA) is also considered. The awareness of teachers on the values implicit in Mathematics was also considered in this study. The Objective was achieved by analysing which values are conveyed in Ghanaian Mathematics textbooks and how these values are conveyed in those textbooks. The purpose of the study was also achieved

by making analysis on the contents of the responses provided by Core Mathematics Teachers who served as respondents to the interview.

Research Questions

The following questions guided the study.

1. Which Mathematical values are emphasised in the Senior High School one (SHS 1) Core Mathematics textbooks?
2. How Mathematical values are conveyed in the Ghanaian SHS 1 Core Mathematics textbooks?
3. Which Mathematics educational values are emphasised in the Ghanaian SHS 1 Core Mathematics textbooks?
4. How do the Ghanaian SHS 1 Core Mathematics textbooks portray Mathematics Educational values?
5. To what extent are Mathematics teachers aware of values implicit in mathematics?

Significance of the Study

Just as encapsulated by Daher and Thabet (2020), this study is believed to help policy makers and various stakeholders in education know the awareness levels of teachers on values implicit in mathematics as a discipline ad in its pedagogy which may provide basis for organising various workshops to expose teachers to mathematics valuing and it position in mathematics teaching and learning. That is, this study brings to bear the various values implicit in mathematics as a discipline and in its pedagogy and its relevance in mathematical concepts formation.

In addition to the above, this study is hoped to help textbook writers to know the important role they play in the development of Mathematics in

Ghana. It may help them develop peculiar ways of choosing their content and pedagogy to reflect our Ghanaian ways of mathematising. That is, it will help publishers understand the multicultural complexities in the mathematics classroom and how textbook contents can either help students develop interest or phobia for mathematics.

Moreover, exploring values implicit in textbooks will serve as a wakeup call on curriculum developers and regulatory bodies who approve various books for use in Ghanaian Senior High schools. Shield (1998) as cited in Seah and Bishop (2000) revealed in his research that some of the Australian Mathematics textbooks did not express the intent of their national syllabus which calls for urgent consideration of Ghanaian local textbooks since no study has been done in this area.

This study is believed to help the Ministry of Education make conscious effort in making Ghanaian core mathematics textbooks convey right set of values and intent in enculturating Ghanaian students.

Finally, this study will add to existing literature on valuing especially concerning values, which are conveyed in mathematics textbooks.

Limitation

Although the aim of this study has been achieved in the large extent the study still had some shortcomings.

A major limitation of this study is that the four SHS 1 Core Mathematics teachers sampled and interviewed for this study may not be a fair representation of the total number of Ghanaian SHS 1 Core Mathematics teachers. Finding from their responses to the interview may therefore be limited to only the four teachers sampled.

Delimitations

This study limited itself to only the four best-selling Ghanaian SHS 1 Core Mathematics textbooks and four Ghanaian SHS 1 Core Mathematics teachers who held bachelor's degrees in mathematics education. The four best-selling Ghanaian SHS 1 Core Mathematics textbooks used were all approved by the National Council for Curriculum and Assessment (NaCCA).The four SHS1 Core Mathematics teachers were sampled from only two senior high schools in the Asunafo North Municipality.

Findings from the interview were therefore limited to the selected Core Mathematics teachers since they were not significant enough to be a fair representation of the views of all Mathematics teachers taking into consideration the number of Core Mathematics teachers used for the study.

Organisation of the Study

This study was organized in five chapters. Chapter one dealt with the background to the study, statements of the problem, research questions, significance of the study, limitations of the study, delimitations of the study and organization of the study.

Chapter Two was concerned with review of related literature which is put under the following headings.

1. Theoretical Review: This discussed values in Mathematics such as Mathematics educational values, Mathematical values, general educational values. It also had other sub-headings as, Values in Mathematics education, values and their relationship with other affective construct, and Value awareness in Mathematics education

2. Conceptual Review: It also talked about the various concepts under valuing with emphases on Mathematical values and Mathematics educational values conveyed in Core Mathematics textbooks.
3. Empirical Reviews: This session reviewed empirical literatures relating to values in mathematics.
4. Summary of reviews: A recap of what has been discussed under literature review has been considered under this session

Chapter Three also focused on research design, population for the study, Sampling Techniques, Data Collection Instruments, Validity and Reliability, Pre-Testing of the Instruments, Data collection Procedure, and Data Processing and Analysis.

Chapter Four dealt with data analysis, interpretation and discussions based on the data from the books used and interview responses while Chapter Five made summary of the key findings, conclusion and made recommendations for future studies.

CHAPTER TWO

LITERATURE REVIEW

The chapter provides review of related literature for the study. Literature has been reviewed under the following themes: Theoretical framework, Conceptual framework, and Empirical review. Chapter summary is also given at the end of the review.

Theoretical Review

Although cognitive and affective aims are all important in acquiring knowledge in Mathematics, most syllabus emphasise cognitive aims at the expense of the affective domain. This might be due to the fact that cognitive aims are easy to measure as compare to affective aims or/and affective aims are catalyst to achieve cognitive aims (Seah & Bishop 2000). But there are things that we believe in, that shape the way we think and they help us take certain decisions in life which according to Penelope and Clarkson (2019) indicate our values which is paramount in everything we do. According to Bishop (1988), value are the greatest weapon in enculturating children. It is undoubtedly clear that what students' value is what they pay attention to and ultimately learn. Therefore, the role of values in Mathematics is pivotal in their education.

Values as an affective construct have had several definitions which according to Corey and Ninomiya (2019) are mostly influenced by considerations such as how values differ from other affective constructs such as beliefs, attitudes , emotions among others. Values also differ in terms of personal, societal and (or) cultural levels.

Seah and Anderson (2015) in an attempt to define values stated that:

> Values are the convictions which an individual has internalized as being the things of importance and worth. What an individual values defines for her/him a window through which she/he views the world around her/him. Valuing provides the individual with the will and determination to maintain any course of action chosen in the learning and teaching of Mathematics. They regulate the ways in which a learner's/teacher's cognitive skills and emotional dispositions are aligned to learning/teaching in any given educational context (p.169).

Seah (2016) also defined values as "an individual's embrace of convictions which are considered to be of importance and worth. It provides the individual with the will and grit to maintain any 'I want to' mindset in the learning and teaching of Mathematics" (p. 575)

Dede (2006a) considered values as any behaviour or idea that one places much premium on as a personal choice which is basically influenced by societal orientation.

From the above definitions, it could be deduced that values are individual choices which are held to be of great importance and are internalized after taking into consideration several alternatives. These choices made are based on the importance placed on the alternative which may be guided by what society places premium on since we are a product of our environment and are influenced by societal inclinations. Corey and Ninomiya (2019) therefore argues that values can be grouped under two main headings; the individual/community holding the values and the particular phenomena that is being valued. That is to say that values are defined by individual

preferences as well as cultural orientations. All the above definitions were not defined by a particular discipline and reflect a general definition among which values unique to other subjects could be derived.

This study however was guided by a framework with the following categorisations.

1. Values in Mathematics
2. Values and their relationship with other affective constructs.
3. Value awareness and mathematics education

Values in Mathematics

Dede (2006a) grouped values in Mathematics under two broad categories as Aesthetic values and Ethical values. Aesthetic values according to him, are the beauty aspects of Mathematics while ethical values talk about how good or bad a behaviour is in relation to mathematics. Dede argued that, ethical values form a major role in education because they govern the moral aspects of teaching which is defined by how good or bad a behaviour is accepted by the community. Ernest (2016) however argues that Mathematics in itself is ethics free and it is only on its application to human life does ethics find its way into Mathematics. He opined that the idea that ethics plays central role in Mathematics is controversial considering the claim that Mathematics is pure as well as context and value free. According to Sam and Ernest (1997), values in Mathematics could be grouped into three main categories as;

(1) Epistemological values: epistemology is defined by Ernest (2016) as "the philosophical study of knowledge, knowing and the conditions for their legitimacy" (p.66). Sam and Ernest (1997) explain these values to be associated with how acquisition of knowledge, assessment of knowledge

as well as characteristics of Mathematics knowledge. Harré and Krausz (1996) as cited in Ernest (2016) identified universalism, absolutism and Objectism as key dimensions of epistemological values. To them, universalism dimension implies that Mathematics statements are true and hold in all context, to all persons and at all times. Objectism implies that there are aspects of Mathematical statements which are independent of personal beliefs and perspectives of an individual or society. Rationalism also implies that the concept of logic must be valued above any other thing in Mathematics and it includes logical proofs, analysis, arguments as well as critiques. Sam and Ernest (1997) therefore, opined that epistemological value includes Rationalism, systematism, accuracy and others which they espouse to be theoretical aspect of Mathematics. A critical view of Epistemological values from the standpoint of various researchers may be dealing with, more or less, cognitive, procedural and absolutist aspect of Mathematics which emphasises the power of reason, accuracy and procedural systematism.

(2) Social and cultural values: Every individual is a social object and hence is influenced by and may also influence the environment he/she finds himself /herself as opined by social cognitivist like Albert Bandura. These values portray the interaction between the individual, his environment and his behaviour. These values emphasise cooperation, justice and the beauty of Mathematics. Dede (2006a) suggests that these values reflect much of the affective component of Mathematics valuing and cited examples to include gratitude, integrity, and moderation.

(3) Personal values: According to Sam and Ernest (1997), personal values relate to values associated with an individual which affect him/her as a learner and as a person and include values such as patience, creativity and confidence. Dede (2006a) suggests personal values to include curiosity, thriftiness, and trust.

The heart of this research is however based on the classification of Bishop (1996) as cited in Bishop et, al. (1999) who classified values in mathematics into three categories as General Educational values, mathematical values and mathematics educational values.

General Educational Values

These are the values which help in controlling behaviour and activities of the school, cultural groups or the general societal wellbeing. According to Dede (2006a), they basically contain ethical values such as integrity, modesty and kindness. Dollah et al. (2019) described general educational values as values relating to norms governing a particular educational institution or, and a particular society. When students are admonished for cheating, the value of honesty and good behaviour are imbibed in students which are in line with societal norms which are also derived from General Educational Values (Seah & Bishop, 2000). So, moral and civic virtues are emphasised by General Educational Values (Seah et al., 2017). Seah (2016) refers to General Educational Values as values through Mathematical education. He opines that these values govern the framework of education and are mostly taught through other subjects.

Mathematical values

Mathematics as a discipline has its own unique values which distinguishes it from other disciplines. These values, which are unique to mathematics, are what Bishop (1988) refers to as Mathematical Values.

Seah (2016) viewed Mathematical values as values of mathematics education. To him, Mathematical values reflect what Mathematics as a discipline puts premium on. Dede (2006a) corroborated this by explaining further that Mathematical values reflect the nature of mathematical knowledge. Bishop (1988) opined that Mathematical Values are values espoused by western Mathematics and by that assertion he implied that Mathematics is a cultural construct. Bishop therefore listed six main Mathematical values taught under Western cultures, which he put under three main complementary pair of categories as.

a) Rationalism – Objectism: Rationalism operates on the principles of logic, connectedness, completeness, and cohesion (Bishop, 1988; Dede, 2006a). From the viewpoint of Bishop, Rationalism is the lifeblood of mathematics, which operates mainly on the principle of deductive logical reasoning. In direct contrast to deductive reasoning is Inductive reasoning which believes in intuitive and discovery learning. Mathematical arguments are made not based on diverse positions but judged from the connectedness, completeness, and logic in the argument (Bishop, 1991). That is to say that Rationalism value operates on the principle of reason and explanations behind a particular concept or phenomena which is determined through the logic the reason or explanation it makes. Bishop further emphasised that there

are aesthetic components of Rationalism that thrive on the beauty of wholeness, completeness, cohesion and clarity of arguments and reason of phenomena explained. Rationalism, therefore, is about explaining, abstracting and a particular way of theorizing without which Mathematical language and symbols will be difficult to appreciate and understood (Bishop, 1988).

Bishop explained further that objectivizing abstractions helps in handling Mathematics easily and with precision. He further stated that the use of logical connections, examples and counter examples, proofs and generalizations help to appreciate Mathematics as if it was an object. Objectism value therefore operates on the principle that, not only do ideas emanate from our interaction with our environment, but also with objects which provide basis for abstraction. That is why Bishop (1988) states that, "Rationalism emphasises the logic of reasoning but Objectism gave the intuitive basis for the search for the 'atom' of arguments." (p. 68). Powell and Frankenstein (1997) supported this idea that some concepts and theories are dependent on material reality. In effect, Objectism emphasises the need for symbolic representations, concretization as well as objectivization of abstract concepts or ideas. These two values were termed as ideological values by Alan Bishop.

In summary, complex and abstract Mathematical concepts like infinity are objectivized using symbols '+∞' and '-∞' to give the abstract concepts and object look. These abstract concepts which are objectivized are understood through explanations, logic, reason, cohesion and completeness. So, while Objectism portrays the power of Mathematics to objectize abstract concepts,

Rationalism emphasises the power of logic, reason, and comprehension in what the symbols communicate.

b) Control – Progress: Control as a value of Mathematical knowledge helps one to have a feeling of mastery over his/her environment. Bishop (1988) opines that the value of control helps one to make appropriate predictions on various occurrences in the society due to mastery of the environments through the use of Mathematical knowledge. He explained that the values of control imply knowing the various dynamics of ideas and events and willingness to take charge in dealing with societal events and occurrences which provide a sense of security.

Value of control helps one to apply Mathematical algorithms to societal situations which looks gloomy and makes it easier to solve. This makes one have the feeling that other societal problems are solvable. It does not only imply applying problem solving approaches to develop and or apply algorithms but also applying Mathematical ideas particularly to the external world (Bishop, 1991). He further emphasised that the value of control can be made visible using Mathematical ideas in technological advancement in societal activities. In simple terms, the value of control is centered on three main areas; the use of Mathematical rules, the ability to make predictions with algorithms and ability to apply ideas to situations in the environment (Bishop, Clarkson, FitzSimons, & Seah, 2000) which makes one have mastery of his environment.

The value of Progress emphasises opening the schema of Mathematics to accommodate new ideas. Progress values is also premised on the concept of alternativism, which means accepting, and valuing equally important alternatives in addressing a particular phenomenon. That is to say welcoming alternative convictions and perspectives in solving new problems is a key characteristic of the value of Progress in Mathematics and so encourages inquiries and discoveries. This supports the underlying philosophy of Progress that, "The unknown can become known" (Bishop, 1998, p.72). These two values of control and Progress where termed as sentimental values by Bishop since they have to do with feelings and attitudes.

c) Openness – Mystery: Openness as a value of Mathematics is about the formalization of Mathematical knowledge by dehumanizing it so that it could be open to criticism by anybody anywhere. Values of Openness Highlight Mathematics truth as facts and not opinionated and therefore could be verified and scrutinised. It seeks to objectivize it by giving it a formal look so that one can prove or criticize its components by simply following right procedures and obeying simple logic behind the theorem or fact. The value of Openness creates room for questioning, doubting, experimenting, and eventually proving Mathematical truth and ideas as well as its principles. On the other hand, the value of Mystery reflects the often-shady nature of Mathematics. Thus, even though Mathematics conveys the value of Openness, there is yet a blare component which many people try hard to unravel. That is why Bertrand Russell (nd) as cited in Bishop (1988) stated that, "Mathematics is the subject in which we never know what

we are talking about, nor whether what we are saying is true"(p.78). It conveys the abstract, mysterious and exclusive nature of Mathematics and certain surprises associated with Mathematics such as dividing the circumference of any circular objects by its diameter gives ' π' which is almost the same (3.142). So, on the Progress - Mystery continuum, Mathematics may be mysterious until clues are given to students to have insight and hence see Mathematics to be open and easy to understand. For example, students may see using algebra tiles in teaching quadratic functions mysterious until linkages are made with deans block which makes students see the concepts as easy to understand. These values highlighted, therefore, reiterate the facts that Mathematics is never value free and hence has cultural components.

The value of Rationalism emphasises that an argument is valid based on reason, logic and explanation associated with it. Rationalism is therefore transferred to people using explanation (Bishop, 1988). Abstract ideas may be objectivized based on the cultural inclination of students so that students can have better abstraction of concepts and apply them in their cultural setting. Bishop (1988) explains further that various civilizations (countries) have different approaches in mathematizing and hence there is no and should not be any cast in stone approach in counting, numbering, showing location and making descriptions among others which are not universal since culture varies from one society to another. But in explaining concepts, objects and symbols are the intuitive and imaginative bases for abstractions. These two values together lie on the Rationalism-Objectism continuum.

One may gain control over their environment through the development of mastery over their environment so that they could make predictions on various occurrences in the environment. Thus, making predictions on what will happen as well as what will not happen. To my best of knowledge, the use of technology by a meteorologist to make various forecast of the whether portrays the use of control values. This may also manifest in the classroom setting through the use of algorithms, rules and facts to solve societal problems. The society is always bedeviled with new challenges and problems which require creativity and innovation. This challenges the security and control of one's environment and hence requires inquiry and the use of new perspective and sometimes modifications of existing approaches to meet current demands. In the classroom setting, students' schema is mostly reorganised to accommodate new body of knowledge which may be in contravention of what already exist. Example, students who were used to the nine planets must reorient themselves to appreciate the fact that the planets are eight on the announcement of Pluto as a dwarf planet. In the classroom setting, students in upper primary school will have to cope with a new and abstract way of counting which may be different from what they did in Kindergarten where stones and other concrete materials were used.

Openness Value of Mathematics suggests that Mathematics is not opinionated and could be verified by anybody. Example, the approximated value of π could be verified by dividing the circumference of the circular objects by its diameter. This is expressed through its dehumanized nature and formalization of concepts which bring some sense of democracy in Mathematics. Even though Mathematics exhibits the value of Openness, there

are still some levels of Mystery behind Mathematics. we continually unravel new ideas about Mathematics which mostly come as a shock. It is worthy to note that what one person may know to be an open value may be Mystery to another person.

Mathematics Educational Values

Mathematical educational values talk about values which are conveyed implicitly in the Mathematics classroom. Western Mathematics is taught in different countries and so, we mostly think that the same Mathematical values will be transmitted (Seah & Bishop, 2000). We become naïve of the fact that each country has its own unique cultural orientation coupled with the fact that different classroom settings, individuals and pedagogical factors may influence values conveyed (Dede, 2006a; Seah & Bishop, 2000; Seah, Baba & Zang, 2017; Seah, 2016).

Seah et al. (2017) therefore, refers to Mathematics educational values as the values that relate to pedagogical practices of school Mathematics and may include efforts, ability, the use of information communication technology among others. These factors may influence what is desirable to be considered as in the context of Mathematics education. Seah (2016) further added that Mathematical educational values are manifested when instructions are tailored to encompass what is valued by teachers, students, the society and the school cultural setting to facilitate better comprehension with its associate impact on students' performance. He therefore referred to Mathematics educational values as Mathematics for learning.

There exists a large range of Mathematics educational values conveyed in Mathematics classroom. However, this study focuses on five

complementary values which are arguably transmitted in Mathematics classroom today as suggested by Dede (2006a) and Seah and Bishop (2000). The first two depicts the pedagogical aspects of Mathematics education while the remaining three form the cultural components of Mathematics education. These complementary values are.

I. Formalistic – Activist view; Formalistic views Mathematics as " meaningless formal game played with marks on paper, following rules"(Ernest, 1991, p.10). According to him, Formalistic view can be encapsulated under two main claims.

   a) Pure Mathematics can be expressed as uninterpreted formal systems, in which the truths of Mathematics are represented by formal theorems.

   b) The safety of these formal systems can be demonstrated in terms of their freedom from inconsistency, by means of meta-Mathematics.

According to Dede (2006a), Formalistic views show receptive and deductive learning of values in Mathematics while the Activist view is based on intuition and on inductive reasoning which implies discovery learning. Ernest's (1991) assertion on intuitionism is that "Classical mathematics is neither necessary nor unique for an alternative is not only possible but exist" (p. 63).

In summary, on the Formalistic and Activist continuum, Dormolen (1986) posits that those who hold the Formalistic view believe that the proper way of Mathematics reasoning is deductive reasoning. They believe inductive reasoning or intuitive reasoning is not part of genuine mathematics activities

but are preliminary activities to motivate students towards deductive reasoning. This is in contrast with the Activist view which according to Dormolen (1986), believes that inductive reasoning motivates students to inquire, discover and generalize when necessary which is believed to promote creativity.

The viewpoint of the teacher however affects the way they teach. According to Dormolen (1986), teachers who hold the Formalistic view guide students towards acquisition of rules, procedures, theorem, proofs, exercises, and other programmed instructions. On the other hand, teachers who hold the Activist view create an environment for students to identify patterns, rules and structure which may help them in classifying, ordering, generalizing, formalising and exploring, provided the activities are mathematical in nature.

II. Instrumental understanding/learning-

III. Relational understanding/ Learning; Skemp (1976) believes that two kinds of understanding occur in the Mathematics classroom which he classified as Relational and Instrumental understanding. Skemp argued that it is undoubtedly true that he did not see the latter as a form of understanding but arguably, Instrumental understanding helps students to solve some questions which are like the context in which the rules were applied. Even though its application in other contexts may become problematic because they lack understanding of the rules and its application, Instrumental understanding is also a form of understanding. In Instrumental understanding, rules are swallowed hook, line and sinker without any questioning which becomes difficult to apply them in different context. Skemp therefore described

Instrumental learning as "rules without reason" (p.2). It emphasises mastery of rules, formulas, facts, and skills and applying them in solving special questions (Dede, 2006a; Grootenboer & Marshman, 2016). In direct contrast to Instrumental understanding/learning is Relational understanding/ learning which emphasises the power of reason. Relational understanding emphasises application of concepts to the real world and knowing the reasons behind the concepts taught and using systematic procedures. According to Dede (2006a), Relational understanding stresses on displaying the relationship among various concepts and forming appropriate graphics. Skemp (1976) opines that even though Relational learning really takes much time as compared to Instrumental learning, but the concepts once learnt is more everlasting.

Skemp (1976) opines that, there is often a mismatch between a teacher's pedagogy and students preferred way of understanding which creates problems in students learning. He stated the possible mismatch to include.

1. When pupils' goals are to understand instrumentally but are taught by teachers who want them to understand relationally.
2. When the pupils' goal is to understand relationally but are taught by teachers who want them to understand instrumentally.

Skemp however see the problem in the first instance to persist in the short term but views the second instance to have debilitating effects on teaching and learning. He opines further that, preference of teachers concerning any of these approaches sometimes depend on several factors which includes overburdened syllabi, the examinational centered nature of our education and difficulty in assessing whether one understand Instrumentally or

Relationally. Ernest (1991) believes that in practice, students at the lower level of education tend to be taught instrumentally and are only taught relationally at the higher level with the intention that, students at the higher level could be more independent. This may imply that the maturation level of students is also a determining factor which among others influences the pedagogy of teachers.

III. Relevance – Theoretical knowledge; Relevance of Mathematical knowledge is assessed on how it is directed toward solving particular cultural problems whiles Theoretical Mathematics knowledge may not be associated with any familiar everyday context. (Seah & Bishop, 2000). The Relevance and Theoretical continuum associate itself with whether the Mathematics taught has any Relevance to daily life activities or the real world or is associated with activities which does not have any clear Relevance to human activities. Relevance values highlight the importance of concepts in solving societal problems. It establishes how concepts learnt are important in solving socio-cultural problems. The Theoretical value suggests Mathematical knowledge which may be foreign in nature and may not be relevant in our indigenous society since every culture has its unique Mathematics knowledge and way of mathematizing which propels their Progress (Dede 2006a).

IV. Accessibility-Specialism: The Accessibility and Specialism continuum associate itself with the level of cognition in participating in Mathematical activities. Accessibility deals with mathematical activities which according to Bishop (1988) is within the cognitive capacity of students. Specialism on the other hand is

about Mathematics activities which could only be done by students who belong to the elite group or gifted (Seah and Bishop, 2000). These values also highlight whether Mathematical activities are prepared by or engaged in by people who have or do not have talents in Mathematics (Dede, 2006a). Seah and Seah and Bishop (2000) opines that Accessibility value emphasises Mathematics for all while those on the Specialism value emphasises Mathematics for selected elite group of gifted mathematicians.

According to Bishop (1988), enculturation must be for all students and hence the curriculum content must not be beyond the intellectual capacities of students. Teachers who emphasise the Accessibility value use questions which are within the cognitive capacities of students. The inverse is also true for those who emphasise Specialism value.

V. Evaluation - Reasoning: According to Seah and Bishop (2006), Evaluation involves knowing and application of routine operations. To them, Evaluation involves knowing algorithms and operations to predict an unknown answer. Example could include an instance where students are able to solve a particular question because the operations involved are familiar to them or they might have used it before. Reasoning on the other hand emphasises the power of reason and communication in problem solving (Dede, 2006a). Reasoning involves questions that may involve other operations other than the once used in the classroom examples and may hence involve some level of thinking. Teachers who convey the Evaluation value will give exercises which may involve operations

similar to the ones taught in the classroom discussion. Exercises which may involve other operations other than that used for explaining the concepts may be given by teachers who convey the Reasoning value.

The above complementary values coveyed in the Mathematics classroom environments demonstrate that , indeed Mathematics is neither value free nor cultural free and hence teachers need to be concious of the values they conveyed through their pedagogical approaches.

Summary of Values in Mathematics

Seah (2016) grouped values in Mathematics education into three as; values through Mathematics education, values of Mathematics education and values for Mathematics education which reflect General Educational Values, Mathematical Values and Mathematics Educational Values by Bishop (1988) respectively.

Mathematical Values from the perspective of Bishop (1988) reflect the nature of Mathematical knowledge. They represent values, which are implicit in Mathematics as a discipline. These values are presented in complementary pairs with each value not been superior to the other per say but ensure complementarity. Rationalism and Objectivism even though may show some form of disparity, complement each other in ensuring that not only will Mathematics be based on reason but requires objects, images and symbols which may serve as a basis for abstraction. Making meaning from concepts and abstractions will make one have control of his environments. Control and security of our environment may be challenged as the world Progresses for which logic and alternative ways of addressing challenges is inevitable. The

purpose of Rationalism is therefore for Progress (Bishop, 1988). We are aware of various Mathematical principles and axioms; however, we always encounter new Mathematics realities which makes Mathematics looks like an opaque discipline which is difficult to know all.

Mathematics educational values on the other hand are related to pedagogy and practice in the mathematics classroom. While Formalistic view focuses on the need for deductive logic and reasoning and sees inductive approaches only as a means to deductive reasoning, the Activist view sees intuitiveness and the need for inquiries and discoveries which makes students creative thinkers. The Instrumental- Relational continuum also presents two pedagogical approaches where the former focuses on using algorithms to solve mathematical problems without necessarily considering the reasons behind it while the latter focuses on the power of reason and understanding of rules and procedures used. Whether the mathematics taught in the classroom has connection to real life or not reflect Relevance and Theoretical Knowledge respectively. Mathematical task may sometimes be above the cognitive the cognitive level of the students and could only be done by gifted students. This reflect Specialism value while Accessibility value deals with mathematical task which are within the cognitive level of students. The evaluation-Reasoning continuum also present instances where task assigned to students may involve the use of routine operations or without the use of without the use of routine operations but application of other creative approaches respectively.

General Educational values reflect ethical and moral considerations which governs human behavior under the auspices of the school and includes values as fairness, respect among others. These values touch on ethics in

societies including the educational setting, individual values which are influenced by cultural inclinations and societal norms as well as values which mathematics as a discipline puts premium on. Seah, Davis, and Carr (2017) for example believe that the extent to which students' value understanding value has a correlation with Relational understanding. This is supported by Seah, Anderson and Clarkson (2016) who believe that part of student's negative attitude towards Mathematics can be attributed to pedagogical lapses in tailoring lessons to meet the value needs of students. It is emphasised further that mathematization is a contextual concept which is defined by the cultural disposition of the people in the said culture. This presuppose that each culture has its distinct way of mathematising. The complementary values as outline by Bishop (1988) however reflects valuing in western educational setting.

Relationship and Differences between Values, Beliefs, Attitude and Emotions.

Students are more likely to produce affective response as cognitive response in their various interactions in the Mathematics classroom which among others may include expression of like or dislike for Mathematics lessons, difficulty or easiness of Mathematics task, and expression of Relevance of Mathematical task to real life (Grootenboer & Marshman, 2016). Even though Seah , Davis and Carr (2017) argue that the affective domain influences cognitive abilities, cognitive domain receives much attention in the Mathematics classroom as compared to the affective domain (Taqiah & Bahari, 2018). Values as an affective construct has not received much attention even within the affective domain as compared to attitudes, beliefs and perception.

This may be due to probably the difficulties in clearly distinguishing between the various components of the affective domain (Grootenboer & Marshman, 2016). Grootenboer and Marshman believes that, affective components such as attitude, values and beliefs are sometimes used interchangeably even though differences exist between these affective constructs. Distinguishing values from beliefs for example, is often vague (Bishop, 2003). It is therefore essential to try and establish the relationship as well as the differences that exist within the various components of the affective domain.

McLeod (1992) to distinguish between the affective constituent components stated that, beliefs, attitudes and emotions differ with respect to their stability to affective responses, the intensity of the affect they seek to describe the degree to which cognition plays role in their responses and reactions as well as the time they take to develop. McLeod opines that, beliefs have high cognitive involvement and mostly takes longer period to develop as compared to attitude and emotions. Attitude on the other hand may also involve more cognition than emotions, which is relatively affective in nature and hence involves little cognition. It therefore forms and vanishes within twinkle of an eye. He argues further that, beliefs, attitudes and emotions represent increasing level of affective involvement and decreasing level of cognition as well as increasing level of intensity of response and decreasing level of stability of response.

This is further corroborated by Groutenboer ad Marshman (2016) who likened components of the affective domain to a complex web of interrelated dimensions. They however tried to define another dimension 'value'

juxtaposing that with beliefs, attitude and emotions. In terms of their interrelatedness, values shares a lot of commonalities with beliefs and attitude as compared to emotions. This seeks to imply that, values is relatively cognitive and less affective .Even though values, beliefs and attitude are interrelated and basically overlapping constructs, values have both personal and social dimensions (Dede, 2006a).

The Blooms taxanomy also suggest that beliefs and attitudes are internalized into values (Krathwohl, Bloom, & Masia, 1964 as cited in Barkatsas & Seah, 2018). But this may not be true in it entirerity as Barkatsas and Seah(2018) argue that two people for example, may value a common object or ideas but may share different belief systems. Grootenboer and Marshman believes that these values may not have clear dinstinctions since they are overlapping constructs. Explanation from Grootenboers and Marshman on beliefs as emerging from personal experiences or being derieved from reasonable others and its comparison to attitudes which together forms the periphery of values implies that values may be both infuenced by personal,societal, cultural, and institutional orientations.

Value awareness and Mathematics Education

Every Mathematics activity involves values, beliefs as well as personal interest which is made visible especially through EthnoMathematics (Bishop, 2016). Dede (2011) corroborated this by further suggesting that, various societies have their unique way of carrying out Mathematics education which is influenced by a lot of factors including cultural inclinations, belief sytems and phillosophical positions. But why is it so important to be aware of

values in Mathematics?. Bishop (2016) provides the following answers to the question;

1. Values reflect the affective domain of mathematics which he believes even though has received some level of recognition has received little attention in terms of research.
2. They affects the quality of mathematics learning in schools.
3. Teaching mathematics without considering it values is 'nonsense' and is believed to be at the heart of lack of sustainablity of promising curriculum and teaching development since they fail to consider the often implied nature of values in mathematics.
4. It is essential in curriculum and new pedagogical practise development.

The response of Bishop (2016) is not any different from the position of members of Values in Mathematics Teaching (VIMT) as reported by Bishop, Seah and Chin (2003). VIMT was a project finaced by Taiwanese National Science Council aimed at investigation the Values held by mathematics teachers about mathematics as well as it associate pedagogies adopted among other reasons. Members of VIMT opines that, the more teachers are aware of their own value position, the more flexible they will be in their thinking about practices in the mathematics classroom.

A lot of mathematics teachers are however unawre of values implicit in mathematics (Taqiah & Bahari, 2018). Taqiah and Bahari (2018) reports that, even though many Mathemaics teachers may have the zeal to convey the needed values in the Mathematics classroom, a lot of them are ignorant of the values which are often implied in Mathematics as a discipline and its

pedagogies. But according to Seah and Wong (2012) , the extent to which a teacher is seen to be effective depends on his value awareness which may also include negotiating between what is co-valued by both the teacher and the/among students. By relating what is co-valued among students and Mathematics teachers to Alan Bishop's categorization of values in Mathematics education , students may able to engage in meaningful learning and as a results lead to increase in students academic achievements as in the case of some Asian countries. Bishop (2016) espoused further that, the problem of Mathematics awareness could be attributed to the fact that some people still hold the belief that Mathematics universalism presuposses that Mathematics is cultural free and value free. But Bishop gave clarity to this argument by explaining that the perception that Mathematics is cultural free and value free does not mean Mathematics has no values but many think that Mathematics values is not beyond what a particular culture emphasises in their education system. By that assertion, Bishop meant that most Mathematics teachers are ignorant of the fact that Mathematics as a discipline has its unique values as well as other values conveyed through pedagogies adopted by Mathematics teachers which may be beyond the Values emphasised by a particular culture in their educational system. Bishop, Seah and Chin (2003) argue further that, the activities of international competition and global comparisons like TIMMS could also contribute to the perception that vlues do not play much role in Mathematics education since the comparison fail to establish the fact that valuing system of a particular may be different. These activities is reported to fuel the long held belief that Mathematics do not neccesarily need to take human and social context in account in their

Mathematics teaching (Bishop , seah & Chin, 2003) since they believe Mathematics teaching is skill oriented (Bishop, 1988).

Values constitutes teachers identity and hence the Values of teachers affect what and how they teach as well as what and how their students learn (Bishop, Seah & Chin, 2003: Procter, 2015). It is therefore important for teachers to gain the needed awareness of values even though the focus of this study only included teachers awareness of vaues impicit in Mathematics as a discipline and its pedagogy.

Conceptual Review

Textbooks provides pivotal support in students learning. It affects students learning of Mathematics in diverse ways including usage of Mathematical task in them for practice, and also its influence on how they think (Barkatsas & Seah, 2018; Daher, 2021; Dede, 2006a; Gracin, 2018). Daher and Abu Thabet (2020) opine that, not only is textbooks useful for students but also Mathematics teacher's teacher since they provide teachers with diverse forms of Mathematical knowledge including content and pedagogical knowledge. Seah and Bishop (2000) rather refer to Mathematics textbooks as invisible teachers. It is therefore clear that talking about students' achievements and performance is not without considering the type of textbooks they use.

Mathematics was espoused to be value free and culture free until various researchers established otherwise that Mathematics is neither cultural free nor value free (Albanese & Perales, 2015; Bishop, 1991; Davis et al., 2010; Dede, 2006) and so are textbooks. Attention on values had not received attention until recently as compared to other constituent of the affective

domain (Pa & Tapsir, 2013) and hence not surprising content analysis of textbook values has received little attention globally and no attention at all when we consider the Ghanaian jurisdiction .

According to Daher (2020) values in Mathematics textbooks affects students learning and therefore there is the need to make sure that Mathematics textbooks contain the right content.

Different values are implicit in Mathematics textbooks and affects Mathematics teaching and learning. These values include General Educational Values, Mathematics Educational values, and Mathematical values. It may also contain other values such as societal values, epistemological values, institutional values and personal values systems (Dede, 2006a). This is presented in figure 1 below.

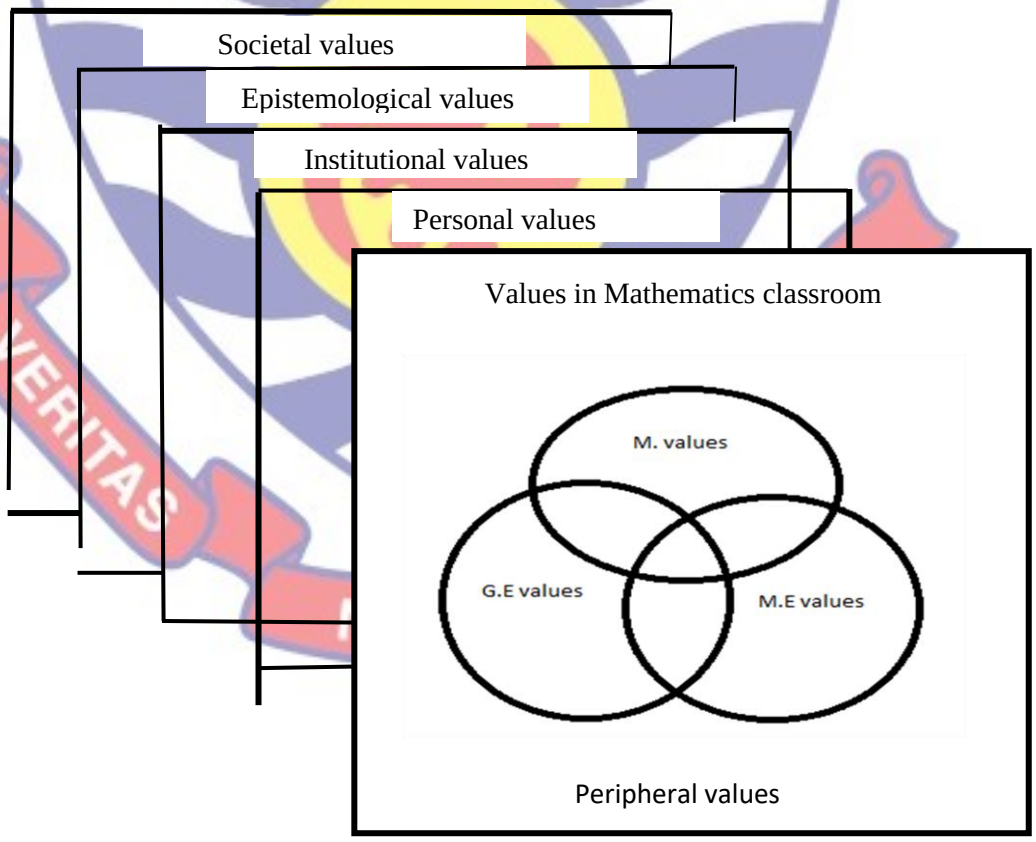

Figure 1: Relationship between values conveyed in Mathematics (adopted from Seah & Bishop, 2000: p. 9)

Note. M. values: Mathematical values

M.E values: Mathematics Educational values

G.E values: General Educational values

The above is a framework which shows the relationship between various values contained in Mathematics textbooks as adopted from Seah and Seah and Bishop (2000). The school is a subset of society and therefore influences and is influenced by societal inclinations and values. Societal values among other values are situated beyond the Mathematical classroom and may influence activities carried out in the Mathematics classroom. According to Bishop (1988), society accepts some aspects of Mathematical values without questioning others which are seen to be in contradiction with societal values are questioned in certain instances. A comparative research by (Fan, Zhao, & Niu, 2018) revealed that, culture plays considerable role in the study of Mathematics and even in the writing and publication of Mathematics textbooks. This was brought to light when a Chinese version of a Mathematics textbook was different from its UK version when it was assessed in terms of cultural values, beliefs, artifacts among others.

The epistemological perspective which is associated with knowledge and truth suggest the absolute nature of Mathematical truth (Ernest, 2016). Ernest opines in Epistemological universalism that, there are some classes of Mathematical statement which holds irrespective of context, place, persons among others. He further opines that there are some Mathematical statements which are independent of personal beliefs, perspectives. This implies that Mathematical statements are absolute but may be mathematized in culturally

different ways even though this position is questioned by the Fallibilist who argue that Mathematical truth are not absolute and hence is not above correction and revision (Ernest, 1991). There might be other philosophical viewpoints of epistemological values, but the underlining thing is that epistemological values are continually constructed by Mathematics educators though various pedagogical innovations depending on viewpoints in the Mathematical classroom.

Various institutions also have their own values, and these values may in one way, or the other affect personal values and way Mathematics knowledge is constructed. Montessori institutions as well as some international schools puts much premium on practical activities in the Mathematics classroom which may be in contrast with that happen in other public and private institutions. But all these affect what happens in the Mathematics classroom.

As observed in Figure 1 above, Mathematical Values, General Educational Values as well as Mathematics Educational Values are not mutually exclusive of one another. There are some values which fits into more than one category. Seah and Seah and Bishop (2000) for example posits that, Progress and creativity for examples convey Mathematic Values, Mathematics Educational Values and even General Educational Values even though he argues that it is much a Mathematical and Mathematics educational value as a General Educational Value. It is however clear from Figure 1 that, general educational values do not convey Mathematical values, Mathematical values do not convey Mathematics educational values among others. There are other minor values which may lie within the major values outlined above which

have not been clearly stated and highlighted in this framework but contributes to the major values. Together these values are conveyed through the role of teachers, the syllabus, textbooks among others.

Research as revealed that values in Mathematics are sometimes signaled or emphasised differently among two different countries and cultures (Dollah & Widjaja, 2018; Dollah, Widjaja, Zabit, & Omar, 2019). For example, the value of Progress was emphasised more using directive phrases and questions in Malaysian textbook than that of the Australian Textbook (Dollah et al., 2019). It is also worthy to emphasise that, even though Mathematics Educational Values may not convey Mathematical Values, same cannot be said about their complementary values. Thus, a particular value signal may convey more than two sets of values under the same value frame.

This study however looks at Mathematical Values and Mathematics Educational Values as conveyed in Senior High School (SHS) Mathematics textbooks. In Ghana, school textbooks are approved by National Council for Curriculum and Assessment (NaCCA) and Ghana Education Service (GES). They perform this duty by making sure that the books convey the right content and aspiration on the nation's curriculum. Other peripheral values like how textbooks are designed, and general outlook of the textbooks are also implicit values in textbooks and teacher's general appearance in the Mathematics classroom (Neuman, 1997 as cited in Seah & Bishop, 2000).

Empirical Reviews

Values as an affective construct in Mathematics has received considerable attention in recent times which include among others; personal values held by students concerning what they find relevant in the teaching and

learning of Mathematics (Zhang et al., 2016; Davis, Seah, Howard, & Wilmot 2021; Seah, Davis, & Carr, 2019), teachers perspective and awareness of various values implicit in Mathematics (Taqiah & Bahari, 2018), values held on cultural lines or on societal inclinations (Corey & Ninomiya , 2019), and values conveyed in Mathematics textbooks (Daher , 2021 ; Dede, 2006a ; Seah & Bishop, 2000).

Values held by students and Teachers in the Mathematics classroom

Research has shown that, the classroom environment is an ambiance of different value systems. These may include personal and cultural values held and/or portrayed by teachers and students. This implies that, a teacher may have his own set of values against a student who may also have his/her own values. The end product may sometimes be a mismatch as suggested by Skemp (1976). Several researchers have therefore tried to highlight values held by teachers.

Zhang et al. (2016) surveyed 1386 students from 3 regions in China using Questionnaires to investigate what students' value in their Mathematical instructional interaction in the three selected regions. It was revealed that, students put premium on the Relevance of what is been taught in their Mathematics classroom, communication between the teachers and students to ensure proper feedback and comprehension among learners, achievement in terms of their mastery of concept and ability to solve problems using different approaches and ability to use formulas among others.

Davis, Seah, Howard and Wilmot (2021) in a research which sought to find out what senior high school students' value in their study of Mathematics used 415 Senior High students in Ghana (Cape Coast) with questionnaire as

their research instrument. Findings from the research revealed students value the use of instructional aid in the teaching of Mathematics even though people would have thought that they will be comfortable learning Mathematics abstract forms. The students also valued other things such as understanding behind concepts and what makes a solution right or wrong, the need for connecting classroom instruction to everyday experiences through contextual teaching and learning, the need for feedback in instructions among others. Findings from another research by Seah, Davis, and Carr (2019) reveals that most of the things Ghanaians students valued were extrinsic and could perhaps be the reasons for poor performance of students in Mathematics in Ghana as compared to their colleagues in the western world. Achievement and fluency as attribute value, though very important just connote that Ghanaian students are interested in what was important about Mathematics rather than what could be done using Mathematics as connection, understanding and communication deepens one's Mathematical knowledge. These revelations were known after questionnaires were used to survey 1256 primary school students from 18 primary and public senior high schools in the cape coast Metropolis (Ghana).

Davis, Carr and Ampadu (2019) in a research to find out the values primary, junior high and senior high school students in the Cape Coast Metropolis put premium on along the various grade levels revealed that students place premium on seven component values differently according to the multivariant Variance Analysis (MANOVA) analysis performed. Achievement, Relevance, fluency, authority, ICT, versatility, and strategies

were valued differently by the 1,256 students who participated in the research by responding to questions in a WIFI questionnaires administered.

Taqiah and Bahari (2018) in a research which was aimed at finding out teachers' perspective as well as ascertain if teachers have the needed knowledge in implementing three main values in Mathematics which are Mathematical values, Mathematics education values and general educational values used descriptive qualitative research design. After a sample of eight teachers made up of four primary teachers and four secondary school teachers were interviewed, it is observed that teachers had the zeal to implements the three values. However, the teachers did not have enough knowledge on the various Mathematics values and their application.

Similarly, Aktaş and Argün (2018) in a research which was aimed at examining Mathematical values conveyed by secondary school Mathematics teachers in the Mathematics classroom used semi -structured interviews and video recording of observations as his main instruments. After using 5 senior high school Mathematics teachers as his sample size in a case study, it was found that Mathematics teachers emphasised Objectism, Control and Progress values more than their complementary pairs. Reasons for their emphasis of these values included the nature of certain topics, the readiness of the learners as most importantly what the teacher valued which is known to affect what he teaches and what students also learn.

The above research was further strengthened by the work of Carr (2019) who sampled and analyzed 34 empirical studies with majority of them coming from Germany and USA. Research sampled mainly used questionnaires, interviews and observations even though pre- and post-

assessment of students valuing was adopted in some instances after some interventions were provided in the data collection process. The main purpose of the study was to assess what has been achieved in various studies in value research. Majority of the research were mainly focused on high school students even though some attention was also given to lower graders. Findings of the research suggest that, student's motivation, efforts and attention given to mathematics are key determinant in understanding the valuing system of students in mathematics education.

Societal and Cultural influence on the Mathematics values conveyed

What is valued by two set of cultures might not be the same (Mullis & Martin, 2017) and that accounts for the reason why different cultures may have their own peculiar way of mathematizing. Mullis and Martin report that, different countries may vary with respect to the extent to which they emphasise understanding, memorization among other values.

A research was conducted by Dede (2014) which centered on a comparison of Turkish and German Mathematics Teachers' Values. The purpose was to determine whether nationality influences mathematics educational values of mathematics teachers of the two countries. Using a sample of 60 made up of 27 German teachers and Turkish Mathematics Teachers, descriptive and inferential statistics revealed that nationality has a strong effect on Mathematics teachers' mathematics educational values.

Corey and Ninomiya (2019) researched into community Mathematics values imbibed in teaching practices of Japanese teachers taking into consideration their lesson planning, lesson and emphasizing reasoning in Mathematical instruction. Six researchers were selected to observe in this

exercise made up of three Japanese and three US researchers who observed and interviewed 84 junior high and elementary school teachers in Japan. Findings of the research reveals that, these two cohorts of researchers were observing from different views and hence had contrasting views on teachers' practices. Whiles the cohort from the US saw the delivery of the lesson to be problematic since they saw that the teacher wasted much time on a student and often allowed vocal students to hijack the class, the Japanese cohort saw otherwise. But one thing was clear that, the Japanese cohort were influenced by eight values after thematic analysis. These values included emphasis on logical thinking, deeper understanding of Mathematics, being true to Mathematical principles, responsibility of students learning, adaptation of students, mastery of craft, responsibility of community improvements and Openness of teaching practices which fall in lines with some Mathematics and its educational principles emphasised by Bishop (1988). Hence, they thought that even though the concerns raised by the US cohort was valid, the value of logical reasoning and students quest to have understanding makes it necessary for teachers to do what they did. This raises issues on the valuing systems of the two cohort from Japan and UK.

Nakawa (2019) in a research to find out how personal, social and Mathematical values could be incorporated into students learning activities in Tokyo. A sample size of sixteen students aged between five and six years who were kindergarten students were used for the qualitative study in a Mathematics activity. Personal and social values of fairness and equity was held by the students which was evident in the responses they provided on a particular story the researcher told and sought for their views. These values

were seen to be very relevant in attaining other Mathematical values such as Rationalism and hence implied that they have the needed requirement for the next educational level. The response may also represent what the society, the grade level, and the institution emphasise which could also represent what the nation value even though there is no research to support this assertion.

Values conveyed in Mathematics Textbooks

Research into values in Mathematics textbook is very hard to find even though values in textbooks determines values conveyed to students and which may affect the existing schema of both teachers and students. These values could be internalized and hence could have a long-term effect on students, teachers, and the world. It has therefore become of essence for researchers to find out values implicit in various textbooks. Little research is however known on values conveyed in Mathematics textbooks. In the quest to fill this gab in literature, this research reviewed literature on values by researchers like Dede (2006a), Seah and Bishop (2021) and Daher (2021) among other researchers in the field.

Daher (2021) sought to find out values conveyed in Palestinian grade six Mathematics textbooks. The research was limited to only geometry and measurement topics in the textbook using Sam and Ernest (1997) model of classifying values in Mathematics as epistemological values, personal values, and social/cultural values. After a deductive content analysis, it was found that the Palestinian textbooks placed premium on epistemological values the most followed by personal values and then social/cultural values which was least valued.

A research by Dollah and Widjaja (2018) analysed a form four Mathematics textbook from both Australia and Malaysia using content analysis. Focus of the analysis was on values of Rationalism embedded in the textbook contents in Trigonometry and Linear Equations. Finding of the research revealed five characteristics of the value of Rationalism as reason, explanation, abstraction, logical thinking, and theorem. Hypothetical reasoning as a characteristic of Rationalism was missing in both textbooks from Malaysia and Australia. Abstractions and theorem however appeared only in Malaysian textbook whiles abstractions appeared in the textbooks of both countries.

When content analysis was used to find out how the value of Progress was conveyed in form four Malaysian and Australian Mathematics textbooks, it was found that the value of Progress was conveyed mainly through the use of questioning, characteristics of growth, the use of alternatives and generalizations (Dollah, Widjaja, Zabit, & Omar, 2019). Dollah et al. (2019) explained further that the value of Progress with characteristics of alternatives was displayed using alternative approaches in solving a particular question. With respect to Progress using questioning, value was conveyed using directive questions like ‘what’, ‘how ‘and ‘why’ whiles the phrases like ‘find’, ‘draw ‘and calculate were also adopted. Patterns were identified and appropriate conclusions drawn to display the value of Progress with characteristics of generalization whiles history was also used to convey growth. Analysis made revealed further that the values of Progress was conveyed in the Malaysian and Australian textbooks using different characteristics. Whiles both countries emphasised the value of Progress using

directive statements and questions, the characteristics of alternative and growth was conveyed more in the Australian Mathematics textbook than that of the Malaysian even though the value of Progress with characteristics of growth was conveyed in all the books using histories.

Dede (2006a) used semantic content analysis to identify Mathematics educational values and Mathematical values in eight Mathematics textbooks published by two publishers in Turkey. Findings of the research reveals that, with regards to Mathematical values, both 6th and 7th primary school graders textbooks placed much emphasis on Rationalism as against Objectism, control over Progress and Openness values was also emphasised as against Mystery values. With regards to Mathematics educational values, findings of the research reveal that, the 6th and 7th primary graders textbooks emphasised Formalistic views, Theoretical knowledge, Instrumental understanding, Accessibility, and evaluation as against their complementary values activity views, Relevance, Relational understanding, Specialism, and reasoning.

Seah and Seah and Bishop (2000) researched into values conveyed in lower secondary school Mathematics textbooks in Singapore and Victoria. The research used 8 textbooks and adopted semantic content analysis. Checklist was the main research instrument which was used to identify value signals. Findings of the research revealed that, the Mathematics textbooks for lower secondary schools in both Singapore and Victoria emphasised Objectism, control and Mystery Mathematical values against their complementary values of Rationalism, Progress and Openness. Mathematics educational values such as Formalistic views, Instrumental understanding, Theoretical knowledge, Specialism and Evaluation were emphasised more as

against their complementary values of Activist views, Relevance, Relational Understanding, Accessibility and Reasoning.

Dede (2006b), in a research on the topic Mathematical values conveyed by High school Mathematics textbooks used a total of 12 Mathematics textbooks by three publishers which covered 9th, 10th and 11th graders Mathematics syllabus. Rationalism, Control, and Openness Mathematical values were emphasised more as compared to their complementary values. Also, Mathematics educational values such as Formalistic view, Theoretical knowledge, Instrumental learning/understanding, Accessibility and Evaluation were also conveyed more in the 9th, 10th and 11th graders textbooks as compared to their complementary values.

Summary of Review

It is clear from various reviews that value as an affective construct in Mathematics education is getting enough attention in recent times. Researchers have explored different dimensions of values in the teaching and learning of Mathematics. Finding from the Literature reviewed makes it clear that individuals, societies, institutions various disciplines have values. These values exist among students, teachers, grade levels and cultures. Values that exist among grade levels were explored which revealed diversities of values held by students at different grade levels. For example, whiles primary school students' response to What I Find Important (WIFI) questionnaire administered by Seah, Davis, and Carr (2019) reveals students' value for fluency and achievements as against Connections and communication in the Cape Coast Metropolis, Senior High School students who responded to questionnaires by Davis, Seah, Howard, and Wilmot (2021) valued

comprehension, communication, and Relevance. This makes it clear that even though they share the same geographical setting, each grade level valued differently. Research by Zhang et al. (2016) as well as Davis et al. (2021) reported further that, students within the same grade level may also value differently which raises the issue of diversity of value systems in the mathematics classroom.

With respect to issues relating to value in pedagogy teaching of mathematics, various pedagogical approaches including the use of storytelling were seen to aid in imbibing mathematical values like Rationalism in students (Nakawa, 2019) even though findings from Taqiah and Bahari (2018) suggest that, even though most teachers have the zeal to conveyed the needed valued in their teaching, they did not have enough knowledge on values implicit in mathematics teaching and learning. That is, most mathematics teachers were either not aware of values implicit in mathematics or had little level of awareness of values in mathematics. This may presuppose that; most mathematics teachers may not convey the right values implicit in mathematics.

Research reviewed has revealed certain seemingly contradictory usage of value signals in identifying values in Mathematics. For example, Dede (2006a) and Seah and Seah and Bishop (2000) considered the use of imperatives and detailed instructions in conveying the value of control and the use alternatives solution to problems as well as deriving a concept from another (thus, using the area of a square to derive that of a triangle) for the value of Progress. However, the use of directive verbs like ‘calculate’, ‘find’, and ‘draw’ even though are imperatives are considered for Progress by Dollah et al. (2019). Even though a particular value signal may convey more than one

value, the usage of imperatives in conveying both the value of Progress and the value of control seems conflicting.

'Objectism' was used by Bishop (1988) in explaining the concepts of using symbols, objects, and other artifact to provide imaginative basis for abstraction. This same concept is explained by Dede (2006a) using 'Objectivism'. For this study, Objectism used by Bishop (1988) was considered.

Finding from the works of Dede (2006a), as well as Seah and Seah and Bishop (2000) also highlight the seemingly neglect and/ or ignorance of textbooks writer and Publishers in ensuring a balance in the values conveyed in mathematics textbooks. Even though textbooks are very pivotal in the teaching and learning process, it has not received the attention it requires. They report on lack balance in the values in mathematics as a discipline and the values implicit in the teaching and learning of mathematics (Bishop, 1988; Dede, 2006a; Seah & Bishop, 2000). That is why Bishop (1988) report that he will present a curriculum where Rationalism is emphasise more than control, Progress emphasised more than control and the value of Openness more than Mystery. With textbooks being the teacher of teachers and an 'invisible teacher' (Bishop et al., 2000), it becomes of great importance to explore values conveyed in textbooks in performing their pedagogical role and values in Mathematics as a disciplined conveyed in textbooks.

However, no research is known on the values conveyed in mathematics textbooks in Ghana. Considering the fact those books from two different countries may emphasise different values or convey them in different ways (Dollah & Widjaja, 2018; Dollah et al., 2019) makes this research necessary.

This study therefore explored values conveyed in Mathematics textbooks and checked the level of awareness of teachers on values conveyed in mathematics.

CHAPTER THREE

RESEARCH METHODS

This chapter presents the research methods that were used to carry out the study. The research design, population, sampling procedure, reliability and validity of the research instrument used were therefore presented. Also presented in this chapter is Pre-Testing phase of the instrument, Data collection Procedure, and Data Processing Analysis.

Research Design

This study involves two parts. The first part was concerning exploring values implicit in Ghanaian SHS 1 Core Mathematics textbooks while the second part talks about the awareness of Core Mathematics teachers on the values implicit in Mathematics. Phenomenological study design was used as the design for the exploring values implicit in mathematic textbooks while the descriptive survey design was used for exploring the extent to which Ghanaian SHS core mathematics teachers are aware of values implicit in mathematics.

Leedy and Ormrod (2016) opines that phenomenological study is aimed at getting deeper understanding of a particular phenomenon. To him, by looking at multiple perspective to an issue, a researcher may be able to come up with a generalisation as to what something really is. This design is appropriate for this study as this study is primarily qualitative which is to explore the values implicit in the best-selling Ghanaian SHS 1 core Mathematics textbooks. This is done by integrating content analysis, which is also described, by Leedy and Ormrod (2016) as a design but not necessary a stand-alone design into this study to understand what values are conveyed in the various best-selling Ghanaian SHS 1 core mathematics textbooks ad also

how these textbooks convey the said values. Leedy and Ormrod opines that, content analysis may also be an integral part data analysis in a phenomenological study. That is the integration of content analysis into a phenomenological study will help make inept study of textbook contents, identify various value signals, make comparative analysis with respect to their complementary pairs other to make informed conclusions as to whether which values are conveyed in the textbooks ad whether there is a balance in the values conveyed. It will further help in identifying how these values are conveyed in best-selling Ghanaian SHS 1 core mathematics textbooks.

Descriptive survey design according to Leedy and Ormrod (2016) involves acquiring information about one or more groups of people concerning their characteristics, opinions attitudes and experiences. Survey design using interview as in the case of this study involves posing series of questions to willing participant who responds to them. Interviews used according to Leedy and Ormrod (2016) could be either face to face or telephony interviews in descriptive survey design. In the case of this study, face-to-face interview was employed to gather the views of SHS 1 core mathematics teachers on their awareness of values implicit in mathematics. It also became appropriate because this study seeks to describe the views just as they are expressed by the respondent. It was also appropriate as Leedy and Ormrod (2016) involved a small sample size as in the case of this study, which will make it more practical as espoused.

Population

This study involves two different groups which are books and Teachers respectively. The target population with respect to books for this

study was best-selling Ghanaian Core Mathematics textbooks for Senior High Schools 1 (SHS 1) in Ghana. These are popular Core Mathematics textbooks used by most students in Ghanaian Senior High Schools. The best-selling Core Mathematics textbooks were mainly determined from online web sites like schoolmallgh.com where textbooks are sold. Each of these textbooks had all the thirteen topics in the Ghanaian SHS 1 Mathematics syllabus clearly covered and were approved by NaCCA and GES.

With respect to the targeted population for the teachers, Ghanaian SHS 1 Core Mathematics teachers were the main target group. That is professional teachers who had a number of years teaching experience especially in the teaching of Mathematics were targeted.

Sampling Procedure

Sampling in this study was done in two part. The first was for best-selling Ghanaian SHS 1 Core Mathematics Textbooks while the other is for Ghanaian SHS 1 Core Mathematics teachers.

Four Ghanaian best-selling SHS 1 Core Mathematic textbooks were considered for this study. These textbooks were approved by GES and NaCCA and were sampled purposively for the study. Leedy and Ormrod (2016) stated that, purposive sampling helps to identify participant who will provide desired perspective to the topic under study. The purposive approach in sampling was appropriate in selecting only best-selling Ghanaian SHS 1 Core Mathematics textbooks approved by GES and NaCCA. These four best-selling Ghanaian SHS 1 Core Mathematics textbooks were checked for their approval status using the NaCCA short code.

Four Ghanaian SHS 1 Core Mathematics teachers who were holding degrees in Mathematics Education were also interviewed to know their awareness of the various values conveyed in Mathematics. These four teachers were selected because Bishop argues that, "At present there is little knowledge about how aware teachers are of their own value positions, about how these affect their teaching, and about how their teaching thereby develops certain values in their students" (Bishop, 1999, p.5). By extension, there is little knowledge on how aware teachers are on various values conveyed in Mathematics as a discipline and in its pedagogies. This has become necessary as Seah (2016) reports that, teachers of nowadays are mostly interested in what need to be taught and when without considering how and what value will be conveyed in the process.

Purposive sampling was used to select only professional Ghanaian SHS 1 Mathematics teachers who held bachelor's degrees in Mathematics Education to be interviewed. Purposive sampling was also used to select four professional SHS 1 Core Mathematics teachers in the Asunafo North Municipality in the Ahafo region from two schools. This is because SHS 1 is a transitional stage and requires teachers who will equip them with the needed values which will make mathematics meaningful and interesting in the preceding years and hence exploring their awareness was necessary. The small sample size for the interviewed Ghanaian SHS 1 Core Mathematics teachers was premised on the argument of Leedy and Ormrod (2016) that" Whether they are conducted face-to-face, over the telephone, or via Skype or video conferencing software, personal interviews allow a researcher to clarify ambiguous answers and, when appropriate, seek follow-up information.

Because such interviews take time, however, they may not be practical when large sample sizes are important" (p. 142). The choice of the region was by proximity since how teachers are posted in Ghana makes the school environment an atmosphere of various cultures. All teachers sampled were interviewed using an interview guide adapted from Taqiah and Bahari (2018).

Data Collection Instruments

This study used checklist and interview guides as the main research instruments. According to Medina (2016), a textbook evaluation checklist is simply a set of items, criteria or categorization which is ticked when the set of items are identified under such category. The checklist was developed from the works of Dede (2006a) as well as Seah and Bishop (2000) for this study. That is, the value signal from each of the mathematical values and mathematics educational values were adapted from the works of Dede (2006a), and Seah, and Bishop (2000). These researchers are authorities with respect to valuing in mathematics textbooks and hence adapting from their signal frame was seen to be appropriate. The checklist had the following headings.

i. Values: this column contains the two main values, which are Mathematical values, and Mathematics educational values. Under each of these values are sub-values. The complimentary values were split and treated individually for the purpose of their identification and analysis.

ii. Description: this heading gives brief information of the type of value explored.

iii. Activities: this talks about Mathematical activities in which the values indicated in 'i' above are implicit

iv. Value Signals: this column is about what gave indication that a particular value is conveyed.

It worthy to note that, a particular value signal may convey more than one value. Table 2 below shows Mathematical values and their value signals.

Table 2: Mathematical values and its value signals

Mathematical Values	Value Signals
Rationalism	Words that establish logic, connectedness, completeness, cohesion, cause, and effect. Examples: hence, therefore, so, thus,
Objectism	Conditional tenses such as if, suppose, etc. The use of symbols, diagrams, and images
Control Values	The use of instructions in performing a Mathematical task. The use of imperatives in solving questions
Progress	The use of alternatives solutions and procedure Application of concepts in other fields. Questions, which allow students to use their creative ideas.
Openness	The use of pronouns like we, you and their related forms like 'your', 'our' among others. Exercises that can be easy to solve
Mystery	Often associated with difficult and with complicated examples

Source: Adapted from Seah and Bishop (2000) and Dede (2006a)

From Table 2 above, Bishop (1988) grouped Rationalism-Objectism, Control-Progress, Mystery- Openness as complementary values. Dede (2006a) as well as Seah and Seah and Bishop (2000) also grouped Formalistic-

Activist, Relevance-Theoretical, Instrumental-Relational, Accessibility-Special and Evaluation-Reasoning as complementary values under Mathematics educational values as presented in the table below.

Table 3 below also represent various Mathematics Educational Values and some of their common Value signals.

Table 3: Mathematics educational values and its value signals

Mathematics Educational Values	Value Signals
Formalistic View	The use of deductive approaches in lesson presentation Emphasise the use of rules
Activist View	The use of inductive presentation The use of discoveries and generalizations
Relevance	The use of examples which are associated with the local context. emphasise the use of demonstrations portrays human control of his environments
Theoretical	Mathematics exercises and examples which is abstract and does not seem to have any bearing on daily life activities
Instrumental	Emphasise the use of rules, procedures, and formulas without explanations
Relational	Examples that demonstrate the relations between concepts It emphasises meaning and explanation
Accessibility	Content which are not beyond the intellectual capacity of students
Specialism	Contents which could not be understood by everybody but by some few elite and gifted students
Evaluation	Assessment questions given at the end of the topic, which uses routine operations like examples, solved.
Reasoning	Self-assessment exercises which involve operations different from examples solved

Source: Adapted from Seah and Bishop (2000) and Dede (2006a)

The interview guide used also contained vital questions that explored teacher's knowledge on values implicit in Mathematics as a discipline and its

pedagogies. It basically consisted of semi structured questions which the four Ghanaian SHS 1 Core Mathematics teachers interviewed responded to as contained in Appendix B.

Validity

Validity of an instrument is the extent to which an instrument measures what it is supposed to measure (Leedy & Ormrod, 2016). To ensure face validity of the instruments used, the two instruments was given to my supervisor to access the quality of the instrument and make recommendations for modification when necessary. The wording of the items in the checklist was checked to ensure it readability and to make sure it is devoid of ambiguity. Same was done for the interview guide to ensure that it solicit the right kind of information.

Pre-Testing of Instruments

The study was involved in a pre-testing phase where a topic was explored to identify the values implicit using the checklist. The trail study was useful for identifying the uniqueness and possible overlaps in the categorization. This also helped to evaluate the code frame and make possible modification as suggested by Schreier (2016). The pre-testing phase also helped to identify challenges in using the interview guide and served as a dress rehearsal for the main study.

Reliability

According to Leedy and Ormrod (2016), reliability refers to extent to which an instrument yield consistent results when the object/ entity measured remains unchanged. Schreier (2012) clarifies this further by making the argument that, a reliable instrument is the one which produces data that is free

from error. This implies that, a research finding is as reliable as the instrument used. To ensure reliability of the checklist used, the same checklist with signal frame for the research was presented to and used by my supervisor. The same topics and the same textbooks sampled were explored by each of us independently using the same checklist. The values emphasized with their numbers were compared to ensure that the instrument produces consistent results. The data compared yielded results that depict an imbalance in the values conveyed in the textbooks. This was same for the case of my supervisor and myself.

Data Collection Procedure

Data were collected using the checklist adapted from Dede (2006a) and Seah and Seah and Bishop (2000) and interview guide adapted from Taqiah and Bahari (2018). Thorough exploration was made on each of the thirteen topics in the four selected textbooks to identify values implicit in them. This was done by taking each topic, carefully and systematically looking through to identify value signals for Mathematical values and then for Mathematics Educational Values. To ensure that analyses are done with ease, textbooks sampled were coded as BK 1A, BK 1B, BK IC and BK 1D which basically means Textbook A, B, C and D respectively all of which are form one Core Mathematics textbooks.

The Interview was done in two senior high schools in the Asunafo North municipality. Two teachers were sampled per school hence giving four teachers. This was to get diverse views as possible. Prior to the day for actual data collection, the schools were visited to familiarise with the Mathematics teachers in the school. Headmaster of the school was also notified on the

purpose of the study. This familiarisation was based on the argument by Leedy and Ormrod (2016) that face-to-face interviews helps to establish rapport, which helps in yielding the highest response rate. Rapport was established as they agreed to provide relevant information on the day of data collection.

On the day set for data collection, the Headmasters were visited for introduction and disclose the intention of my study as said earlier and to receive the green light to collect the data. The Head of Departments for Mathematics were seen in the various schools on the Instructions of the various Headmasters. SHS 1 Core Mathematics Teachers who were available and ready for the interview were approached after some initial discussions to give their views freely. They were also assured of the confidentiality of the data collected. Their consent was sort for audio recording of the interview after which the interviews kick started.

Respondents to the interview were given the chance to seek clarification when they did not seem to understand the question. They were also asked to clarify some of their responses to get a rich data for the study. The voice recordings were transcribed and summarised.

Data Processing and Analysis

According to Leedy and Ormrod (2016), "A content analysis is a detailed and systematic examination of the contents of a particular body of material for the purpose of identifying patterns, themes, or biases" (p. 257). This became useful in having a categorization matrix, which will help identify the various values portrayed in Ghanaian SHS 1 core mathematics textbooks. Content analysis was appropriate to describe the meaning of materials which have qualitative nature as in the case of mathematics values. For mostly

linguistic nature of signals of values implicit in Mathematics textbook, semantic content analysis became the data analysis tool for this study.

Semantic content analysis is a constructive process, which categorizes subjects and dimensions under various themes of the material under study (Tavşancıl & Aslan, 2001 as cited in Ozdem, 2011). Polat (2014) opines that, semantic content analysis helps to quantify data, which are qualitative in nature. Content analysis is not only suitabl e for identifying 'what' but also 'how' showing the interpretative nature of this design (Schreier, 2012). Through semantic content analysis, value signal helped in putting values implicit in Mathematics into various subgroups as Mathematics Educational and Mathematical Values. Various complementary values under Mathematics Educational and Mathematical values were explored

For research question 1 and research question 3, the number of times the various values are signaled were counted and presented on frequencies. Each of the form one Core Mathematics textbooks was explored page by page. A particular value was explored at a time for all the pages of the 13 topics in the Ghanaian SHS 1 Core Mathematics textbooks and tallied before moving on to the next value. For Example, when the value of Rationalism was being explored, it was done for all the thirteen topics for the four textbooks sampled before moving on to its complementary value of Objectism. This was done until all the values were explored for the four textbooks considered. This process continued until all the four textbooks were completely explored. This procedure was used to ensure that mistakes are not made in assigning the tally of a particular value explored to another value. It also helped in identifying patterns with which each of the textbooks conveyed a particular value and

their various dynamics. Tallies were presented on frequency tables, which also helped in the analysis. The tables indicated the number of times each value was signaled, and the results were compared with its complementary values. Totals from each value under the complementary values for all thirteen topics in each book is computed. The grand total however reflects the sum of all the total number of values conveyed for each of the Values under the complementary pair of values for all the four books considered for the analysis, which helped to compute their percentages relative to their complementary pairs as shown in Table 4.

Table 4: Complementary pair of Values in Mathematics

Values in Mathematics	Complementary pairs
Mathematical Values	Rationalism vs Objectism
	Control vs Progress
	Openness vs Mystery
	Formalistic View vs Activist View
	Instrumental vs Relational
Mathematics Educational Values	Understanding
	Relevance vs Theoretical
	Accessibility vs Specialism
	Evaluation vs Reasoning

Source: Adapted from Seah and Bishop (2000) and Dede (2006a)

Table 4 above gives a preview of how the data gathered from the content analysis was compared and analysed. Under Mathematical Values, Rational – Objectism, Control- Progress, and Openness – Mystery was the main subheadings while Formalistic-Activist view, Instrumental Understanding-Relational Understanding, Relevance-Theoretical values,

Accessibility-Specialism values as well as Evaluation-Reasoning values formed the subheadings under the Mathematics Educational values under which comparisons and analysis and further analysis were done.

The analyses considered only the values captured in Table 4 above and excluded peripheral values and other values captured in Figure 1.

This helped in answering research questions 1-4 as stated below.

1. Which Mathematical values are emphasised in the Senior High School one (SHS 1) Core Mathematics textbooks?
2. How are Mathematical values conveyed in the Ghanaian SHS 1 Core Mathematics textbooks?
3. Which Mathematics educational values are emphasised in the Ghanaian SHS 1 Core Mathematics textbooks?
4. How do the Ghanaian SHS 1 Core Mathematics textbooks portray Mathematics Educational values?

It is also worth to take note that these headings have other subheadings which reflect their complementary pairs. These headings and subheadings will help answer four of the five research questions.

In total, four Core Mathematics textbooks for SHS 1 students approved by the Ghana Educational Service (GES) and the National Council for Curriculum and Assessment (NaCCA) were analyzed after they were sampled purposively.

To ensure anonymity and meeting other ethical considerations, these books are named BK 1A, BK 1B, BK1C and BK 1D where 'BK 1' means 'book 1 for Senior High Schools' whiles 'A', 'B', 'C' and 'D' represents the

four books used. Examples, exercises and illustrations used to explain the various concepts are labelled 'Case' in this study.

Excepts were taken from the examples in the textbooks and how mathematical values as well as mathematics educational values were portrayed in the various books identified and were presented as 'cases'. Each case may represent either an illustration, solve example, or self-assessment question given at the end of the topic. Values conveyed in the books evident in the cases were compared to their complementary pairs for analysis for all the four SHS 1 Core Mathematics textbooks. This helped in answering research question 2 and question 4. This became important as Seah and Bishop (2000) reports for example that, whiles the Victorian Mathematics Textbook signal the value of Progress using pronouns such as 'we', 'you' and their related forms, the Singaporean textbook conveyed the value of Progress through rough inviting reader question posing. It therefore became necessary to find out how these values were conveyed in Ghanaian form one Core Mathematics textbooks.

Interview responses on teacher's awareness of values implicit in Mathematics as a discipline and in its pedagogy were also reported. Excerpts from the interview were presented and analysed. Excerpts were also drawn to support major arguments. For anonymity and meeting ethical standards, the respondents were labelled T1, T2, T3 and T4, which implies Teacher 1, Teacher 2, Teacher 3, and Teacher 4 respectively who were SHS Core Mathematics teachers who served as respondents to the interview questions. The interviewer was also labelled (R). The qualitative data obtained from the interview were transcribed, analysed qualitatively and presented as narrative

descriptive with illustrative examples. That is, based on the responses provided by the respondents, the extent to which teachers were seen to understand mathematical values as well as mathematics educational values were reported using excerpts of the responses to support arguments made.

CHAPTER FOUR

RESULTS AND DISCUSSION

This chapter presents the results from the data obtained from the study and make extensive discussions on them.

Four Ghanaian SHS 1 Core Mathematics teachers were also interviewed. Table 5 below presents the demographics of the four teachers interviewed.

Table 5: Demographics of interviewed respondents

Respondent	Gender	Professional Qualification	Years of Teaching Experience
R1	Male	Bachelor's degree	7
R2	Female	Bachelor's degree	11
R3	Male	Bachelor's degree	6
R4	Male	Bachelor's degree	3

Source: Field Data (2020)

In Table 5 above, four respondents made of three male teachers and a female Mathematics teacher from two Senior High Schools in the Ahafo region of Ghana were used for the study. It was realized that each of the teachers was holding a bachelor's degree in mathematics which is a requirement to teach in the senior high school. The teachers had worked between 3 to 11 years as professional teachers in various Senior High schools

They had also taught Core Mathematics at the SHS 1 level for quite some time and hence had appreciable number of years' experience in the field of teaching.

Four best-selling Ghanaian SHS 1 Mathematics textbooks were considered. Findings from the studies are presented by reporting on what Mathematical values are conveyed in the four SHS 1 Core Mathematics textbooks considered and how they are conveyed. Responses from the respondents are also reported and analysed. Research Questions 1-5 are therefore answered from the data gathered from the study.

Research Question 1: Which Mathematical values are emphasised in the Senior High School one (SHS 1) Core Mathematics textbooks?

Mathematical Values are associated with values conveyed in Mathematics as a discipline (Bishop, 1991). These values are analysed by putting the complementary values on a continuum with respect to their complementary pairs. The value signals aided in analysing the various contents of the textbooks sampled. The various values were counted as and when they appeared in the illustrations, examples and exercises in the textbooks as shown in the example below.

Example 1

Given that P=$\frac{a-n}{3+an}$, make a the subject of the relation

Solution

P=$\frac{a-n}{3+an}$ (cross multiply)

P (3 +an) = a-n (clear the bracket)

3p+anp= a-n (group terms with a)

3p+n=a-anp (factorize a)

3p + n = a (1-np) (divide both sides by 1-np)

a=$\frac{3p-n}{1-np}$ (BK 1B, Page 56)

With the example above, the value of Control for example is identified by counting the number of times they are signaled in the example. Control values are signaled through the number of imperatives and structured instructions. Therefore, in the above example, the number of times the value is signaled were counted as 5. That is;" cross multiply", "clear the bracket", "group terms with a", "factorize a", "divide both sides by 1- np" which were structured instructions in solving the question.

Through counting the number of times mathematics symbols are used in the example 1, the number of times the value of Objectism value was signaled could be quantified. In example 1, the use of =, +, - and other mathematics symbols helps project the value of Objectism.

Illustration 1

If A={1,4} and B={1,2, 3, } then A n B= B U A = {1,2, 3, 4}

In the above illustration, the use of the word "then" has been used to establish reason or logic in the argument. This conveys the value of Rationalism.

In similar scenario, the use of proves to establish the value of openness in axioms which may look opaque is shown in the illustration below

Illustration 2

If P={2, 3,4}, Q={ 3,4,5} and R= { 3,4, 7}

Then (P ∪ Q) ∪ R= P ∪ (Q ∪ R) = {2, 3,4,5,7}

In the above example, the axiom (P ∪ Q) ∪ R= P ∪ (Q ∪ R) is proved using an illustrative example to make the axiom open making students aware that mathematics axioms are open to proves. Therefore the axiom (P ∪ Q) ∪ R= P ∪ (Q ∪ R) is counted as an example of a mystery value. The use of the

example P={2, 3,4}, Q={ 3,4,5} and R= { 3,4, 7} to prove the axiom is then counted as an open value.

Data on these values are captured in Table 6, Table 7, Table 8, and Table 9 for BK 1A , BK 1B, BK 1C and BK 1D respectively.

Table 6 presents the results of Mathematical values implicit in the best-selling Ghanaian SHS BK 1A.

Table 6: Mathematical Values in Mathematics Textbook 1 A

		Complementary		Complementary		Complementary	
Book	**Topic**	**Rationalism**	**Objectism**	**Control**	**Progress**	**Openness**	**Mystery**
BK 1A	Sets	140	640	151	74	107	14
	Real Number System	62	414	146	41	198	17
	Algebraic Expressions	16	400	132	28	98	14
	Surds	7	370	57	12	125	2
	Number Bases	35	250	165	14	122	10
	Relations and Functions	58	230	143	18	103	6
	Plane Geometry I	69	380	170	4	132	6
	Linear Equations and Inequalities	54	378	300	9	109	16
	Bearings and Vectors in a Plane	90	248	160	11	98	30
	Statistics I	41	244	98	-	137	9
	Rigid Motion	25	80	53	24	82	8
	Ratio and Rates	26	110	119	-	125	11
	Percentages I	65	300	129	11	145	6
	TOTAL	**688**	**4024**	**1823**	**246**	**1592**	**204**

Source: Field data (2020)

The results from Table 6 above shows that, from a total of 421 pages of BK 1A, the values of Rationalism, Objectism, Control, Progress, Openness, and Mystery were signaled 688, 4024, 1823, 246, 1592, and 204 times respectively.

The table shows that Objectism value (4024) is conveyed more than all the other Mathematical values followed by Control (1823), Openness (1592), Rationalism (688), Progress (246) and Mystery (204) in the that chronological order.

Table 6 also shows that Objectism (4024), Control (1823) and Openness (1592) values were conveyed more than their complementary values of Rationalism (688), Progress (246) and Mystery (204) respectively. That is, the value of Rationalism is conveyed 3336 less than the value of Objectism, Control value is signaled 1969 more than the value of Progress while the value of Mystery is emphasised 1388 less than the value of Openness. This implies that the complementary pair of value with the widest difference (3336) in terms of value count is Rationalism-Objectism continuum while Progress-Mystery continuum was the complementary pair with the least difference (1388).

In terms of the total value count for each of the values under the thirteen topics in the Ghanaian SHS 1 Mathematics textbook 1A, it is seen that Objectism is the highest conveyed value signal in a single topic with a total value count of 640 in the topic ‘Sets’. Topics like Statistics I as well as Ratio and rates did not convey the value of Progress at all. In general, the values conveyed in each of the individual topics reflected what was conveyed in the total value count under each Mathematical Value in the 421 pages of BK 1A.

Thus, each of the topics conveyed more Objectism Values than Rationalism, Control than Progress, and Openness than Mystery respectively.

Table 7 below also presents the results of values signaled in best-selling SHS BK 1B.

Table 7: Mathematical Values in Mathematics Textbook 1B

		Complementary		Complementary		Complementary	
Book	**Topics**	**Rationalism**	**Objectism**	**Control**	**Progress**	**Openness**	**Mystery**
BK 1B	Sets	43	227	136	53	87	17
	Real Number System	32	250	89	42	95	12
	Algebraic Expressions	16	198	82	16	85	9
	Surds	9	235	40	10	73	4
	Number Bases	15	168	137	10	82	5
	Relations and Functions	18	230	103	25	82	8
	Plane Geometry I	52	233	93	13	93	27
	Linear Equations and Inequalities	27	178	87	10	87	8
	Bearings and Vectors in a Plane	20	325	130	30	90	11
	Statistics I	31	177	75	14	111	8
	Rigid Motion	23	162	69	17	54	9
	Ratio and Rates	25	137	78	13	72	9
	Percentages I	36	200	88	9	69	7
	TOTAL	**347**	**2720**	**1207**	**271**	**1080**	**134**

Source: Field data (2020)

Results from Table 7 above indicates that, the total number of value count from 443 pages of BK 1B for Rationalism, Progress and Mystery were 347, 271, and 134 respectively while their complementary pairs of Objectism, Control and Openness were 2720, 1207, and 1080 respectively. It is observed

from Table 7 that Rationalism value (347) is less than Objectism Value (2720), Control value (1207) is more than Progress value (271) while Openness value (1080) is more than Mystery value (134). It is evident in table 7 that, the value of Objectism (2720) is conveyed more than any other value in BK 1B while Mystery (134) was also conveyed less than any other value in BK 1B. With respect to values conveyed in each of the individual topics contained in best-selling Mathematics textbook 1B, it is observed from Table 7 that, the value conveyed the most in an individual topic is Objectism. This is seen in the topic Real Number system where the Objectism value is conveyed 250 times. The value of Mystery was the value conveyed the least in an individual topic. This is evident in the topic surds where the value of Mystery is conveyed only 4 times. The total value counts for each of the topics in the 443 pages of BK 1B was seen to reflect what is contained in the total value counts for all the thirteen topics. For example, the value of control was conveyed 137 times while the value of Progress was conveyed 10 times in the topic which reflect the total counts of values for these complementary values of Control (1207) and Progress (271) where control is seen to be conveyed more than the value of Progress. Ratioalism-Objectism had the widest difference of 2373 while the control-progress values were the complementary value with the least difference of 936. The ccomplemntary value with the highest total value counts were Rationalism-Objectism values with a atotal values count of 3067 whiles the complementary value with the least total value counts were Openness- Mystery values with a total value cunt of 1214. In all, 5759 mathematical values were conveyed in BK 1B. That is, 5759 value

counts represents all the different individual complementary pairs of values conveyed in BK 1B.

Table 8 presents the results of Mathematical Values Conveyed in best-selling SHS Core Mathematics book 1C.

Table 8: Mathematical Values in Mathematics Textbook C (BK 1C)

		Complementary		Complementary		Complementary	
Book	**Topic**	**Rationalism**	**Objectism**	**Control**	**Progress**	**Openness**	**Mystery**
BK1C	Sets	150	420	146	20	132	14
	Real Number System	63	526	132	15	147	6
	Algebraic Expressions	23	175	115	17	116	8
	Surds	4	315	35	-	69	-
	Number Bases	25	148	140	6	111	4
	Relations and Functions	20	230	94	4	132	6
	Plane Geometry I	78	365	170	3	47	27
	Linear Equations and Inequalities	43	300	213	10	124	8
	Bearings and Vectors in a Plane	30	346	120	4	103	16
	Statistics I	37	147	70	-	78	4
	Rigid Motion	25	153	46	10	30	4
	Ratio and Rates	30	200	98	15	100	8
	Percentages I	48	232	100	27	163	5
	TOTAL	**576**	**3557**	**1481**	**131**	**1352**	**108**

Source: Field data (2020)

The results from Table 8 above indicates that, the total value counts from 123 pages of BK 1C for Rationalism, Objectism, Control, Progress, Openness, and Mystery were 576, 3557, 1481, 13, 1352, and 108 respectively. This indicates that the value of Objectism is the highest conveyed value in BK 1C which is 2074 more than the second highest value of Control. Rationalism is also 776 less than Openness value, which is 129 less than the value of Control. Rationalism value is a 445 more than the value of Progress, which is also 23 more than the Mystery value.

When the various values were compared to their complementary pairs, it was observed that the total value count of Objectism (3557) is more than Rationalism, Control (1481) is more than Progress (131) while the value of Openness (1352) is also signaled more than the value of Mystery (108). The total value count of Objectism value is 526 in the topic Real Number System which is the highest number of value signal counted in a single topic in BK 1C. However, it is also seen that the value of Progress is not conveyed at all in the topic surds as well as Statistics I. Similarly, no value of Mystery is conveyed in the topic Surds. It is also observed from table 8 that, for all the topics explored in the 123 pages of the best- selling Ghanaian SHS 1 Core Mathematics textbook BK 1C, Objectism was conveyed more than Rationalism value, Control more than Progress, and Openness more than Mystery. It is also seen in table 8 that, Rationalism-Objectism were the complementary values with the highest total value count of 4133 while Openness- Mystery values were the least conveyed complementary values with a total value count of 1460. BK 1C conveyed a total of 7205 mathematical values.

Table 9 presents results for Mathematical Values conveyed in BK 1D.

Table 9: Mathematical Values in Mathematics Textbook 1D

		Complementary		Complementary		Complementary	
Book	**TOPICS**	**Rationalism**	**Objectism**	**Control**	**Progress**	**Openness**	**Mystery**
BK 1D	Sets	4	100	3	5	7	-
	Real Number System	15	145	5	3	65	2
	Algebraic Expressions	12	200	25	10	33	2
	Surds	6	120	-	5	15	-
	Number Bases	28	87	9	12	14	2
	Relations and Functions	22	231	16	5	122	6
	Plane Geometry I	14	198	25	4	44	5
	Linear Equations and Inequalities	38	254	40	-	35	-
	Bearings and Vectors in a Plane	25	265	22	15	17	2
	Statistics I	40	155	34	12	24	6
	Rigid Motion	30	249	33	9	48	4
	Ratio and Rates	33	111	5	7	19	1
	Percentages I	9	288	22	14	14	2
Total		**276**	**2403**	**239**	**101**	**457**	**32**
Grand Total		**1887**	**12704**	**4750**	**749**	**4431**	**478**

Source: Field Data (2020)

From Table 9 above, it is observed that the total count of values for Rationalism, Objectism, Control, Progress, Openness and Mystery are 276, 2403, 239, 101, 457, and 32 respectively. It is evident in the 364 pages BK 1D that Objectism (2403) is 2127 more than Rationalism (276), Control (239) is 138 more than Progress (101) while Openness (457) is 425 more than Mystery (32). Algebraic Expressions in BK 1D was seen to convey the highest value signal (Objectism) in an individual topic with a total value count of 254. The value of Mystery, Progress and Control were not seen to be conveyed in some

topics in BK 1D. Thus, Mystery was not signaled at all in topics like sets, surds, and linear equations and Inequalities. Similarly, Progress was not conveyed in Linear Equations and Inequalities while Control was also not signaled at all in surds. In all the individual topics, it was observed that all of them emphasized Objectism, Control and Openness respectively as against their complementary pairs except for the topic surds where the value of Progress was conveyed more than the value of Control. BK 1D convey a total of 3508 mathematical values made up of 2679 values for Rationalism – Objectism, 340 for Control- Progress and 489 values for Openness- Mystery. Which implies that Rationalism- Objectism values were the complementary values conveyed the most in BK 1D while Control-Progress were the least conveyed complementary values.

For all the four best- selling Ghanaian SHS 1 Core Mathematics textbooks explored, it was observed that a total of 25049 Mathematical values was conveyed made up of 8577 from BK 1A, 5759 from BK 1B, 7205 from BK 1C, and 3508 from BK 1D. This implies that, BK 1A and BK 1D conveyed the most and least mathematical values respectively.

The number of times a particular value was signaled in a textbook were different depending on the type of textbook used. Generally, the Value of Rationalism (688), Objectism (4024), Control (1823), Openness (1592) and Mystery (204) were conveyed in BK 1A more than any other textbook except for the value of Progress (271) which was conveyed in BK 1B more than any other value.

With 1887, 12704, 4725, 749, 4431 and 478 being the total value counts for Rationalism, Objectism, Control, Progress, Openness, and Mystery

respectively, the four textbooks used conveyed Objectism value more than any other value. From the grand totals for all the 1351 pages of the four best-selling Ghanaian SHS 1 core mathematics textbooks considered for this study, the value of Objectism (12704) is signaled more than the value of Rationalism (1880), Control (4750) is signaled more than the value of Progress (749) while Openness (4431) is emphasised more than the value of Mystery (478).

It was also observed that, even though all the four books signaled more Rationalism- Objectism values, differences exist with which of the complementary values was least conveyed. BK 1A-C conveyed less of Openness-Mystery values while BK 1D conveyed less of Control- Progress value

Further analysis is made on Mathematical values conveyed in the four-best-selling SHS 1 Core Mathematics textbooks under the headings: Rationalism- Objectism, Control- Progress, and Openness- Mystery.

Rationalism-Objectism

Objectism values is concerned with objectivising abstract concepts to provide imaginative and intuitive basis for abstraction. Abstract concepts are then communicated to make meaning, ensure cohesion and completeness often using logical connectors (Bishop, 1991).

It is seen from Tables 6-9 that the value of Rationalism is conveyed 688 times in BK 1A, 347 times in BK 1B, 576 times in BK 1C and 276 times in BK 1D giving a grand total of 1887 as presented in Table 6, Table 7, Table 8, and Table 9 respectively.

It is seen that the value of Objectism is conveyed 4,024 times in BK 1A,2720 times in BK 1B, 3557 times in BK 1C and 2,403 times in BK 1D

giving a grand total of 12,704 as presented in Table 6, Table 7, Table 8, and Table 9 respectively. It is clear from Tables 6-9 that the value of Objectism is conveyed more than its complementary pair of Rationalism even within the individual topics. For example, the value of Objectism is conveyed 500 more than its complementary pair of Rationalism under the topic set in BK 1A. Objectism is also 25 times the value of Rationalism under the topic Algebraic Expressions in the same book. Rationalism is 170 less than the value of Objectism also under the topic Ratio and Rates in BK 1C. The dominance of Objectism value is evident across the other topics in Table 6, Table 7, Table 8 and Table 9 for BK 1A, BK 1B, BK 1C, and BK 1D respectively. In general, it is evident from Table 9 that the value of Objectism is conveyed 10,817 more than the value of Rationalism. Table 10 presents Rationalism and Objectism values conveyed in the four best-selling Ghanaian SHS 1 Core Mathematics textbooks by expressing them in percentage terms.

Table 10: Comparative Summary of Rationalism and Objectism Values

BOOK	RATIONALISM	OBJECTISM
BK 1A	15%	85%
BK 1B	11%	89%
BK 1C	14%	86%
BK 1D	10%	90%
AVERAGE BK 1A-D	13%	87%

Source: Field Data (2020)

From table 10 above, it is seen that the value of Rationalism occupies 13% of the total counts of the complementary pair of values against the value of Objectism which occupies 87% of the total counts of values in the

complementary pair of values. Breakdown of the comparative sets of values are also captured in the Table 10 above. This analogy implies that, the value of Objectism was conveyed more than the Rationalism value as well as the value of Objectism, which is, conveyed 74% more than the value of Rationalism

Control – Progress

Mastery of ones' environment conveys the value of control. That is control value refers to the security provided by Mathematics not only over natural phenomena but its application in solving problems in the social environment (Seah & Bishop, 2000). To ensure that one continue to have control over his environments, one need to broaden his schema to be innovative to accommodate new happening which challenges the security and control one has on his environment. The value of Progress is therefore concerned with expanding Mathematical skills through experiences to ensure stability or continuous control over ones' environment.

It is seen from Tables 6-9 that, the value of Progress is conveyed 246 times in BK 1A, 271 times in BK 1B, 131 times in BK1C and 101 times in BK 1D giving a total of 749.The value of Control is however conveyed 1823 times in BK 1A, 1207 times in BK 1B, 1481 times in BK 1C and 239 times in BK 1D totaling 4750. This implies that the value of Control is conveyed 4001 more than its complementary pair of Progress. This is evident in some individual topics. For example, in a topic like Rigid motion I in BK 1A, the value of Progress is conveyed 29 less than the value of Control.

The data presented in Tables 6- 9 for the complementary pair of Control and Progress are summarised into percentages in Table 11.

Table 11: Comparative Summary of Control and Progress values

BOOK	CONTROL	PROGRESS
BK 1A	88%	12%
BK 1B	82%	18%
BK 1C	92%	8%
BK 1D	70%	30%
AVERAGE BK 1A-D	86%	14%

Source: Field Data (2020)

From table 11 above, it is seen that 88% of the total value counts with respect to the complementary pair of control – Progress conveys control value in BK 1A as against 12% for Progress value which reflect total values of control and Progress as captured in Table 11.

This implies that, the value of Progress was conveyed 76%, 64%, 84% and 40% less than the value of control. This on average means that the value of Control is signaled 72% more than the value of Progress

Openness - Mystery

According to Seah and Bishop (2000), the nature of Mathematics has not ceased to be mysterious hence the knowledge of Mathematics presents some level of shocks and surprises as most people try to unravel the often blurred and opaque components. This is what the Mystery value is all about and when students get insight into what is seen to be opaque and blurred, the concept becomes open to them

The value of Mystery is conveyed 204 times,134 times, 108 times, and 32 times in BK 1A-D respectively.

The value of Openness is signaled 1592, 1080, 1352 and 457 times in BK 1A, BK 1B, BK 1C and BK 1D respectively giving a total of 4431.

For example, in table 9, Linear equations was not seen to convey any value of Mystery in BK 1D . Generally, the value of Openness was conveyed 3953 more than its complementary pair of Mystery.

Table 12 gives a comparative summary of the Openness and Mystery values conveyed in the four books considered for analyses in percentage terms.

Table 12: Comparative Summary of Openness and Mystery

BOOK	Openness	Mystery
BK 1A	89%	11%
BK1B	89%	11%
BK 1C	93%	7%
BK 1D	93%	7%
AVERAGE BK 1A– D	90%	10%

Source: Field Data (2020)

The value of Openness from Tables 6, 7, 8 and 9 as captured in percentage terms in Table 12 is emphasised in the books analysed more than their complementary pair of Mystery. That is, the value of Openness was emphasised 4431 representing 90% of the total counts of the sum of the complementary pair of values against its complementary pair of Mystery which was conveyed 478 times representing 10%. It is also seen from table 5 that, there are instances the value of Mystery is not conveyed at all in certain topics such as sets, surds, and linear Equations and Inequalities in BK 1D as against their complementary pair of Openness which were emphasised 7, 15 and 35 times for sets, surds, and Linear Equations and Inequalities.

In conclusion, from the 1352 pages explored from the four best-selling Ghanaian SHS 1 Core Mathematics textbooks, the values of Objectism, Control and Openness were emphasised more than their complementary values of Rationalism, Progress and Mystery.

Research Question 2: How are Mathematical values conveyed in the Ghanaian SHS 1 Core Mathematics textbooks?

This research question explore the ways various Mathematical values are signaled in the four Ghanaian SHS 1 Core Mathematics textbooks considered for this study. These were done under the subheadings of the Complementary pairs of Mathematical values. Examples which may be solved or unsolved as well as illustrations from the books analysed were used to make emphasis and meaningful analogies of the various values. Each example, illustrations and self-assessment question is termed as Case.

Rationalism- Objectism

Under this continuum, logical connectors in the form of subordinating conjunctions such as 'therefore', 'hence',' since' among others which establishes cause- and – effects were seen to be the main means through which Rationalism value was conveyed in the four best-selling Ghanaian SHS 1 Core Mathematics textbooks. Others subordinating conjunctions such as 'because of' 'that is', 'it means' among others which seeks to explain concepts and ensure cohesion and completeness were also seen as means through which Rationalism value was conveyed in the textbooks considered.

It must be noted that, the use of '∴' even though conveyed Objectism value was seen to communicate the value of Rationalism and hence was considered for analysis for both Rationalism value and Objectism value.

Below are solved and unsolved examples, which demonstrate how the value of Rationalism is captured in Mathematics textbooks considered.

Case 1

The average of five numbers 4, 10, 24 x and 16 is 13. Find the value of x

Solution

Since the average of the five numbers is 13, the sum of the five numbers is

15×13 = 65

Therefore, 4+10+24+x+16=65

54+x = 65

X =11. (BK 1A, p. 349)

From case 1 above, it could be seen that the value of Rationalism is emphasised using subordinating conjunctions 'since' and 'therefore' which establishes cause-and-effects relationship. These conjunctions also establish meaning and create logic in a Mathematical argument. In case 1 above, it is seen that the use of the subordinate conjunction 'since' was used to establish the reason why the sum of the five numbers is 45. 'Therefore' which is a conjunctive adverb helps to transition to the next step of presenting the solution. It does so by establishing the cause-and-effect relationship. That is, since the sum of the five values is 65, then 4+10+24+x+16=65. So, in effect, the value of x =11. This case reflect how Rationalism value was conveyed in all the 1354 pages of the four best- selling Ghanaian SHS 1 Core Mathematics. It is also seen that the subordinating conjunction 'therefore' was sometimes objectivised as '∴ '. This is evident in case 2 below

Case 2

The interior angle of a regular polygon is 108^{O}, find the number of sides of the regular polygon.

Solution

The interior angle of a regular polygon

$$= \frac{(n-2) \times 180^{O}}{n}$$

Where n is the number of sides

$\therefore = \frac{(n-2)\times 180}{n} = 108^{O}$

$\therefore$ multiplying through by n

$\therefore 180(n-2) = 108n$

$\therefore 180n - 360 = 108n$

$\therefore 180n - 108n = 360^{O}$

$\therefore 72n = 360 \quad \therefore n = \frac{360}{72} = 5$ (BK 1A, p. 218)

$\therefore$ the number of sides of the regular polygon is 5

From case 4 it is visible that the use of the objectivised form of 'therefore 'was used in establishing logic.

Case 3

A laborer is paid N300 for three days work. Find his pay for (a) 5 days (b) 17 days (BK IC, p. 446).

… Case 3 also requires the application of logic in solving real life situations. This could be done either using the objectivised forms of the logical connector as in case 2 or the logical connectors themselves as in case 1.

Generally, symbolization was however seen as the main way the value of Objectism was conveyed even though other signals such as the use of objects, charts, diagrams, and images were also identified to be the means through which the value of Objectism was conveyed. Symbols such like +, -, >, =, <, ∴ and the likes were heavily utilized. This is evident in cases 1 and 2 where +, -, =, and ∴ were heavily utilized.

Control - Progress

Value signals like the use of imperatives and the use of systematic instruction have been identified to be the main means the value of control was presented in the four best-selling Ghanaian SHS 1 Mathematics textbooks as demonstrated in Case 4 below.

Case 4

Find the average speed of a car that travels 45km in 2 hours 15 minutes (BK 1B, p. 394).

It was also seen that; the value of Control was also conveyed using the imperative 'find'. The use of algorithms and step by step instructions was also seen to be another mean of demonstrating the value of control. This is demonstrated in case 5 and 6 respectively

Case 5

Solve the value for x in

5x-3 = 3x +7

Solution

5x-3 = 3x+7

To get rid of 3x, subtract 3x from both sides.

i.e., 5x-3-3x= 3x+7-3x

2x-3 = 7

To get rid of -3, add 3 to both sides

i.e., 2x-3+3=7+3

2x = 10

Now let the letter stand on its own. Therefore, dividing both sides by 2 gives

$\frac{2x}{2} = \frac{10}{2}$ $\Rightarrow$ x = 5 (BK 1A, p. 250)

In Case 5 above, it is observed that BK 1A deployed the imperative 'solve 'as well as the use of structured instructions. This also reflect how Control was conveyed in the other books considered.

Case 6

Find the mean of the following numbers 3, 4, 6, 2 and 5

Solution

$$mean = \frac{\Sigma xi}{n} = \frac{3+4+6+2+5}{5} = \frac{20}{5} = 4 \text{ (BK 1D, p. 259)}$$

Case 6 however conveys the value of control using the imperative 'find' and the use of the algorithm $mean = \frac{\Sigma xi}{n}$ in solving the question

The value of Progress is also seen to be signaled using verbs such as 'how', 'why', 'what', 'which' and other related forms such as 'verify', 'prove', 'match' and 'determine' which rely on previous experiences and knowledge to make predictions of future occurrences. This is demonstrated in Case 7.

Case 7

State if each of the following relations are functions

(a) {(-3,1), (-2,3), (-1,0), (0,3), (0,5)}

{(2,7), (3, -5), (5,7), (7,7)} (BK 1D, p.174)

In case 7 above, the one need to prove or determine which of the relations given is a function. This could be done if knowledge of the differences between a relation and a function is already known. The ability of Mathematics to make one engage in all link existing knowledge to new situation characterises the progress value.

Openness and Mystery

The value of Mystery was seen to be conveyed in the Four Ghanaian SHS Core Mathematics textbooks mainly through complicated examples and exercises which do not follow the examples and illustrations given as in the textbooks as demonstrated in Case 8.

Case 8

A cyclist starts a journey from Town A. He rides 10km north, then 5km east and finally 10km on a bearing of $N45^{O}E$

(a) How far east is the cyclist destination from Town A?

(b) How far north is the cyclist destination from Town A

(c) Find the distance and bearing of the cyclist destination from town A. Correct your answer to the nearest km and degrees (BK 1A, p. 296)

In case 7, since this question may not be same or similar to what is already contained in the illustrations and examples used, it may present some form of confusion and opaqueness in unravelling how to go around the situation. The often-shady nature of mathematics portrays the Mystery value.

The value of Openness was however Conveyed in the Ghanaian SHS 1 Core Mathematics textbooks often through Mathematics activities that are easy to solve or within the cognitive abilities. Such activities were therefore

considered for analysis. The use of pronouns like 'we', you, us among others was also identified to signal the value of Openness.

The case 9 and 10 illustrates how these two main ways the value of Openness was signaled.

Case 9

(i) If a = -3, b =2, c = -1. Find the value of 4abc- a^3 (BK 1B, p. 23)

In case 9, students' awareness and insight into the question may make it easier. This is because similar examples have been solved in the book. It may however be seen to be Mystery if it is a new situation

Case 10

To arrange $\frac{1}{3}, \frac{1}{2}, \frac{2}{5}, \frac{1}{4}$ in order of size, you can use 3×2×5×4 = 120 as common denominator. So that we have…

In Case 10 above the use of we and other pronouns create the impression of awareness of an existing trait. So 'we can' , 'we have' among other signal the value of Openness.

So, in Summary, the four best- selling Ghanaian SHS 1 Core Mathematics Textbooks reveal that, the use of Mathematical symbols as evident in Cases 1 and 2 were the main means in which the Objectism values was conveyed even though the use of chart and other ways of objectivising mathematics reality were also employed. The Use of logical connectors in the form of subordinating conjunctions were seen to be heavily utilized in conveying Rationalism values. Other words that established cause- and – effect relationship and giving interpretation such as 'because of', 'that is', among others were also used to convey the value of Rationalism as in Cases 1 and 2.

The use of imperatives like ‘solve’, ‘find’ among others as well as the use of step-by-step instructions also served as the may means the value of Control was conveyed in Ghanaian SHS 1 Core Mathematics textbooks. This is shown in Cases 4 and 5. The use of algorithms was also used to convey the value of Control as in Case 6. For Progress value, the use of verbs such as how, prove, verify were the main way the value of Progress was signaled as evident in Case 7.

Complicated examples which may not be same or similar to what is already conveyed in the Mathematics textbook conveyed the value of Mystery while the use of examples and exercise that are similar to this conveyed in the textbook conveyed the value of Progress.

Research Question 3: Which Mathematics educational values are emphasised in the Ghanaian SHS 1 Core Mathematics textbooks?

Mathematics Educational values from Bishop (1996) as cited in Bishop et, al. (1999) explains Mathematics educational values as values conveyed in the pedagogy employed by the teacher and in this case textbooks in the quest to teach Mathematical concepts. Semantic content analysis was done on the four best-selling Ghanaian SHS 1 core mathematics textbooks using the signal frame as contained in the checklist.

The number of times a value signal is conveyed is counted until each of the textbooks has been fully explored.

Below are examples and illustrative examples which will appreciate how the values were explored.

Illustration 3

1. **New price =$\frac{(100-x)}{100}$ × original price**
2. Original price = $\frac{100}{(100-x)}$ ×New price
3. Discount allowed = $\frac{(Reduction\ in\ price}{original\ price}$ ×100 (BK 1A, page 418)

In the above illustration, the book just gave the axioms without any systematic proves. Therefore, to compute for example 'discount allowed', you just have to put in the values. This depict how the formalistic values are conveyed. The number of times these are conveyed are counted. In this case, this value is conveyed 3 times.

Example 3

Find the value of x which makes the mapping x→ $\frac{4}{x+3}$ undefined.

In the above example, the use of intuitive reasoning and the need to try different examples before coming to a conclusion that the mapping is undefined if x+3=0 or x= -1. Example three above is therefore counted as 1 for conveying the Activist view.

Example 4

Factorize $x^2 + 5x + 6$

In the example above, students may question the importance of factorization to real life and hence may see it as a theoretical knowledge. This example may therefore be counted as one of the theoretical values conveyed. Examples which may be relevant to real life situation will be counted as Relevance Knowledge as shown in example 5.

Example 5

Find the simple interest on Gh₵280 at 3.5% per annum simple interest for 6 month. In the example above, it would be easier to relate to activities in the real would such as borrowing from colleagues and paying back with interest. This portrays the value of relevance. Other values are also counted in similar ways as done in the examples provided using the signal frame. Contrast is drawn between the various complementary values by analysing the data.

Table 13, Table 14, Table 15 and Table 16 presents the data on the counts of various value signals under Mathematics Educational Values in BK 1A, BK 1B, BK 1C and BK 1D respectively.

Table 13 below presents the results of Mathematics Educational Values Conveyed in best- selling Ghanaian Core Mathematics textbook 1A.

Table 13: Mathematics Educational Values for Textbook A (BK 1A)

	TOPIC	Formalistic View	Activist view	Relevance	Theoretical Knowledge	Instrumental understanding	Relational understanding	Accessibility	Specialism	Evaluation	Reasoning
	Sets	98	42	47	65	144	42	203	34	265	21
	Real Number System	81	21	8	120	143	11	116		10	68
	Algebraic Expressions	66	3	7	77	182	-	175	14	167	16
	Surds	54	-	-	52	100	-	87	-	98	-
BK 1A	Number Bases	115	9	2	105	162	3	189	3	163	13
	Relations and Functions	85	21	7	126	184	16	177	4	154	15
	Plane Geometry I	172	5	12	203	175	14	82	38	107	27
	Linear Equations and Inequalities	177	63	55	254	132	23	132	8	140	1
	Bearings and Vectors in a Plane	106	43	38	107	77	38	139	8	130	19
	Statistics I	83	-	92	9	123	23	146	5	122	-
	Rigid Motion	20	3	-	37	86	7	90	-	98	-
	Ratio and Rates	11	161	140	19	48	83	132	12	146	5
	Percentages I	85	151	222	15	68	112	155	31	215	9
	TOTAL	1153	522	630	1189	1624	372	1823	167	1873	128

Source: Field Data (2020)

Results from Table 13 shows that out of the total of 421 pages of BK 1A, the total number of value count for Formalistic view, Theoretical knowledge, Instrumental understanding, Accessibility, and Evaluation values were 1153, 1189, 1624, 1823, and 1873 respectively as against their complementary pairs of Activist View, Relevance, Relational Understanding, Specialism, and Reasoning which were 522, 630, 372, 167 and 128 respectively. It is therefore evident from the table that, the values of Evaluation and Accessibility were heavily emphasized while the values of Specialism and Reasoning were the least emphasized values. Comparing the values conveyed to their complementary pairs, it is observed that the Formalistic view (1153) is 631 more than the Activist view (522), Theoretical knowledge (1189) is 559 more than Relevance value (630), Relational Understanding (372) is 1252 less than Instrumental understanding (1624), Accessibility (1823) is 1656 more than Specialism value (167) while Reasoning value (128) is 1745 less than Evaluation value (1873). The complementary value with the widest difference was therefore seen to be Reasoning and Evaluation values with a difference of 1745 while Theoretical and Relevance value was the complementary values with the least difference.

It is seen from Table 13 that even though generally the Formalistic view is signaled more than the Activist view, this is not the case for individual topics like Ration and Rates, as well as Percentage I where the opposite was rather the case. In Ratio and Rates, the Formalistic view is signaled 150 less than the Activist View, Formalistic view is also conveyed 66 less than the Activist view. Similarly, in Ratio and rates, as well as Percentages I Relational understanding was signaled more than Instrumental understanding

as opposed to the total value counts for all the thirteen topics where Instrumental Learning/ Understanding were conveyed more than Relational learning/ Understanding.

With respect to the individual topics, it is seen that Evaluation value is the most signaled value in an individual topic. That is the Evaluation value is conveyed 265 times in the topic 'sets. However, some values were not signaled at all in some topics. Example, in topics like Statistics and Rigid motion, no value of reasoning was conveyed. Similarly, Relational Understanding value was not conveyed in topics like Algebraic Expression and Surds.

A total of 9481 mathematics educational values were seen to be conveyed in BK 1A. Out of this number, the total counts for Formalistic – Activist view, Relevance- Theoretical Knowledge, Instrumental- Relational learning/ understanding, Accessibility- Specialism, and Evaluation Reasoning were 1675, 1819,1996, 1990, and 2001 respectively. This implies that Evaluation – Reasoning values were the most conveyed complementary pair of values whiles Formalistic- Activist view were the least conveyed pair of values.

Table 14 presents Mathematics Educational Values conveyed in best-selling Ghanaian SHS Core Mathematics textbook 1B.

Table 14: Mathematics Educational Values for Textbook 1B

BOOK	TOPIC	Formalistic view	Activist view	Relevance	Theoretical Knowledge	Instrumental understanding	Relational understanding	Accessibility	Specialism	Evaluation	Reasoning
BK 1B	Sets	64	46	18	140	60	12	71	23	50	18
	Real Number System	47	11	4	100	105	14	86	10	68	2
	Algebraic Expressions	32	4	4	98	92	17	124	17	50	5
	Surds	37	-	-	89	100	3	87	-	98	-
	Number Bases	41	17	3	77	82	10	62	4	46	4
	Relations and Functions	38	17	7	85	73	8	101	2	24	2
	Plane Geometry I	43	9	7	173	62	16	40	52	30	20
	Linear Equations and Inequ	50	3	8	113	57	4	109	25	55	5
	Bearings and Vectors in a F	47	25	12	93	89	23	147	55	81	5
	Statistics I	32	2	72	18	60	39	73	10	50	-
	Rigid Motion	28	6		102	66	8	87	2	50	-
	Ratio and Rates	15	100	102	30	56	40	90	8	74	1
	Percentages I	40	87	127	45	72	60	108	10	80	2
	TOTAL	**514**	**327**	**364**	**1163**	**974**	**254**	**1185**	**218**	**756**	**64**

Source: Field Data (2020)

From Table 14 above, it is seen that out of the 364 pages of BK 1B, the total number of counts of the number of times Formalistic view is emphasised is 514, Activist View 321, Relevance 364, Theoretical knowledge 1163, Instrumental understanding 974, Relational understanding 254, Accessibility 1185, Specialism, 218, Evaluation 756 and Reasoning 64. Results from Table 7 above means that the value of Accessibility is most conveyed value in BK 1B while Reasoning is the least conveyed value.

When the various complementary values are compared, it is observed that the Formalistic view (514) is 187 more the Activist view (327), the Relevance value (364) is 799 less than Theoretical knowledge (1163), Instrumental learning (974) is 720 more than Relational understanding (254), Accessibility value (1185) is 967 more than Specialism (218) while Evaluation (756) is 692 more than the value of Reasoning (64). From the various values continuums it is observed that the continuum with the highest difference is Accessibility – Specialism value (967) while Formalistic – Activist value (187) is the value continuum with the least difference. Even though Formalistic view is conveyed more than Activist view, Percentages as well as Ratio and Rates conveyed more Activist view than Formalistic view. Ratio and Rates conveyed Activist view (100) 85 more than Formalistic view while Percentages also conveyed Activist view (87) 47 more than Formalistic view. Similarly, the value of Relevance was also conveyed more than the Theoretical knowledge in both Ratio and Rates as well as Percentages I. Table 15 presents Mathematics Educational Values conveyed in best- selling Ghanaian SHS 1 Core Mathematics BK 1C. A total of 5819 mathematics educational values were seen to be conveyed in BK 1B . Out of this number,

Formalistic- Activist view, Relevance- Theoretical knowledge were the most conveyed complementary values while Evaluation-Reasoning were the least conveyed complementary values. Table 15 present mathematics educational values implicit in best-selling Ghanaian SHS 1 core mathematics textbook 1C.

Table 15: Mathematics Educational Values for Textbook 1C

	TOPIC	Formalistic view	Activist view	Relevance	Theoretical knowledge	Instrumental understanding	Relational understanding	Accessibility	Specialism	Evaluation	Reasoning
BK 1C	Sets	47	22	42	65	27	35	109	18	57	12
	Real Number System	40	12	18	134	110	67	97	9	100	2
	Algebraic Expressions	40	12	10	115	47	2	110	5	88	2
	Surds	65	18	2	110	67	9	97	2	60	2
	Number Bases	42	-	-	38	21	-	36	-	18	-
	Relations and Functions	65	7	1	97	57	9	90	8	50	3
	Plane Geometry I	56	13	2	174	75	-	170	16	122	14
	Linear Equations and Ineq	43	9	45	200	27	10	29	43	135	36
	Bearings and Vectors in a	26	27	33	52	64	22	12	41	34	34
	Statistics I	52	8	69	21	50	14	80	12	48	1
	Rigid Motion	35	5	-	60	13	2	35	-	17	-
	Ratio and Rates	60	40	147	23	15	80	170	9	126	6
	Percentages I	47	50	297	33	25	104	210	16	154	9
	TOTAL	**618**	**223**	**666**	**1122**	**598**	**354**	**1245**	**179**	**1009**	**121**

Source: Field Data (2020)

The results from Table 15 shows that, the total value counts for Formalistic View, Relevance, Instrumental understanding, Accessibility, and Evaluation values are 618, 666, 598, 1245, and 1009 while their complementary values of Activist view, Theoretical knowledge, Relational understanding, Specialism, and reasoning were 223, 1122, 354, 179, and 121 respectively. It is observed from these value counts that Accessibility is the most conveyed Mathematics Educational value while Reasoning is the least conveyed Mathematics Educational value in BK 1C. it is also evident from Table 15 that the Activist View (223) is signaled 395 less than Formalistic view(618), Theoretical knowledge (1122) is 456 more than Relevance Knowledge (666), Instrumental understanding (598) is 244 more than Relational learning Understanding(354) , Accessibility value (1245) is 1066 more than Specialism value while Reasoning is 888 less than the Evaluation value.

The value counts also largely reflected the total value counts in BK 1B. Few exceptions were uncounted as Percentages I emphasised Activist view (50) 3 more than the Formalistic view (47). Similarly, Bearing and Vectors conveyed Activist view (27) 1 more than the Formalistic view. Relational Understanding (35) was also seen to be conveyed 8 more than its complementary pair of Instrumental understanding (27). Some values were not seen to be conveyed at all. For example, Reasoning was not conveyed in Rigid motion I and Number Bases, Specialism was not conveyed in Rigid Motion I, among others.

Formalistic –Activist view, Relevance – Theoretical knowledge, Instrumental- Relational learning/ underatnding, Accessibility- Specialism,

and Evaluation- Reasoning conveyed 841, 1788, 952, 1424, and 1134 values respectively for each of the complementary pair of values. This gives a total count of mathematics educational values of 6135 in BK 1C . It is also evident that Relevance – Theoretical knowledge and Formalistic- Activist views were the most and least conveyed values in BK 1C respectively. Table 16 presents results of Mathematics Educational Values Conveyed in best-selling Ghanaian SHS 1 BK 1D.

Table 16: Mathematics Educational Values for Textbook 1D

BOOK	TOPIC	Formalistic view	Activist view	Relevance Knowledge	Theoretical Knowledge	Instrumental understanding	Relational understanding	Accessibility	Specialism	Evaluation	Reasoning
	Sets	9	4	5	13	4	6	14	1	4	1
	Real Number System	12	2	2	21	10	2	13	2	22	
	Algebraic Expressions	6	3	-	11	8	-	13	-	7	-
	Surds	11	10	3	11	10	-	14	-	14	-
	Number Bases	12	3	-	23	3	-	12	-	33	-
	Relations and Functions	30	4	-	12	11	-	13	-	88	2
BK 1D	Plane Geometry I	12	2	-	13	12	12	14	8	13	4
	Linear Equations and In	54	12	7	34	24	9	34	44	21	3
	Bearings and Vectors in	62	12	10	53	34	5	34	13	34	9
	Statistics I	40	2	32	13	24	10	13	9	9	-
	Rigid Motion	24	4	-	23	23	3	40	3	12	-
	Ratio and Rates	14	6	8	11	3	13	12	5	3	-
	Percentages I	11	2	12	5	2	11	16	2	9	-
	TOTAL	**297**	**66**	**79**	**243**	**168**	**71**	**242**	**87**	**269**	**19**
	GRAND TOTAL	**2582**	**1138**	**1739**	**3717**	**3364**	**1051**	**4495**	**651**	**3907**	**332**

Source: Field Data (2020)

Results from Table 16 shows that, from the 233 pages of the best-selling Ghanaian SHS 1 Core Mathematics BK 1D, Formalistic View, Relevance Knowledge, Instrumental understanding, Accessibility value, and Evaluation values were conveyed, 298, 79, 168, 242, and 269 times respectively. Also, the total value counts for their complementary pairs of Activist view, Theoretical knowledge, Relational understanding, Specialism, and Reasoning are 66, 243, 71, 87, and 19 respectively. Table 16 further indicates that Formalistic view is the most conveyed value signal while Reasoning is the least conveyed value. Comparing the various values to their complementary pairs, it is observed that Formalistic view (297) is conveyed 231 more than The Activist view, Relevance Knowledge (79) is 164 less than Theoretical knowledge (243), Instrumental learning (168) is 97 more than Relational understanding, Accessibility value (242) is also 155 more than Specialism value while Reasoning (19) value is 250 less than Evaluation value (269). The Formalistic view is conveyed 62 times in Bearing and vectors which is the highest number of times a particular value signal is conveyed in a topic in BK 1D. Some values were however not signaled at all in BK ID. Example, Surd did not convey any Reasoning value, Number bases did not also emphasize any Specialism value, Plane Geometry I did not convey any Relevance Knowledge value among others.

In all, 1541 mathematics educational values were conveyed in BK 1D. The total value count for Formalistic- Activist view, Relevance- Theoretical Knowledge, Instrumental- Relational learning/understanding, Accessibility- Specialism, and Evaluation- Reasoning were 363, 322, 239, 329, and 288 respectively . it is evident that formalistic –Activist view and Instrumental-

Relational underatnding were the most and least conveyed complementary values respectively.

Grand total for the values for the four best-selling Core Mathematics textbooks shows that the total value counts for Formalistic View, Relevance Knowledge, Instrumental learning, Accessibility and Evaluation are 2582, 1739, 3364, 4495, 3907 while their complementary pairs of Activist view, Theoretical knowledge, Relational Understanding, Specialism, and reasoning are 1138, 3717, 1051, 651, and 332 respectively. This gives a total of 22976 Mathematics Educational Values conveyed in the four best-selling Ghanaian SHS 1 Mathematics textbooks of which 9481 are conveyed in BK 1A, 5819 in BK 1B, 6135 in BK 1C, and 1541 in BK 1D respectively. In all the four books, it is observed that Formalistic View, Activist View, Theoretical knowledge, Instrumental Knowledge, Relational Knowledge, Accessibility, Specialism, Evaluation, and Reasoning are conveyed in BK 1A more than any other book considered. In BK C however, Relevance Knowledge is conveyed more than in any other book considered. Reasoning values was seen to be the least conveyed value in all the four books considered.

The four best- selling Ghanaian SHS 1 core mathematics textbooks showed some difference with respect to which of the complementary pair of values was conveyed the most or least . It is evident from the analysis of the various tables that, BK 1A conveyed more Evaluation – Reasoning values and less Formalistic-Activist values, this was not the case of BK 1B which conveyed more Relevance – Theoretical knowledge and les of Evaluation – Reasoning values. BK 1C conveyed more Relevance- Theoretical values just as BK 1B but however conveyed less Formalistic – Activist view. The

formalistic Activist view whish was least conveyed in BK 1C was rather conveyed the most in BK 1D whiles instrumental – Relational understanding was conveyed the least in BK 1D

Further analysis was done by putting the various values under their complementary pairs as Formalistic View- Activist View, Relevance Knowledge – Theoretical knowledge, Instrumental learning – Relational Learning, Accessibility- Specialism, and Evaluation v- Reasoning values. for all the four best- selling Ghanaian SHS 1 Core Mathematics textbooks.

Formalistic View – Activist View

From Tables 13-16 respectively, the Activist View was conveyed 522, 327, 223 and 66 times totaling 1138times in BK 1A, BK 1B, BK 1C, BK 1D respectively. Activist view was also signaled 1153 times in BK 1A, 514 times in BK 1B, 618 times in BK 1C, and 297 times in BK 1D totaling 2582 for all the four books. This means that the Formalistic view is portrayed 1444 more than the Activist view. The Formalistic view was seen to be portrayed more the Activist view in almost all the individual topics in the four books except a topic like Percentages I in BK 1A, BK1B and BK 1C where the Activist view was seen to be conveyed 67, 47 and 3 more than the Formalistic respectively. Also, in a topic like Ratio and Rates in BK 1A and BK 1B, the Formalistic view us seen to be conveyed 150, 85 less than the Activist view respectively. Table 17 presents a comparative analysis of the Formalistic and Activist view in percentage terms.

Table 17: Comparative Summary of Formalistic and Activist View

BOOKS	FORMALISTIC VIEW	ACTIVIST VIEW
BK 1A	69%	31%
BK 1B	61%	39%
BK 1C	73%	27%
BK 1D	82%	18%
AVERAGE BK 1 A-D	69%	31 %

Source: Field Data (2020)

Considering Tables 13, 14, 15, and 16 and its percentage computation of the complementary pair of Formalistic view and Activist view as captured in Table 17, it could be seen clearly that, the Formalistic View has enjoyed a lot of emphasis in Ghanaian Core Mathematics textbooks as compared to its complementary pair of Activist View. This is also evident in Table 17 as the Activist View is seen to be 38%, 22%, 46% and 64% less than the Formalistic View for the four textbooks considered. This averagely implies that the Formalistic view was signaled 38% more than the Activist view

Relevance - Theoretical Knowledge

Teachers most often use a lot of examples, illustrations among others which may or may not be relevant to societal context. That is, examples and exercises as well as illustrations which associate Mathematics to our daily life activities and as a matter of fact sees mathematics to be about daily life activities is seen to convey the value of Relevance.

The Theoretical value on the other hand reflects the teaching of mathematics with examples that only acknowledges mathematics as mathematics and is devoid of societal context.

In the four Ghanaian SHS 1 Core Mathematics textbooks considered, Theoretical value was conveyed 1189, 1163, 1122 and 243 totaling 3,717 in BK 1A-D respectively. The Relevance Value on the other hand is conveyed 630, 364, 666, and 79 totaling 1739 in BK 1A, BK 1B, BK 1C, and BK 1D respectively. This presents a difference of 1978 between the two complementary values. The Theoretical value was largely emphasised more than the Relevance value excepts for few topics like Percentages I where Relevance value was signaled 207, 82, 264, and 7 more than Theoretical knowledge in BK 1A-D respectively. In Ratio and Rates, the value of Theoretical knowledge was conveyed 121, 72, and 124 in BK 1A-C respectively. Same was the case in topic like statistics where Theoretical knowledge was emphasised 83, 54, and 19 less than Relevance Knowledge in BK 1A, BK 1B and BK 1D respectively.

Table 18 present a comparative overview of Relevance and Theoretical knowledge in percentage terms.

Table 18: Comparative Summary of Relevance and Theoretical values

	Relevance	Theoretical
BK 1A	35%	65%
BK1B	24%	76%
BK 1C	37%	63%
BK 1D	25%	75%
AVERAGE BK 1A – D	30%	70%

Source: Field Data (2020)

From Table 18, it is seen that the Relevance value is Conveyed 30%, 52%, 26%, and 50% less than Theoretical value which implies that it is 40% less than the Theoretical value on average. It is seen further that, from all the

books analyzed, the Theoretical value is conveyed more than the Relevance Value.

Instrumental – Relational Understanding

From Tables 13- 16, it was seen that Instrumental understanding is emphasised 1624 times in BK 1A. 974 times in BK 1B, 598 times in BK 1C and 168 times in BK 1D totaling 3364. Relational understanding on the other hand was conveyed 372, 254, 354, and 71 in BK 1A- D totaling 1051.

It is seen from tables 13- 16 that Instrumental understanding was largely emphasized in all the four Ghanaian SHS 1 Core Mathematics textbooks except for some few topics. In a topic like Percentages I in BK 1A, BK 1C and BK ID, the value Relevance value was seen to be conveyed 44, 79, and 9 more than the Relevance value. Relevance value is also seen to be conveyed more than the Theoretical value in topics like Ratio and Rates in BK 1A, BK 1C and BK 1D.

Table 19 summarises the frequencies of Instrumental and Relational Understanding values into percentages.

Table 19: Comparative Summary of Instrumental and Relational Understanding

	Instrumental	Relational
BK 1A	81%	19%
BK1B	79%	21%
BK 1C	63%	37%
BK 1D	70%	30%
AVERAGE BK 1A – D	76%	24%

Source: Field Data (2020)

Instrumental learning is seen from Table 19 to be conveyed more than its complementary value of Relational understanding. Thus, BK 1A (81%) against (19%), BK 1B (79%) against (21%), BK 1C (63%) against (37%) and

BK 1D (70%) against (30%) all in favor of Relational understanding. Relational understanding is seen to conveyed 52% less than its complementary value in average terms.

Accessibility – Specialism

From Tables 13- 16, it is observed that, the value of Accessibility is signaled 1823 in BK 1A, 1185 in BK 1B, 1245 in BK 1C, and 2432 in BK 1D totaling 4495 for the all the four books. The Specialism value is conveyed 167, 218, 179 and 87 in BK 1A-D totaling 651 for all the Ghanaian SHS 1 Core Mathematics textbooks considered. The Accessibility value was signaled more than the value of Specialism in all the four books except for BK 1B where in a topic like Plane Geometry I, the value of Specialism was emphasised 12 more than the Accessibility value. It is also seen that some of the topics in the various books did not convey the value of Specialism at all. Example, Algebraic Expression, Surds, and Number Bases did not convey any value of Specialism in BK 1D.

Table 20: Comparative Summary of Accessibility and Specialism Values

	Accessibility	Specialism
BK 1A	92%	8%
BK1B	78%	22%
BK 1C	85%	15%
BK 1D	76%	24%
BK 1A – D	86%	14%

Source: Field Data (2020)

From Table 20, it is seen that the value of Specialism is conveyed 84%, 56%, 70% and 52% less than the value of Accessibility in BK 1A- D respectively. This value of Specialism is therefore on average 72% less than the value of Accessibility when all the four books were considered.

Evaluation – Reasoning

From Tables 13- 16, it is observed that the value of Evaluation is conveyed 1873, 756, 1009, and 269 in BK 1A-D totaling 3907. Reasoning value is also conveyed 128, 64, 121, and 19 in BK 1A-D totaling 332 for the all the four books. Largely, the value of Reasoning was not seen from Tables 13-16 to be conveyed much in Ghanaian SHS 1 core Mathematics Textbooks. For example, the value of Reasoning was seen to be conveyed in only 5 out of the 13 topics in BK 1D. In BK 1A, it is observed that topics like surd and rigid motion did not convey the Reasoning value. Same can be said in BK 1B and 1C.

Table 21 provides a summary of the frequencies for Evaluation and Reasoning values in Tables 13- 16.

Table 21: Comparative Summary of Evaluation and Reasoning values

	Evaluation	Reasoning
BK 1A	94%	6%
BK1B	92%	8%
BK 1C	89%	11%
BK 1D	94%	6%
BK 1A – D	92%	8%

Source: Field Data (2020)

From Table 21 above, it is seen that the Ghanaian SHS 1 Core Mathematics textbooks emphasised the Evaluation value for than the value of Reasoning. Evaluation value is seen to be conveyed 88%, 84%, 78%, and 88% more than the value of Reasoning in BK 1A, BK 1B, BK 1C and BK 1D

respectively. This gives an average percentage of the complementary values to stand at 92% and 8% for Evaluation and Reasoning respectively.

Research Question 4: How do the Ghanaian SHS 1 Core Mathematics textbooks portray Mathematics Educational values?

This research question was answered by looking critically at the ways the Ghanaian SHS 1 Mathematics textbooks conveyed Mathematics Educational Values. This was done by grouping them under their complementary pair of values.

Formalistic– Activist View

The receptive and deductive approach of teaching and learning which characterizes the Formalistic View is conveyed in the best-selling Ghanaian SHS core mathematics textbooks mainly through the use of algorithms and the use of structured instructions. This is portrayed in case 11 and 12.

Case 11

Find the image of -4 under the mapping f: x $\rightarrow \frac{1}{2}x$ -2

Solution

To find the image of a number when the rue for the mapping is given, substitute the number into the rule

-4 $\rightarrow \frac{1}{2}(-4) - 2$

-4 → -4 ∴ the image of -4 is -4 (BK 1B, p.157).

Case 12

Simple Interest (I) = P×T×R

Time is the year and Rate is the percentage. The Principal is the Initial Amount.

From I= P×T×R

P, R, or T can be made the subject i.e. T= $\rightarrow \frac{I}{PR}$; $R = \frac{I}{PT}$

$P = \frac{I}{RT}$ and hence exercise contained in the remaining pages of BK 1A were all using the same rules.

Dormolen (1986) opines that, teachers who hold the Formalistic view teach through the programmed instructions for students to acquire certain concept just as demonstrated in Cases 11 and 12.

For the Activist View, it is mainly demonstrated in the Ghanaian Mathematics textbooks through Mathematics activities which invoke intuitiveness and engaging in generalization. It is conveyed by guiding students through activities which will help them in making generalizations after exploring patterns as captured in Case 13 below.

Case 13: Finding the sum of interior angles of a regular polygon (BK 1A, p. 217)

Polygons	No. of Sides	No. of Triangles	Sum of Interior Angles
Triangles	3	1	180
Quadrilateral	4	(4-2) = 2	360
Pentagon	5	(5-2) = 3	540
Hexagon	6		
Heptagon	7		
Octagon	8		
Nonagon	9		
Decagon	10		
n- sided figure	N	(n-2)	(n-2) ×180^{O}

From Case 13 above it is seen that the book provides explorative means of identifying patterns before generalization is made. That is, after identifying that the number of triangles is two less than the number of sides, identifying that the sum of interior angles of a triangle is 180^{O}, then they could

generalize that the sum interior angles of a regular polygon of n sides is given as $(n-2) \times 180^{O}$

This basically reflected how the Activist view was conveyed in the textbooks explored

Relevance – Theoretical knowledge

In the Ghanaian context, the value of Relevance was conveyed in the best-selling Ghanaian SHS 1 Core Mathematics textbooks mainly through the use of exercises, illustrations and examples that are practical to our daily life context. Examples are given in case 14 and 15.

Case 14

Nana Ama buys 480 pineapples for Gh₵ 240. She sells all the pineapples for Gh₵ 280. Find her

i) Profit

ii) Profit percent (BK 1B, p. 432)

Case 15

A man invests a sum of money at 4% per annum simple interest. After 3 years, the principal amounts to Gh₵ 7000. Find the sum invested (BK 1D, p. 328).

From the examples given under Percentages in BK 1B and BK 1 D respectively, it is seen that students can connect the examples to their daily life activities. These activities help bridge the gap between school mathematics and out of school mathematics.

Theoretical values were also signaled in the Ghanaian SHS 1 Core Mathematics textbooks mainly through exercises, examples and illustration

which does not include context. That is, they do not link questions to real life situations. Examples are demonstrated in case 16 and 17.

Case 16

Decrease 150 by 20% (BK 1B, p. 416)

Case 17

Factorize $x^2 + 5x + 6$ (BK 1A, p. 98)

Case 16 and 17 above are clearly devoid of real-life context and hence signals the Theoretical value. Too much of these activities makes students think there is no linkage between the Mathematics taught in schools and the general social and economic life.

Instrumental understanding – Relational Understanding

The Instrumental – Relational Continuum emphasises two sets of values. The former emphasises a classroom pedagogical approach which emphasises the use of rules without linking it to the appropriate Schema of students as derived from Skemp (1976). The latter on the other hand emphasises the value conveyed when teaching is tailored towards linking the Mathematics activities to relevant schema of students. Dede (2006a) further distinguishes between these complementary values by explaining further that, Instrumental understanding emphasises the use of formulas, rules and operations as well as their application in questions which requires such rules. Connectedness and linkage of a particular concepts to other concepts as well as the formation of appropriate graphics reflects Relational understanding.

Instrumental understanding is emphasised in the Ghanaian Core mathematics textbooks using a lot of examples and trial exercises as opposed to employing real life problems which requires problem solving strategies. It

is also emphasised using formulas and operations and its related forms. Case 18 and 19 portrays how Instrumental understanding is conveyed in Core mathematics textbooks.

Case 18

Find the mean of 12, 7, 4, 18, 6, 12, 11,9,9,7 (BK 1D, p. 349)

In the above example, it is seen that the books provide the formula for calculating the mean as $\frac{\Sigma x}{n}$ and hence students will have to use the formula anytime they come across questions which ask them to calculate for the mean.

Case 19

We can only add or subtract surds which are alike or have the same form.

Note: reduce first to their basic forms, if they are not

1) $m\sqrt{k}$+ n$\sqrt{k}$ = (m+n) $\sqrt{k}$

2) $m\sqrt{k}$- n$\sqrt{k}$ = (m-n) $\sqrt{k}$

Note: $\sqrt{5} + \sqrt{2} \neq \sqrt{7}$

$\sqrt{5} - \sqrt{2} \neq \sqrt{3}$ (BK 1A, p. 114)

From Case 19, it is also seen that rules are emphasised and how these rules must be applied are emphasised which reflects Instrumental understanding.

Relational understanding on the other hand is conveyed in Ghanaian SHS 1 Core Mathematics textbooks using a particular concept in different context so that students will be able to associate the relationship between concepts as shown in case 20.

Case 20

A ladder leans a vertical wall of height of height 12m. If the foot of the ladder is 5m away from the wall, calculate the length of the ladder (BK 1A, p. 206).

In the above example, Pythagoras theorem is applied in a real-life activity where ladder is used. It helps students in transferring knowledge from one real life to solving Mathematical problems.

Accessibility – Specialism

The Accessibility and Specialism continuum as from the accounts of Dede (2006a) as well as Seah and Seah and Bishop (2000) talks about whether Mathematics activities in the classroom could be performed by everyone or for some elite group who have knowledge in it. The Ghanaian SHS 1 Core Mathematics textbooks conveyed the Accessibility value through Mathematics activities which everyone could do as shown in case 21 and 22.

Case 21

Find the truth set of the following equation.

i) $4x = 12$ (ii) $3x + 7 = 22$ (BK 1D, p. 30)

Case 22

If $\frac{7}{13} = \frac{x}{52}$ solve for x (BK 1A, p. 259).

In Cases 21 and 22, it is expected that any students at the SHS level should be able to solve those basic questions. And these lines of questioning reflect the Accessibility value.

Specialism Values on the other hand was however signaled in Ghanaian SHS 1 Core Mathematics textbooks using complex and

complicated exercises and examples which could only be understood by some gifted students as shown in case 23.

Case 23

A motorist travelled 40 km at an average speed of 30km/h. If he made the return journey at an average speed of 50km/h, find the average speed of the whole journey (BK 1A, p. 395).

In case 23, above, it is seen that specialized vocabulary like 'average', 'speed' if not familiar to student, may not be able to solve the question.

Evaluation- Reasoning

There are instances where exercises given at the end of the lesson requires the use of routine operations used in examples and illustration given. There are also instances where exercises given at the end of the instructional period does not use operations or approaches like what was used in explaining the concepts. The former is reflecting the Evaluation value whiles the latter reflects the Reasoning value. When analyzing the Ghanaian Mathematics textbooks, self-assessment questions and trial questions which requires routine operations used in the examples and illustrations where therefore considered and analyzed under the value of Evaluation whiles self-assessment questions and trial questions which does not require routine operations and hence may require students to think were analyzed under reasoning. Case 24 and 25 reflects the value of Evaluation and Reasoning respectively.

Sample 24

Find the truth set of the following.

1) $X+3 > 5$

2) $7x + 15 < x + 3$ (BK 1C, p. 59).

Sample 25

Two men starts from towns 20km apart and walks towards each other. They meet in 120 minutes. One walks at 6km/h. How fast does the other man walk? (BK 1A, p. 282)

In Case 24, the use of routine symbols as conveyed in the textbooks makes it easier to solve and students may not necessarily resort to the power of reason. That is not However the situation in Case 25 as students needs to wear the thinking cap before they could solve the questions. This style of questioning reflects Evaluation and Reasoning values respectively.

So, in summary, Formalistic view was conveyed in the Ghanaian SHS 1 Core Mathematics textbooks mainly using deductive and receptive methods as evident in Cases 11 and 12. Activities that invokes intuitiveness as shown in Case 13 helped in generalising which reflected how majority of the textbooks conveyed the value Activist view.

Mathematics activities which drew the attention of students to the link between school and out of school signaled how the values of Relevance Knowledge was conveyed as observed in Cases 14 and 15, However activities that are devoid of societal context as in Cases 16 and 17 signaled how Theoretical knowledge was conveyed in best- selling Ghanaian SHS 1 mathematics textbooks.

Mathematics Activities that are tailored linking relevant schema of students reflected Relational learning value as evident in Case 20 while mathematics activities that teaches rules and how rules must be applied as shown in Case 18 and 19 signaled the Instrumental Learning values.

Mathematics Activities which every student can do reflected how Mathematics textbooks conveyed the value of Accessibility as shown in Case 21 and 22 while Mathematical activities which could only be solved by some few gifted students signaled the Specialism value as shown in Case 23.

In the four best-selling Ghanaian SHS 1 Core Mathematics textbooks, it was seen that self-assessment questions which used routine operations similar to the ones conveyed in illustrations and examples used conveyed the value of Evaluation as evident in Case24 whiles mathematics activities which uses operations different from what is conveyed in the examples and illustrations signaled the Reasoning value as shown in Case 25.

Research Question 5: To what extent are Mathematics teachers' aware of values implicit in Mathematics?

Teachers' awareness of values implicit in mathematics as a discipline and in its pedagogy is a very important factor in the teaching and learning process. This is because the extent to which teachers are seen to be effective depends on their level of value awareness (Seah & Wong, 2012). According to Taqiah and Bahari (2018), teachers' awareness of values is essential in creating appropriate environment conducive enough for students learning. They added that, it is also vital in dealing with emotional components of students learning.

In exploring the awareness level of teachers on values implicit in mathematics as a discipline and in the pedagogical components in conveying appropriate concepts, semi structure interviews were used. Excerpts of teachers' responses are used to support major arguments. It should be noted

that, T1, T2, T3, and T4 represents responses from Teachers 1-4 while R represents the question posed by the interviewer.

On whether teachers were aware that mathematics contains values, findings from the interview revealed that two of the teachers representing half of the respondents said they are aware that mathematics contains values. Some of the typical responses were *"Yes. Every discipline may contain values"* (T1) and "*Of course, Yes. Values is part of society which mathematics is part"* (T2).

The responses above were to the interview questions "*Are you aware there are values in mathematics*" suggested that the respondent believed mathematics contains values. The remaining half however were not sure that values were contained in mathematics. This evident in the respondents' responses to the interview "Sorry, I have no idea about that" (T3) and *"Values? in mathematics? I am not sure, but I think it is possible even though I have not thought about that" (*T4).

The response by T4 suggest that, even though he said he was aware of values in society, he was not sure that it could transcend to normal societal interaction to mathematics which is seen to be a discipline devoid of cultural elements. Further comment by T4 that "I think it is possible" may further imply that society is uncertain whether Mathematics really contains values. This may however represent the views of many who are yet to realise that mathematics contains values.

Respondents were then asked what Mathematical values meant to them. The responses from the respondents T1 and T4 suggested that the majority did not understand what mathematical values were. Some of the

typical responses the respondents gave when they were asked "*What does Mathematical Values mean to you?"* included:

T1: *They are values we transmit to students when we teach mathematics. example, by teaching 1+1=2, we want to inculcate the value of accuracy in students.*

T4: *They are what we learn from mathematics, which are basically the importance of mathematics. Example, they help us to count money.*

From the responses from T1 and T4, it could be concluded that, they associated mathematical values to values conveyed in mathematics though Pedagogies employed by the teacher. That is, the responses from T1 suggest the Instrumental understanding and Theoretical knowledge in Mathematics Educational values where 1+1=2 is seen to be absolute and devoid of context. The response from T4 may also reflect the Relevance value under mathematics Educational Values where linkages are made on mathematics activities to it application in everyday life. By the responses of T1 and T4, it was clear that they did not know that Mathematics as a discipline contains values since they misconstrued Mathematics Educational values to be Mathematical values.

It is also imlied in their responses that they went ahead to respond to questions *" in what way do you think mathematical values are conveyed to students?"* through their answers they gave to their question " *what does mathematical values mean to you ?"*So, in effect, they were not able to show how mathematical values are conveyed to students.

The response that *"They are values in mathematics and may include tolerance, logical analysis among others"* (T2) however suggest some level of

understanding of Mathematical values as his response may be associated to Rationalism value which deals with the power of reason even though follow up questions revealed he did not have enough knowledge on what exactly constituted Mathematical values and how they are conveyed to students.

Understanding of the awareness of Mathematics Educational Values was also sought from the respondents. Responses from the respondents revealed that they seem to be holding the same answers they gave when asked of their knowledge of Mathematical values when they were asked "*Are you are of Mathematics Educational values*?". The following are some of the typical responses of the respondents: "*Ah, but are they not the same as the first one (*T1*)* and" *Mathematics Educational values are values we teach in mathematics. Example, every student must justify the reason for providing a particular answer to a given question"* (T2).

The response by T1 suggest a confusion on the differences between Mathematical values and Mathematics Educational Values. The response of T2 implied that he did not know the difference between the two set of values. Even though his responses could be linked to Rationalism value, it does not fall under Mathematics Educational Values. It was only the response that "*In the Mathematics class, we learn things for the purpose of applying it in society. And that is Mathematics Educational values*" (T4) which seem to suggest some level of understanding of what Mathematics Educational values are as the response could be linked to Relevance value under Mathematics Educational values. It could also be implied in the answer given that they have little awareness of values of how mathematics educational values are conveyed to students.

In summary, the four teachers interviewed displayed varied level of awareness of values conveyed in mathematics as a discipline and Values conveyed through pedagogies adopted in teaching mathematics. Whiles some of them declared that they were aware (T1& T2), others (T3 & T4) stated they are not aware of values conveyed in mathematics as a discipline and in its pedagogies. It was evident in their responses that they had little knowledge on what Mathematical Values and Mathematics Educational values as they struggled to draw clear distinctions between the two values. It is implied in their responses that those who declared their awareness of Mathematical and Mathematics Educational values had little knowledge of what its components values were. Their responses only reflected some of the values under Mathematical and Mathematics Educational values.

Discussions

Results of this study suggest that values conveyed in best-selling Ghanaian SHS 1 core mathematics textbooks was basically dominated with symbols which reflects the Objectism value whiles little attention was given to the role of meaningful, systematic, and logical presentation of concepts for students to learn Relationally as contained in Tables 6-9 and Case 2 where symbols like ∴, =, -, +, became dominant in the mathematics activities presented. This was also associated with the dominance of Instrumental learning procedures as it is evident in Cases 18 and 19 where mathematics activities are presented mainly through the use of formulas. It is also visible in the books considered for analysis that they contained a lot of drill questions and examples with inadequate employments of problem-solving strategies which also reflect a clear emphasis of Formalistic view as opposed to the

Activist view as evident in Case 11. Students were not seen to be challenged or stretched by the questions and examples used as evident in Cases 6 and 7 hence remained seemingly stable (Control) since questions given and examples provided did not create much room for students to apply concepts to new situations making little provision for the value of Progress which involves innovation and creativity in linking what exist in the present Schema to new and challenging problems as presented in Case 7. Mathematics concepts were seen to be taught much theoretically than relationally as in Case 18 where the book asked users to find the mean of a given set of numbers. This could have been perhaps made relational if the mean ages of the students in a class were used or other examples, which reflects our local Ghanaian context, which may create adequate linkage between school experiences and everyday experiences. These activities were mostly not too new or not seen to present much shock (Mystery) to pupils since they mostly used routine operations (Evaluation) as presented in Case 24 which may not promote critical and rational thinking (Reasoning).

So, in general, the Ghanaian Core Mathematics textbooks emphasise on Objectism, Control, Openness, Formalistic View, Instrumental understanding, Theoretical value, Accessibility and Evaluation values as opposed to their complementary pairs of Rationalism, Progress, Mystery, Activist View, Relevance, Specialism and Reasoning values respectively.

The findings from this study may imply that, best-selling Ghanaian Mathematics textbooks present an imbalance in values implicit in them. These findings are consistent with the findings of Dede (2006a), Dede (2006b), Seah and Bishop (2000) as well as Taqiah and Bahari (2018) even though some

significant differences also exist. Even though the findings with regards to the percentage of values conveyed in the textbooks analsed by the researchers may not be the same as the ones presented in this study, one thing is clear that all the textbooks analysed by these researchers emphasised Control values for the Mathematical value and Formalistic View, Instrumental understanding, Theoretical value, and Evaluation values for Mathematics Educational Values. For example, According to Seah and Bishop (2000) the Formalistic view, Instrumental understanding, Theoretical knowledge, and Evaluation values represented 92%, 97%, 62% and 93% respectively of the total values conveyed when compared to their complementary pairs. In the Ghanaian context, Formalistic View, Instrumental understanding, Theoretical knowledge, and Evaluation values represented 69%, 76%, 70% and 92% respectively as contained in tables 10, 12, 11 and 14 respectively. This is opposed to their complementary pairs of Activist View, Relational understanding, Relevance and Reasoning values. Similarities also exist between the findings of this study and the work of Dede (2006a) and Dede (2006b) where the values of Openness was emphasised more than its complementary pair of values as evident in Table 8. Objectism value is also seen to be emphasised in both the current study and that of Seah and Bishop (2000) as the Objectism value occupied 87% of the total number of values conveyed among its complementary pair.

The values in the best- selling Ghanaian SHS 1 core mathematics textbooks were seen to be conveyed in a similar way like that of Singaporean and Victorian textbooks as contained in a research by Seah and Bishop (2000). For example, the value of control was conveyed in the best- selling

Ghanaian SHS 1 textbooks mainly through the use of imperatives which is similar to how it is conveyed in the Singaporean mathematics textbook as reported by Seah and Bishop (2000). Also, Rationalism value was conveyed in the best- selling Ghanaian SHS 1 and Singaporean textbooks mainly using logical connectors like hence, therefore among others. It is also worth noting that, the values emphasised in the best-selling Ghanaian SHS 1 core mathematics textbooks even though were in line with the work of Seah and Bishop (2000), were not conveyed exactly in the same manner. For example, while the Activist view from the account of Seah and Bishop (2000) was presented by linking mathematical knowledge to various historical experiences in the Singaporean textbooks, the best-selling Ghanaian SHS 1 core mathematics textbooks conveyed the Activist view mainly using mathematics activities which helps students to explore and discover patterns in generalising.

With regards to the type of value emphasised, it is seen that, while the findings of this study emphasises the value of Objectism and Openness more than their complementary pair of Rationalism and Mystery respectively, this is contrary to the finding of Seah and Bishop (2000) where the textbooks analysed emphasised Rationalism and Mystery values as against their complementary pairs. Dede (2006a) and Dede (2006b) emphasised the value of Rationalism more than its complementary pair of Objectism value which is also in contrast with the findings of this study where Objectism was seen to be emphasised more than the Rationalism value.

For Mathematics Educational Values, it is observed that the findings of all the researchers indicated that all the textbooks emphasised Formalistic

view, Theoretical understanding, Instrumental learning/understanding and Evaluation values which is in line with the findings of this study. However, the Accessibility and Specialism continuum presents a slight disparity. Whiles the findings of this study is line with Dede (2006a) and Dede (2006b) where the value of Accessibility is emphasised more than the value of Specialism, this is not the case of Seah and Bishop (2000) where the findings indicated emphasis of both Victorian and Singaporean textbooks on the value of Specialism.

The emphasis on for example, Instrumental understanding and Theoretical learning as opposed to Relational learning and Relevance is in line with the work of Davis, Bishop and Seah (2010) which is further supported by Fletcher (2010) that, there seems to be a gap between school mathematics and out of school mathematics. Students seem to see a disconnect between the mathematics they learn in the school and out of school mathematics. This means that they see no linkage between the mathematics they study in the school and in the home and hence may not put much premium on mathematics learnt in the school. They may however learn mostly for the purpose of passing their examination. This may imply that; the Ghanaian students may learn mathematics not for the purpose of contributing to the quest to solve societal problems but for the purpose of passing examinations. It also gives a clue as to why students have phobia for mathematics. This may be because what is learnt in the classroom is not seen by them to be related to real life situations and may hence not put much premium on that but may rather see it as a great challenge and punishment they are ushered into.

The responses from the interview conducted for the four Ghanaian SHS 1 core mathematics teachers suggest that, some/most teachers are not well informed on the various values implicit in mathematics as evident in the response of T3 who stated categorically that he was not aware that mathematics contains values. Those who said they were aware that mathematics contains values could also not also differentiate explicitly between the Mathematical Values and Mathematics Educational Values. This is evident in the response of T2 who gave almost the same response when asked about his knowledge on Mathematical values and Mathematics Educational values respectively.

The findings of the interview are consistent with the research by Taqiah and Bahari (2018) even though the interviews were conducted in different jurisdictions and responses from these two studies were not seen to be the same. Findings from the two research seem to establish that mathematics teachers have little or no knowledge on the value implicit in Mathematics even though samples used were not representative enough to generalize. This may also imply that teachers may not be conveying the right sets of values in Mathematics classroom. Arguing because teacher's subjectivity in conveying a particular value may affect student performance (Bishop et al. 1999), teacher's awareness of values implicit in Mathematics teaching and its effects on what and how students learn Mathematics is very important. According to Dormolen (1986), the decision to adopt the Formalistic approach or the Activist approach has effect on what the students learn. Even though the discussion is not on which of them (Formalistic view, Activist) is preferable, a reasonable balance in the conveyance of these values

may yield a positive result. This is in line with the assertion of Bishop et al. (1999) that, none of the complimentary values is seen to be superior to the other but a reasonable balance between them may yield better results. He gave an example that, an emphasis on Objectism characterized with the use of symbols at the expense of Rationalism will results in a situation where students manipulate these symbols as if they were object but without understanding. Teachers awareness of these values will therefore help create a reasonable balance in the values conveyed.

CHAPTER FIVE

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

This chapter provides a general summary of the entire study. It does so by providing an overview of the research problem and the methodology employed in the study. It also provides summary of the key Findings which is reported in Chapter Four of this study. It also provides conclusions based on the findings of the research as well as recommendations.

This study explored values implicit in four Ghanaian SHS 1 Core Mathematics textbooks approved by NaCCA. It also explored the awareness of teachers on valuing in mathematics. The various sub – categories of complementary values by Bishop (1988) Mathematical Values namely Rationalism – Objectism, Control – Progress, and Openness – Mystery continuums and Mathematics Educational values Formalistic View -Activist View, Relevance – Theoretical, Instrumental – Relational Understanding, Accessibility – Specialism, and Evaluation – Reasoning continuums formed the major framework of the study. Four best-selling SHS 1 Core Mathematics textbooks for year one students were purposively sampled for this study. These were textbooks approved by NaCCA as well as GES. The values implicit in these textbooks were explored using a checklist adapted from Dede (2006a) as well as Seah and Bishop (2000). Four Core Mathematics Teachers were also sampled using the purposive sampling technique. Their knowledge about the values implicit was explored using semi-structure interviews, which was adapted from Taqiah and Bahari (2018).

Finding from the semantic content analysis were analyzed mainly presented through the use of frequency counts and presented as frequency

tables. The qualitative data obtained from the interview were transcribed, analysed qualitatively and presented as narrative descriptive with some illustrative examples.

Summary of Key Findings

1. Objectism Value, Control Value, and Openness Value were conveyed more than their complementary pair of Rationalism, Progress, and Mystery Values in the four best- selling Ghanaian SHS 1 Core Mathematics textbooks.
2. The use of symbols, diagrams, figures tables, graphs among others were the main means the value of Objectism was conveyed in the four best-selling Ghanaian SHS 1 Core Mathematics textbooks. The use of words that establishes logic, cohesion, connectedness as well as cause and effects such as ‘therefore’, ‘implies’, ‘hence’ were seen to be the way Ghanaian textbooks conveyed the value of Rationalism. Ghanaian textbooks also conveyed the value of Control through the use of imperatives and structured instructions and the use of algorithms while the value of Progress was mainly conveyed using a particular formula to derive other formulas and the use of scales to predicts actual values on the ground. Mathematics questions which are easy for students to solve and questions which help in recalling what is already learnt characterized how the Ghanaian textbooks conveyed the Value of Openness whiles the Mystery values was conveyed in complicated Mathematics task and activities which helps them discover new ideas which mostly comes as a surprise.

3. The Formalistic View, Theoretical knowledge, Instrumental understanding, Accessibility, and Evaluation were seen to be conveyed more than their complementary values of Activist View, Relevance Knowledge, Relational Understanding, Specialism, and Reasoning in the four best-selling Ghanaian SHS 1 Core Mathematics textbooks.
4. The Formalistic view using Mathematics activities that emphasises on the use of deductive. Exercises, examples, and illustration which reflected daily life activities in the Ghanaian context were the main means the value of Relevance was communicated in Ghanaian textbooks whiles the use of examples, exercises and illustrations which is devoid of context and does not seem to have any bearing on real life context in the Ghanaian society conveyed the Theoretical values. Textbooks only stressed on the use of rules and procedures to solve question which was main the means the Instrumental understanding Values was signaled. Instrumental understanding was also signaled through activities that did not connect students to their relevant previous knowledge. Mathematics activities that connected new knowledge to student's relevant previous knowledge and formation of appropriate graphics characterized how Relational understanding was signaled in Ghanaian SHS one Core Mathematics textbooks. Mathematics activities that everyone could perform or understand signaled the Accessibility value whiles Mathematics activities that could only be done by selected few of gifted and other elite groups signaled the value of Specialism. Assessment questions

given at the end of each section which used routine operations similar to those in the illustrations and examples given signaled the Evaluation value. Reasoning value was conveyed though the use of exercises and assessment questions which does not require routine operations used in examples and illustrations in that topic and may require reasoning.

5. The four Ghanaian SHS 1 Core Mathematics teachers interviewed were seen to have little awareness on values conveyed in Mathematics as a discipline and in its pedagogies

Conclusions

The Values of Objectism, Control, and Openness were conveyed in the Ghanaian SHS mathematics textbooks more than their complimentary pair of values. Much emphasis on Objectism which was characterized with the use of symbolism and little emphasis on logic, meaning, cohesion and reason could probably be the reason students have phobia and other negative attitude towards the study of Mathematics students. Bishop et al. (1999) assert that, putting much premium on the Objectism value is often associated with frequent treatments of symbols as objects without understanding. This could be the reason why students often ask, "what will πr^2 do in my life?", because they learn without reason. Emphasis on control and Openness implies that the Ghanaian textbooks emphasises equipping students with knowledge in dealing with immediate problems but do not equip them with dealing with skills in dealing with problems that challenges the control they have over their environments since students may lack knowledge on the connection between various concepts.

Emphasis on deductive reasoning conveyed through the pedagogy adopted by Ghanaian Mathematics textbooks implies that Ghanaian students may lack innovation since approaches adopted do not encourage the use of intuition. The use of Instrumental learning approaches by textbooks may imply that, Ghanaian students may lack the requisite knowledge in relating classroom experiences to dealing with real life situations. This is in line with the chief Examiners Report (2019) who in one of their recommendations stated that Mathematics "is part of us and we use in our everyday life. That mathematics is used by both literates and illiterates alike" (p.4) and there should therefore be a conscious effort to explain the importance of mathematics for real life and not only for the purpose of writing exams. This is also in line with emphasis on Theoretical knowledge at the expense of Relevance Knowledge. That is, emphasis on Formalistic view, Theoretical knowledge, Instrumental learning, Accessibility, and Evaluation implies that Ghanaian Mathematics textbooks does not seem to convey values necessary for preparing students towards solving societal problems.

Teachers lack Awareness on values conveyed in Mathematics as a discipline as well as in its pedagogy may imply that, these Mathematics teachers may not convey the right values in their teaching. It is important to do the study on large scale to observe the broader picture.

Recommendations

Based on the findings from this research, the following recommendations are drawn;

1. Teachers and textbooks writers need to be educated on the values which are implicit in Mathematics and how they may be conveyed.

2. GES and NaCCA need to ensure that textbooks published and approved convey balanced mathematics and mathematics educational values in making Mathematics relevant to students learning.
3. Various Teacher training institutions that train teachers should create the needed awareness on values implicit in Mathematics as a discipline and in its pedagogies and proper ways of conveying them through their teacher education programmes.

Suggestions for Further Studies

The findings from this research have highlighted the need to advance further studies into Values in Mathematics. The following are suggested

1. A larger sample of SHS 1, SHS 2 and SHS 3 Mathematics textbooks could be used to give a data which will be representative of the total number of textbooks approved by GES and NaCCA which could provide reasonable basis for generalization.
2. Primary and junior high Mathematics textbooks also need to be explored to ascertain the balance in the values conveyed in them.
3. Extensive study could be conducted to explore the awareness of teachers teaching at various grade levels on Values implicit in Mathematics.

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APPENDICES

APPENDIX A

Checklist for Content Analysis

VALUES	DESCRIPTION	TYPES OF ACTIVITIES	VALUE SIGNALS
MATHEMATICAL VALUES	What Mathematics as a discipline puts premium on	Activities that reflect i, ii, iii, iv, v and vi	The value signals that reflect activities in i, ii, iii, iv, v and vii
i. Rationalism	Relate to the use of logic, explanation, cohesion, completeness and meaning	Mathematical activities which use languages that expresses logic, cohesion, completeness and meaning	Words that establish logic, connectedness, completeness, cohesion and cause- and- effect relationship
ii. Objectism	The use of symbols, objects, and images as intuitive and imaginative basis for abstraction	Mathematics symbols and languages that provide imaginative and intuitive basis for abstraction	The use of conditional tenses such as if, suppose etc. The use of Mathematical symbols, diagrams and images
iii. Control	Demonstrate the act of having mastery of one's physical and social environments	Activities that emphasise the use of algorithms and do not give much freedom for using one's own approach Activities that involve the use of imperatives	The use of instructions in performing a Mathematical task The use of imperatives such as add. Subtract, divide among others in performing Mathematics activities

iv. Progress	The use of alternatives, discoveries new perspectives to mitigate treat to control of one's environments	Mathematics activities that allow for the usage of different alternative solutions Mathematics that helps in discovering a formular from other formula Activities that use scale to predict actual occurrences on the ground	The use of alternative solutions and procedures Application of concepts in other fields. Questions which allow students to use their creative ideas The use of scale and projections
v. Openness	Formalizing and dehumanizing Mathematics to make it a secured body of knowledge	Mathema tics activities that are easy to solve are within the cognitive level of students Activities that remind students of what they know already	The use of pronouns like 'we', 'you' and their related forms like 'your', 'our' among others. Exercises that are easy to solve. Statements that remind us of our previous knowledge. Example: we recall that…. etc.
Mystery	Shocks and surprises associated with Mathematics which makes Mathematics a mysterious body of Knowledge	Mathematical activities that that are complicated and may sometimes be above the cognitive level of students	Often associated with difficult and with complicated examples

MATHEMATICS EDUCATIONAL VALUES	They reflect pedagogical and cultural components of Mathematics in the Mathematics classroom	Activities that reflect the description in I, ii, iii, iv, v, vi, vii, viii, ix and x	Value signals that portray the values in i, ii, iii, iv, v, vi, vii, viii, ix and x
i. Formalistic view	They view deductive reasoning as the only way of reasoning They see Mathematics through the lens of rules, algorithms, theorems, and its related forms	Mathematics activities that emphasise deductive reasoning	The use of deductive approaches in lesson presentation Emphasises the use of rules
ii. Activist View	They prioritize the use of inductive reasoning Emphasises the use of discoveries and generalizations.	Mathematics activities that use intuitive and inductive approaches	The use of inductive presentation of concepts The use of discoveries and generalizations
iii. Relevance	Relate to the Mathematics that is relevant to our daily life activities and is visible to students	Exercises and examples that portray that Mathematics is about daily life events	The use of examples which are associated with local context Emphasise the use of demonstrations that portray human control of his environments.
iv. Theoretical	Relate to Mathematics concept teaching that are in abstract form and do not seem to clearly have any bearing on daily life	Exercises that emphasise Mathematics as being Mathematics and may not visibly relate to daily life activities	Mathematics exercise and examples which are in abstract and does not seem to have any bearing on daily life activities
v. Instrumental	Teaching and learning of rules	Mathematics activities in	Emphasises the use of rules,

understanding	without reason Emphasises memorization	which only rules, operations and formulas are emphasised	procedures and formulas without explanations
vi. Relational Understanding	Meaningful teaching and learning Knowing what works at a point in time and why	Mathematics Activities that establish a clear linkage between concepts and activities	Examples that demonstrate the relationship between concepts It emphasises meaning and understanding
vii. Accessibility	Mathematics teaching of contents that is geared towards understanding for all Mathematics contents that are within the cognitive level of students	Mathematics exercises and examples that could be understood by all	Contents that are not beyond the cognitive capacity of students
viii. Specialism	Mathematics teaching the emphasises on the use of Contents that can only be understood by only gifted and elite groups Difficult and complicated questions	The use of Mathematics activities (exercises and examples) that could only be understood by some gifted students or elite groups	Contents which could not be understood by everybody but some few elite and gifted students

ix. Evaluation	Associated with following procedures and approaches	Assessment and trial questions given at the end of the topic which reflect the examples given in the delivery of the lesson Uses routine operations used in illustrations and examples given in the lesson delivery	Assessment questions given at the end of the topic which uses routine operations like examples solved and illustrations.
x. Reasoning	Emphasises the power of reason and communication in Mathematics	Assessment questions given at the end of the topic require students to engage in so reasoning since they may not contain routine operations used in the example	Self-assessment exercises which involve operations different from examples solved.

APPENDIX B

Interview Guide on Values Awareness in Mathematics

1. Are you aware that values are contained in mathematics?
2. What does Mathematical Values mean to you?
3. How do you think Mathematical values are conveyed to students?
4. Are you aware of Mathematics Educational values?