UNIVERSITY OF CAPE COAST

SENIOR HIGH SCHOOL TEACHERS' PERCEPTION TOWARDS THE USE OF CONCRETE MATERIALS IN TEACHING AND LEARNING MATHEMATICS

SAMUEL GAMELI WORDUI

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BY

SAMUEL GAMELI WORDUI

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

AUGUST 2023

DECLARATION

Candidate's Declaration

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

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

Name: Samuel Gameli Wordui

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: Mr. Benjamín Yao Sokpe

ABSTRACT

The study investigated the perception of Senior High School (SHS) mathematics teachers towards the use of concrete teaching and learning materials (TLMs) in the Cape Coast Metropolis of Ghana. The study adopted explanatory sequential mixed method approach. A survey design was employed to explore the perception of 132 SHS mathematics teachers towards the use of TLMs. Teachers were sampled using proportionate stratified sampling technique from the ten public SHSs in the Metropolis. The quantitative data were analyzed using descriptive statistics, ANOVA, correlation and multiple regression analyses whilst thematic analyses was used to analyze the qualitative data. The findings highlighted teachers' overall positive perception towards the use of TLMs. Teachers have reported their highest perception in their confidence and knowledge in using TLMs and believed that its usage was very important because it helps improve upon students' achievement in mathematics. The results also revealed teachers' high perception in time/classroom constraints in using TLMs and the cost of TLMs. The least perceived factor by teachers was availability of TLMs. Teachers' self-efficacy/Benefits in using TLMs was reported as the best predictor of teachers' overall perceptions towards the use of TLMs; and the least predictor was the Cost of TLMs. The study also revealed that teachers' teaching experience and qualification were not determinant factors of teachers' use of TLMs. It is recommended that the Ministry of Education through Ghana Education Service could try to make the necessary provisions and resources

available to teachers for effective teaching and learning of mathematics. Some implications are drawn from the study and discussed in the main work.

KEY WORDS

Concrete materials

Explanatory sequential mixed methods

Hands-on and minds-on activities

Pedagogical content knowledge

Teaching and learning materials (TLMs)

Teacher' self-efficacy beliefs

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DEDICATION

To my wife, Mrs. Peace Aku Wordui; and my children, Mawunyo, Angel Gabriella, Precious Fafa, and Gloria.

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LIST OF ACRONYMS

MoE	Ministry of Education
NaCCA	National Council for Curriculum and Assessment
NCTM	National Council of Teachers of Mathematics
SHS	Senior High School
TLMs	Teaching and Learning Materials

CHAPTER ONE

INTRODUCTION

In this era of technological advancement globally, there has arisen much pressure on mathematics educators to devise meaningful and engaging pedagogical strategies to teaching mathematics for improved educational outcomes (National Council for Curriculum and Assessment [NaCCA], 2020). In Ghana, the focus of teaching mathematics has shifted considerably from the teacher-centred methodology to a more learner-centred perspective whereby teachers employ concrete hands-on and minds-on instructional materials to enhance learners' mathematical and problem-solving skills (NaCCA, 2020).

Stein and Bovalino (2001), have identified that concrete materials can be essential tools for assisting learners to perform cognitions in more meaningful ways. They believed that when students are offered concrete experiences to estimate and perform tasks on concrete materials, it can promote the advancement of intellectually interlinked insights of mathematical thinking. Likewise, Durmus and Karakirik (2006) have also admitted to the assertion that the utilization of concrete materials not only boosts up learners' enlightenment of the concepts taught and problem-solving abilities, but also contributes to their positive dispositions towards mathematics, for the fact that, they presumably offer hands-on activities that direct attention and intensify motivation. This study sought to explore mathematics teachers' perceptions towards the utilization of concrete materials in establishing mathematical meaning at the Senior High School (SHS) level in the Cape Coast Metropolis of Ghana.

Background to the Study

Mathematics is an essential subject which has many applications in real life. For this reason, todays' global workplace requires some level of competence and expertise in solving everyday problems for its competitive advancement and sustainability. The survival of which is largely contingent on creativity and innovation as its driving forces, which demand solid foundation in mathematics, science and information technology. It is therefore very imperative for mathematics educators to deploy instructional strategies which would allow for practically engaging hands-on and minds-on experiences in the classrooms which learners would consider as fun and accept mathematics as a culture (NaCCA, 2020).

According to Mutodi and Ngirande (2014), Piaget postulated in 1952 that children have not developed well enough their mental capabilities that is needed for their comprehension of abstract mathematical concepts that are demonstrated to them only verbally and symbolically. He believed that mathematics should therefore be taught to children with concrete materials. It is in support of this argument that Pham (2015) made a strong case for the utilization of concrete manipulatives at any academic level of students' learning in his research. In line with Piaget's proposition, Larbi and Okyere (2016) have also made a claim that learners require the direction of the tutor to operate concrete materials. They contended that the usage of concrete items helps the tutor and students to depart from the conventional classroom ambience and instructional approach. Teachers, therefore, need to be conversant with the learning theories and research in education that support the utilization of concrete objects to accomplish mathematical tasks in the classroom (Cuisenaire, n.d.). They should also endeavour to be aware of the impact of the utilization of concrete instructional models on students' mathematics achievement as was envisaged in the Ghanaian Mathematics Curriculum (NaCCA, 2020).

In mathematical knowledge acquisition in the classroom, students are multi-dimensional with diverse cognitive abilities and intelligences (NaCCA, 2020). So, students tend to have different rates of assimilation, evaluation, construction and internalization of the new experiences they encounter. The aforementioned assertion clearly resonated with the cognitive developmental theory expounded by Piaget in 1970 and his subsequent conception of equilibrium theory in 1985. Piaget as a cognitive constructivist, held the philosophy that children are active learners. He believed that when learners are given the needed learning environments, they feel at ease and therefore gather the zeal to construct new knowledge for themselves through the processes of assimilation, accommodation and equilibration. Through these processes, learners are able to build upon their prior knowledge gradually till they have attained a stable state of memory. At this instance, the learners are believed to have developed more sophisticated schemata which help them to be more adaptable to their learning environment. How can mathematics educators assist learners to successfully go through these processes in the classroom? This leaves a big gap for mathematics educators and curriculum developers to fill.

In the quest to bridge this gap, mathematics educators throughout the world are researching into finding meaningful teaching pedagogies that would suit and appeal to all the diverse learning channel preferences of students (Golafshani, 2013) so as to increase their interest and performance in mathematics. It was against this background that Shaw (as cited in Pham, 2015) has demonstrated that the utilization of concrete objects in mathematics lessons has assisted to minimize to a considerable measure the bridge between the concrete and abstract mathematical concepts. In view of this, Pham (2015) also stressed that concrete materials are essential tools that can assist learners of any academic level to grasp the concepts of mathematics. Pham further underscores the relevance of the usage of concrete materials by arguing that the usage of manipulatives was not just beneficial to students of low academic abilities but also good for those of high academic abilities as well. From literature, the utility of concrete materials has scintillated and reenergized many students, especially, the kinesthetic, visual and auditory learners to better experience and explore mathematics in the teaching-learning process meaningfully.

Steedly, Dragoo, Arafeh and Luke (as cited in Mutodi & Ngirande, 2014) have the opinion that mathematics instruction and learners' understanding are more efficacious if concrete materials are utilized. However, Maslen, Douglas, Kadosh, Levy and Savulescu (2014) cautioned that concrete materials are potentially detrimental if utilized inappropriately. It therefore calls for teachers' experience and knowledge regarding the utility of concrete materials to teach the right concepts that they would have intended to teach their students. According to

Milgram and Wu (2008, as cited in Mutodi & Ngirande, 2014), when concrete materials are not utilized judiciously in the teaching-learning process in our classrooms, they have the potential to make learners believe that two mathematical views exist: concrete materials and symbolic.

Arguably, many educational researches have revealed that when concrete teaching and learning materials are appropriately utilized in the teaching-learning process, it enhanced the learners' comprehension of the content materials and improved their learning outcomes (see for example: Chappell & Strutchens, 2001; Ruzic & O'Connell, 2001; Sebesta & Martin, 2004). In the same vein, Marshall and Swan (2008) also have affirmed in their research that teachers have held perceived views that mathematics manipulatives usage promoted pupils' mathematics learning. It is therefore obvious that the hands-on experience that learners are judiciously provided with through the use of concrete materials, encourages them to do meaningful reflections on whatever they have learnt. It also equips students with that stimulating urge to draw many conceptual relationships from the mathematics being taught. In effect, this quickens their interest in mathematical reasoning and problem-solving capabilities, and eventually cements their positive views about mathematics (Durmus & Karakirik, 2006).

Cuisenaire (n.d.) has also alluded to the fact that from ancient dispensations, humans of several diverse civilizations have utilized concrete materials to assist them to find solution to everyday mathematics problems. In that, these manipulatives have been regarded as indispensable ingredients in teaching mathematics at the elementary school stage. He continued to posit that manipulatives can be essential tools for rendering effective, active and engaging instructions in the mathematics classroom teaching. In furtherance of his argument, he asserts that manipulative usage also helps to heighten the mathematical reasoning competences of learners. In line with that assertion, Cuisenaire alluded to the fact that educational experts have proposed three stages through which this learning transpires: (1) concrete stage – the concrete objects are utilized in the introduction of the mathematical concept; students purposefully engage in meaningful activities using the concrete materials to discover the concept; (2) representational stage – the mathematical concept is identified with pictorial symbols to exemplify the concrete materials (manipulatives) of the previous stage; learners depict now how the concept at this pictorial level could be both visualized and communicated; and finally, (3) the abstract stage – the mathematical symbols are utilized to convene the concept in symbolic language (e.g. the idea of presenting the numeral 4 with four counters); learners speak the language of mathematics to show their comprehension of the concept mathematically.

Historically, Cuisenaire (n.d.) narrated an elaborate account to support the usage of concrete materials in doing mathematics that:

> The ancient civilizations of Southwest Asia (the Middle East) used counting boards. These were wooden or clay trays covered with a thin layer of sand. The user would draw symbols in the sand to tally, for example, an account or take an inventory. The ancient Romans modified

counting boards to create the world's first abacus. The Chinese abacus, which came into use centuries later, may have been an adaptation of the Roman abacus (p. 2).

Besides that, the Americas also developed concrete devices for accounting purposes. In further account, Cuisenaire claimed that:

> The late 1800s saw the invention of the first true manipulatives—maneuverable objects that appeal to several different senses and are specifically designed for teaching mathematical concepts. Friedrich Froebel, a German educator who, in 1837, started the world's first kindergarten program[me], developed different types of objects to help his kindergartners recognize patterns and appreciate geometric forms found in nature. In the early 1900s, Italian-born educator Maria Montessori further advanced the idea that manipulatives are important in education. She designed many materials to help preschool and elementary school students discover and learn basic ideas in math and other subjects (p. 2).

Since then, national curricula all over the world have witnessed tremendous revision and a shift towards the integration of concrete learning experiences into mathematics lesson deliveries. Additionally, Cuisenaire (n.d.) concluded the narrative by acknowledging the fact that for decades, the National Council of Teachers of Mathematics (NCTM) has recommended the utility of manipulatives in teaching mathematical concepts at all grade levels. It therefore suffices to adopt and implement this recommendation fully into mathematics lessons at all educational levels.

For this and many other reasons, similar educational policies and curriculum reforms were reported in Ghana, especially, from September, 2007 to date. For example, the Ministry of Education (MoE), Ghana, with collaborative effort with its partners in education have rigorously revised the mathematics teaching curricula from the Primary School, Junior High School (JHS), Senior High School (SHS) and through to the tertiary level till date. MoE (2010) believed and maintained that excellent knowledge of science and mathematics would be a determining factor for development in almost all facets of human endeavour. This brought about a complete revision of the Ghanaian mathematics teaching curricula to align with the constructivist philosophy of teaching and learning. In recent times, NaCCA (2020) stated clearly, in uncertain terms, both the teaching and learning philosophies that should propel the teaching and learning of mathematics in Ghana. From the 2020 Common Core Programme (CCP) curriculum for mathematics, NaCCA expounded that the teaching philosophy for mathematics education in Ghana should be anchored on learner-centred methodologies that create learning environments that are rich and promote discovery learning where learners are physically and cognitively engaged. It further stipulated the learning philosophy for mathematics by arguing that learners are not passive recipients of knowledge but rather active constructors of knowledge as investigators. It believes that when learners are placed in contextualized engaging environments where the teacher only acts as a facilitator, the learner sees the learning activities more real thereby helping him/her developing critical thinking and problem-solving skills.

The MoE in Ghana believed that mathematics, henceforth, should be delivered utilizing hands-on and minds-on strategies that students would deem as exciting and consider as a culture. In the document, MoE placed much emphasis on the utility of models, diagrams, charts, symbols, and so on to assist students to communicate mathematical ideas and concepts. In like manner, teacher education institutions also recorded a remarkable face-lift and upgrades to produce competent, self-confident and knowledgeable prospective teachers who would be well poised in pedagogical content knowledge and readily available to fix the gaps in students' achievements in mathematics and science in the country (MoE, 2015, 2018). Notwithstanding all these transformational changes in the educational sector, especially, in the SHSs, there is still underperformance of students in mathematics (West Africa Examinations Council [WAEC], Chief Examiners' Report, 2019; 2020; 2021). Therefore, the focus of the current study is to look into SHS mathematics teachers' perceptions towards the utilization of concrete materials to teaching mathematical concepts.

Statement of the Problem

The basic role of education is to inform the human head (cognition); transform the heart (affection); and empower the hands (creativity) for successful living in society (MoE, 2010; NaCCA, 2020). Mathematics education plays a very prominent and relevant role in national development and global advancement in this era of technology. Because mathematics has multi-faceted applications in every aspect of human endeavour, people with the requisite mathematical competence and skills have greater opportunities to survive and succeed in life.

Many students who failed to live up to this expectation will either drop out of school or enter into many meager ventures in life. If this happens, a nation is not likely to develop both economically and technologically.

For this reason, in many countries all over the world, mathematics has been made compulsory at certain levels of education. In line with this global phenomenon, mathematics is used as filter for graduates of SHSs transiting into the tertiary level of education. Larbi and Okyere (2016) reiterated the fact that no one can progress in this modern era of technology without adequate and sufficient knowledge of mathematics. For example, in Australia, much premium is placed on the subject mathematics such that mathematics results were used as a critical filter into higher education and vocations (Collis, as cited in Addae & Agyei, 2018). The situation as pertaining in Ghana is not different in any way as Mensah-Wonkyi and Adu (2016) have emphatically stipulated that an applicant must secure a pass in mathematics before he or she can enter into any tertiary educational institution. Despite the relevance of mathematics in real life situations, Eshun (2000) and Awanta (2000) as cited by Larbi and Okyere (2016) have revealed in their investigations that secondary school students are not very much enthused in reading mathematics.

Furthermore, available empirical records show unsatisfactory mathematics performances of Ghanaian students in the Core Mathematics in the West African Senior School Certificate Examination (WASSCE) for over a decade. For instance, the MoE (2015, 2018) has highlighted in its Educational Sector Performance Reports (ESPR) the abysmal performance of Ghanaian candidates who took part in the Core Mathematics WASSC examinations from 2006 up to 2017 excluding 2010. Because of the change of the three-year SHS educational programme to a four-year programme, no examination was held in 2010. The 2015 ESPR report stressed the fact that the WAEC has specified the grades A1 to E8 as a pass. According to the report, a ‘credit’ was considered as obtaining a grade from A1 to C6. This was regarded as “the minimum qualification required to enter tertiary education” (p. 26). In the report, the term ‘pass rate’ was adopted to mean achievement of a credit and was computed for only candidates who took part in the examinations, and have obtained a grade.

The report revealed that 242,157 candidates registered for the 2014 WASSCE with only 77,491 passing Core Mathematics. They were regarded as candidates who qualified to enter tertiary institutions. This left behind about 164,666 candidates who could not progress further. To avert this worrying trend, the government in 2015 took some very important actions. One of such memorable interventions was through the Secondary Education Improvement Project (SEIP) which was aimed at providing teachers from 125 SHSs with some training in instruction on some selected topics deemed difficult in mathematics and science. The focus of the project was to help improve students’ pass rate in the four core subjects by providing the 125 SHSs with ICT facilities to enable the teachers there teach effectively.

In spite of the then government’s interventions, Ghanaian students’ WASSCE results still remain a concern. Detailed results from the West African Examinations Council (WAEC) also have revealed a worrying trend in the performance of Ghanaian students in the WASSC examinations from 2006 up to 2022 excluding 2010. The results as were reported from 2006 up to 2022 are recorded in Table 1. Table 1 below shows a worrying situation for Ghanaian students. The implication is that this might lead to impediment in development of some SHS graduates and the nation at large.

Table 1: Results of Ghanaian Students' Performance in WASSCE

Examination Year	% Pass Rate ($A1$ to $C6$)
2006	33
2007	25
2008	28
2009	30
2011	44
2012	50
2013	37
2014	32
2015	25
2016	33
2017	42
2018	38
2019	65
2020	66
2021	54
2022	41

Source: WAEC, Ghana

Many researches have been done in mathematics education to explore the factors which account for the low achievement of students in mathematics. For example, Eshun (2004) saw that the learner's intellectual ability, maturity, learning style, emotional and social adjustment as well as attitudes were some of the prevailing factors that influence their mathematics learning. For some time now, many research works have been done in Ghana on students' and teachers' attitudes towards mathematics; teachers' classroom teaching practices; teachers' classroom delivery pedagogies; students' mathematics anxiety; and teachers' pedagogical content knowledge for teaching mathematics at SHS level (see for instance: Addae & Agyei, 2018; Agyei, 2013; Agyei & Benning, 2015; Agyei & Mensah, 2018; Asiedu-Addo & Yidana, 2004; Eshun, 2004; Awanta, 2004; Mensah-Wonkyi & Adu, 2016; Yarkwah & Gbormittah, 2020). Eshun (2004) noted that positive dispositions of students towards different components of mathematics was needful. He further stressed that attitudes towards mathematics might have a potential effect on a leaner's readiness and willingness to study and earn from mathematics instruction.

Mura (1995) as cited in Golafshani (2013) noted that the use of the traditional lecture method of teaching is still dominating in our schools even though there have been several recommendations by curriculum standards concerning concrete experiences and representations. Knowing these realities, why mathematics teachers have still held unto divided views about the utilization of concrete materials in teaching and learning of mathematical concepts? is still an issue of concern (Mutodi and Ngirande, 2014). Additionally, Golafshani (2013) has also reflected on the question that if indeed teachers are utilizing manipulatives appropriately in their mathematics lessons, why is a lot of students lacking fundamental mathematical concepts or unable to transfer this knowledge to other areas of studies and practice?

Being aware of this constructivist ways of teaching and learning of mathematics where concrete experiences are utilized to cognitively and physically engage students, the Core Mathematics Chief Examiner in the 2017 report suggested that teachers at the SHS level should consider utilizing relevant teaching and learning materials to teach the content outlined in the syllabus since it will enhance candidates' understanding of the underlying concepts. In further argument, the Chief Examiner in the report for 2018 reiterated categorically that SHS mathematics teachers should, in a way, find meaningful approaches to teaching the contents of mathematics to their students for them to have in-depth knowledge in areas of their weaknesses by explaining thoroughly the important concepts. To buttress the Chief Examiner's assertion, literature have also affirmed that one meaningful strategy to enhance students' in-depth understanding of mathematical concepts and improve their communication in mathematics is to use concrete materials or manipulatives (Durmus & Karakirik, 2006; Larbi & Okyere, 2016; Mutodi & Ngirande, 2014). The important and relevant roles that mathematics TLMs play in enhancing students meaningful learning and improving their learning outcomes cannot be overlooked.

In the Ghanaian context, NaCCA (2019, 2020) has recommended the utilization of concrete hands-on instructional materials as a pedagogy in teaching and learning of mathematics because it is supported by the constructivist theory of teaching and learning and research. According to NaCCA when concrete materials are used appropriately, learners can relate with mathematics concepts better and establish mathematical understanding for themselves. When teachers create a conducive and interactive environment rich with enquiry-driven experiences where students are placed at the centre of the learning, they are able to actively construct an in-depth mathematical knowledge through their operation and manipulation of the materials. Larbi and Okyere (2016) accentuated in their study that the utilization of algebra tiles helped to improve students' mathematical thinking in solving algebra problems. Personal experiences have also revealed that the utility of concrete instructional materials makes the teaching and learning of mathematics concepts more interesting, fun, real and engaging to learners. Learners feel enthusiastic about what they learn; they easily relate with the concepts being taught; and are able to construct long-lasting understanding of the concepts thereby improving upon their achievement in mathematics.

A research conducted by Yarkwah and Gbormittah (2020) in the Sekondi-Takoradi Metropolis indicated that mathematics teachers were implementing the constructivist classroom teaching practices successfully as was enjoined in the SHS mathematics curriculum. The implication is that if teachers are effectively utilizing the constructivist teaching practices, then there should be noticeable evidence in students' learning outcomes in the WASSCE results. The study also noted that there were available teaching and learning resources. It however found that there were inadequate technological resources. But there was no mention of teachers' perception towards the use of the available teaching and learning resources. Kabutey (2016) reported in his study the low state of the available teaching and learning resources in the Western Region of Ghana at the SHS level. He noted that, teachers had limited access to the available resources even though they believed that these resources had some positive effects on their teaching of mathematics. It was also highlighted that the available resources were old and some components were not functioning well. The implication is that teachers might be aligned to using these concrete materials in their classroom teaching practices, but because of the low state of the resources, they might decide not to or to use them. If it happens like this, our students are not likely to fully benefit from this way of teaching and learning. Hence, students' performance at the SHS level might still not improve appreciably.

Research has established that teachers' use of concrete materials or manipulations are influenced by their perception towards its usage. For example, Mutodi and Ngirande (2014) argued that teachers have held onto divided views towards the use of concrete materials. These views in a way might affect teachers' use of the materials. Literature reviewed in the area of teachers' use of concrete materials or manipulatives have pointed out some factors which might possibly influence teachers' decisions to utilize these resources in teaching and learning mathematics. Teachers' background factors such as teachers' qualification or expertise and experience have been reported to have influenced their utilization of concrete materials. Mutodi and Ngirande (2014) asserted in their study that 86.7% of mathematics teachers agreed that their experience and expertise were determinant factors that affect their utilization of concrete experiences in their lessons. This seems to imply that well qualified and experienced teachers might have the requisite skills and knowledge to select, prepare and organize these teaching and learning materials effectively in their lessons. This assertion was acknowledged by Birgen (as cited in Kabutey, 2016), who maintained that qualification and experience were vital factors required for teachers' successful accomplishment of a task. Carbonneau, Zhang and Ardasheva, (2018) have also revealed that teachers' teaching experience was largely accountable for their future intended utilization of manipulatives in mathematics lessons.

For this reason, in Ghana, it is a necessary requirement for teachers at the SHS level to have at least a first degree certificate, more preferably professional one, before they are allowed to teach. This is to ensure that teachers possess the right skills and knowledge needed to bring about the desired outcomes of education in the country. Concerning teachers' qualification, Etsey (2005) claimed that teachers' professional qualifications were crucial in education. Etsey further reiterated the importance of teachers' competence by alluding to the fact that teachers' professional competences guarantee the quality of their teaching which results in affecting positively students' learning. Butakor and Dziwornu (2018) have also observed that the low academic performance of learners in mathematics was largely attributed to untrained teachers who were teaching the subject. In line with this, the MoE through the National Teaching Council (NTC) in recent times, specifically in 2021, did a nationwide registration and licensing of teachers at the SHS level.

Other factors cited by many researchers as possibly affecting teachers' use of concrete materials are: availability of materials, cost of materials, time management constraints, classroom management constraints (large class sizes), mathematics achievement in using TLMs, relevance and importance of using concrete TLMs, and teacher's self-efficacy beliefs. Teacher's self-efficacy is used in this study to operationally mean teacher's self-confidence and competence in using TLMs. Literature have observed that the availability and cost of manipulatives were largely attributable to its perceptive utilization by mathematics teachers (Golafshani, 2013; Marshall & Swan, 2008; Olatunde, 2010). Teachers in the study conducted by Mutodi and Ngirande (2014) admitted that their integration of concrete TLMs in mathematics lessons was dependent on the cost or the availability of these teaching and learning resources. Olatunde (2010) have also revealed that 75% of teachers had favourable perceptions towards the need for and importance of instructional resources (mathematics laboratories) in secondary schools. Nyawira (2015) also identified "inadequate instructional resources", "inadequate teacher development", "heavy work load" and "large class sizes" as factors that influence teachers' use of instructional resources in teaching mathematics in secondary schools.

In Ghana, a study carried out by Agyemang (2021), showed that TLMs were not available in most of the schools in the Tano South Municipality. Similarly, Kabutey (2016) has also reported the non-availability of TLMs and the malfunctioning of some of the parts of the limited resources that were available in the schools. A study by Tchordie (2017) in the Ho Municipality have revealed that the availability of TLMs has strong relationship with the use of TLMs and students' academic achievement. This means that the more the TLMs are adequately available, the more teachers will use them; and in effect, it will enhance students' academic performance. According Atsey (as cited in Kabutey,

2016) the non-availability of TLMs in Ghanaian schools was notably one of the causes of students' underperformance in their academics. Etsey (2005) stressed the key roles TLMs play in enhancing students' meaningful learning by maintaining that:

> The TLMs aid teaching and learning because pupils are able to see and often feel what the teacher teaches. They stimulate ideas, demand an active response from the learners and provide enjoyment. The lesson becomes more alive and understanding and grasping of the major concepts become easier. Since there were less TLMs in the Shama sub-metro schools, the situation made it difficult for the pupils to understand the lessons and this led to lower performance because lack of suitable teaching materials and accommodation tends to reduce the effectiveness of teaching. (p. 24).

Many other researchers (e.g.: Ampomah, Owusu & Ampofo, 2019; Baidoo-Anu, 2018; Mereku et al., 2005) have reported similar situations all over the country in regards to inadequate TLMs for teaching and learning mathematics. This unfortunate situation has hindered many teachers from successfully implementing the curriculum goals. Not much evidence there is in literature reviewed to show if availability and cost of TLMs could possibly predict teachers' use of concrete TLMs in the Cape Coast Metropolis.

Dawadi (2020) accentuated that the benefits of utilizing concrete objects are to essentially offer contextualized learning experiences to students for them to fully appropriate real-world knowledge. The implication is that when learners are placed in rich and contextualized learning environments, they can feel, handle and explore these concrete experiences to discover real-world learning experiences for themselves. Many researchers have highlighted that the utilization of TLMs results in long-lasting and permanent understanding. The use of concrete materials has also been recognized to have improved students' attitudes towards mathematics; and have helped to increase their interest and motivation for mathematics (Durmus & Karakirik, 2006; Kontas, 2016). It can be inferred from the foregoing assertions that the utilization of concrete instructional materials helps to concretize the mathematical concepts that students learn. The utilization also helps to eliminate the abstract nature of the mathematics as perceived by some students. In view of this, the learners' fear for the subject is reduced. Hence, fostering and solidifying students' interest and motivation for the subject as noted by Durmus and Karakirik (2006). Larbi and Okyere (2016) have also posited that the use of manipulatives was beneficial to improving students' academic performance.

Likewise, Mutodi and Ngirande (2014) have also indicated in their research that 100% of respondents have reported their positive view towards the usage of concrete materials simply because it helps improve students' academic achievement. Similarly, respondents also perceived the utility of concrete materials as relevant and important in teaching mathematics especially when introducing new topics in mathematics lessons (e.g., Mutodi & Ngirande, 2014; Pham, 2015). A research carried out by Pham (2015) discovered that teachers reported time and classroom management constraints as variables influencing their decisions and choice of using manipulatives in their mathematics lessons. Many researchers (e.g. Butakor & Dziwornu, 2018; Mereku et al., 2005) have also highlighted large class sizes as a factor affecting teachers' classroom practices and students' performance.

Teachers' self-efficacy beliefs refer to teachers' beliefs in their competences in delivery on a task successfully. It includes teacher's competency, confidence, motivation, experience, skills, tenacity and persistency on the task towards achieving a set goal (Carbonneau et al., 2018). Carbonneau et al. have observed that teachers' mathematics content and teaching self-efficacies were negative predictors of their future intended use of manipulatives in mathematics lessons. The implication is that as teachers' self-beliefs in their competence in content and pedagogy increases, the amount of time they intend to spend in using manipulatives decreases. Golafshani (2013) and Vizzi (2016) have also indicated that teachers have reported low self-efficacy and "lack of teachers' competence" or "lack of knowledge of variety of uses" as factors that affect their use of manipulatives. It is not clear in literature what pertains to mathematics teachers in Ghana in regard to this finding.

For this reason, it is worth investigating the possible factors which could influence teachers' perception towards the use of concrete materials. It is also not known which of these factors could best predict the perception of SHS mathematics teachers towards the use of concrete materials in the Cape Coast Metropolis. Therefore, this study sought to investigate senior high school mathematics teachers' perceptions towards the use of concrete materials.

Purpose of the Study

The focus of this current study is to investigate the factors which are influencing the perception of SHS mathematics teachers towards the use of concrete teaching and learning materials in the Cape Coast Metropolis.

Research Questions

Based on the purpose of the study, the following research questions and hypothesis were employed to find answers to the problem under investigation at an alpha-value of .05 significance level.

1. What are the possible factors influencing SHS mathematics teachers' use of concrete teaching and learning materials?
2. What is the perception of SHS mathematics teachers towards the use of concrete teaching and learning materials?
3. To what extent do these factors identified and teaching experience predict SHS mathematics teachers' use of concrete teaching and learning materials?

Hypothesis

Ho: There is no statistically significant difference between mathematics teachers' qualifications and their perception towards the use of concrete materials.

Significance of the Study

The findings of the current study would enrich the pedagogical knowledge base of the researcher in the use of concrete TLMs in the teaching and learning of mathematics at the SHS level. Similarly, it would help to provide succinct information for decision making on the selection and integration of mathematics

TLMs into lessons and curriculum to stakeholders such as students, teachers, schools, administrators, parents, government and society. Also, the findings from this study might enable the designers of the curriculum to improve the contents of the materials to make the users of the materials gain more from them.

Delimitations

The study is delimited to only the variables under investigations: SHS mathematics teachers' perceptions towards the utilization of concrete teaching and learning materials as mathematics teaching pedagogy. It is also delimited to only public SHS mathematics teachers in the Cape Coast Metropolis; and therefore, the findings cannot be generalized on the entire population of mathematics teachers in Ghana.

Limitation

It is not what people say that they always practise, so teachers' favourable responses about their perceptive usage of concrete TLMs might influence the results of the study. Another limitation is that perceptions and attitudes can be influenced on a daily basis and a bad encounter on the day of the survey could skew the teachers' responses to the survey. Furthermore, the research design employed, the instruments developed, time of instrumentation, statistical tools and analysis used, human errors are all limitations that could limit the validity of the results. Efforts were made to minimize the effect of the limitation on the outcome of the study by adhering to the protocols of data collection, processing and analysis. The data was subjected to rigorous screening and editing, which helped in eliminating four respondents from the main analyses.

Definition of Operational Terms

Pedagogical content knowledge: According to Shulman (1986), pedagogical content knowledge stands for teachers' interpretations and transformations of subject-matter knowledge in the context of facilitating students' acquisition of knowledge.

Instructional materials: The teaching and learning aids or resources that can be used to enhance the teaching-learning process.

Manipulatives: The physical, concrete or virtual models that can serve as teaching and learning resources.

Concrete materials: The physical, real objects or manipulatives used in some hands-on lesson demonstrations to facilitate learners' understanding.

Achievement: An attainment of some characteristics, traits, skills, and knowledge in a particular field of study or an accomplishment in an area of study or training usually represented by scores or grades.

Teaching and learning materials (TLMs) or technologies: All the physical and virtual materials, tools, equipment and gadgets used to make teaching and learning meaningful, fun, interesting, real, hands-on and engaging. Examples: computers, calculators, ludo dice, pack of cards, coins, 3-dimensional solid models, rulers, compasses, internet, unit cubes, graph books and boards, text books, teaching syllabus, workbooks, etc.

Teacher self-efficacy belief: Teachers' perceived self-confidence, motivation and competence in their capabilities to accomplishing a desired task successfully.

Organization of the Study

The study began with an introduction throwing more light on the intended purpose for the study in chapter one. It also comprises the background to the study, statement of the problem, purpose of the study, research questions/hypotheses, significance of the study, delimitations, limitations, definition of operational terms and the organization of the study.

Chapter two reviews the literature related to the study which covered the theoretical framework, definition of terms, teachers' perceptive use of mathematics manipulatives, mathematics achievement and manipulative usage, and empirical review, and ended with a summary.

Chapter three describes the methodology that was used in this study. This chapter highlights the research design, population, sampling procedure, data collection instruments, data collection procedures and data analysis procedure and a summary.

Chapter four presents the results in relation to the purpose of the study and discusses the results in line with the previous findings as was reviewed in chapter two. The discussion was presented according to the research questions and hypothesis that were posed in chapter one with implications. It ends with a summary of findings.

Chapter five summarizes the findings, draws conclusions and makes recommendations that may be beneficial to policy makers, educational authorities and teachers.

CHAPTER TWO

LITERATURE REVIEW

Overview

The main focus of the study is to investigate SHS mathematics teachers' perceptive usage of concrete teaching and learning resources in the Cape Coast Metropolis of Ghana. This chapter throws more spotlights on the works of other researchers related to the study. The main focus of the discussion is hinged on the theoretical framework that underpins this study. The study is hinged on the learning theory of constructivism and supported by self-efficacy theory. This is followed with review on the utility of concrete materials and empirical reviews. It further reviews the factors which account for the perception of SHS mathematics teachers towards the usage of concrete materials in teaching and learning and ends with summary of the chapter.

Theory of Constructivism

According to Driscoll (2005) as cited in Liggett (2017), constructivism has that students are constructors of their own knowledge as they try to develop meaning from their learning encounters. He believes that learners come to the learning process with their prior knowledge which they build upon through active engagement. Constructivist teachers, therefore, believe that knowledge must be constructed by the learners themselves rather than them passively receiving it in the teaching and learning process. Liggett (2017) cited Piaget (1970) by alluding to the fact that Piaget's learning theory brought about the view that young children can learn mathematical concepts well by utilizing concrete items. This suggests further, that children construct their own mathematical meaning better in environments where they can easily chance on or interact with concrete materials or manipulatives to eliminate the challenge of mathematical abstraction. For instance, from experience, students have the enthusiasm to grasp the concept of probability better when they handle and manipulate concrete materials like coins, pack of cards and dice in the classroom.

Furthermore, Piaget propounded a cognitive development theory in 1970; and subsequently, his theory on the conception of equilibrium in 1985. In the theory, he proposed that children develop their cognitive capabilities through four sequential stages. He believed that children's cognitive tasks should be matched with their cognitive developmental abilities which they have attained at a particular stage. This obviously, therefore, means that mathematics teachers ought to have sound and well-grounded knowledge in child psychology, instructional content and pedagogy. This will enable them to have the courage and confidence to know as to what to teach; to whom to teach it; when to teach it; why to teach it; and how to teach it. The four stages as suggested by Piaget are: sensorimotor, preoperational, concrete operational, and formal operational.

The sensorimotor stage spans from birth to two years. Ojose (2008) noted that this stage is evident by the ability of the child to recognize objects after it has been taken away from his/her sight. This results in object permanence. So, the child at this stage purely uses his/her senses and motor skills to familiarize with objects and things in his/her environment under safe conditions. For example, the child is able to identify with the ringing tone a mobile phone; sometimes link numbers to objects say one toy, two pens, etc.

Preoperational stage is from the ages of two to seven. Ojose (2008) argues that at this stage the child has developed language skills, self-centred dispositions, symbolic thinking, and less developed in logical reasoning. Ojose further suggested that at this developmental stage, learners need to be involved in problem-solving activities that integrate instructional resources like blocks, sands, and water. At this instance while the learner is engaged in solving the problem, the teacher should involve the child in conversation about the activities being carried out. This will enable the teacher to delve into and infer from the learner's cognitive processes. Ojose (2008) asserted that the view point of learners at this stage is also limited to one component or dimension of an object at the neglect of the other component.

Concrete Operational stage is marked by significant cognitive development and is the period when children build up language and other fundamental skills quickly (Ojose, 2008) from the ages of seven to twelve (McClung, 1998). McClung claimed that, at this stage, the child reasons logically about groupings and relations. The learner is able to make meaning of numbers; and also, reasons cognitively based on concrete experiences. Ojose (2008) asserted that leaners at this stage are able to utilize their senses to know; they can also handle two or three dimensions at the same time without a succession. It means that learners at this stage of cognitive development as propounded by

Piaget would desire to explore new mathematical meanings for themselves through investigations on manipulating concrete materials of dimensions.

Burns and Silbey (2000) as cited by Ojose (2008) maintained that engaging activities and different strategies of representing a mathematical outcome can be strategies of enhancing learners' cognitive growth at this stage. Ojose underscores the relevance of utilizing hand-on experiences at this stage. He believes that these experiences afford students with the needed cognitive tools for executing mathematical problems successfully. Therefore, he edges teachers on to utilize manipulatives in mathematics lessons to help students to discover place value and arithmetic concepts.

Formal operational is the final stage which is from age twelve to adulthood (McClung, 1998). At this stage now, the learner is able to make hypothetical statements and deductions from multiple consequences. This helps the learner to construct his own mathematical knowledge (Ojose, 2008). Ojose acknowledged that, at this point in time, the child is able to demonstrate abstract reasoning by employing symbols without relying on perceptive information.

In 1985, Piaget further expanded this theory to account for how new experiences of learners are shaped, through the process of assimilation, in order to integrate them into or with existing schemas or knowledge. The existing schemas are believed to be altered through a process of accommodation to allow for new advanced knowledge. The process is perceived to progress till the learner becomes fully adaptable to the new learning encounters through equilibration, where the learner now is settled and has developed sophisticated schemas for complex cognitive tasks. In line with this learning theory, the Ghanaian mathematics curriculum has adopted the spiral kind of curriculum whereby the cognitive load of the content is introduced to learners in small bits at each level with complexity increasing as the learner progresses to higher levels of education (see: Bruner, 1960).

Jerome Bruner in 1960 through extensive research and study of the cognitive development stage theory propounded by Jean Piaget, advanced his argument in his book entitled *The Process of Education* that:

> We begin with the hypothesis that any subject can be taught effectively in some intellectually honest form to any child at any stage of development. It is a bold hypothesis and an essential one in thinking about the nature of a curriculum. No evidence exists to contradict it; considerable evidence is being amassed that supports it (p. 32).

Bruner believes that the child can be taught any content effectively at any stage of development provided the teacher guided the child in some intellectually honest manner. He also believes that this emphatical submission was a fearless one and an important one when considering the nature of a curriculum. Bruner alluded to the fact that there was no evidence to disprove his hypothesis in that large amount of evidence was being gathered to buttress it.

Another proponent of the constructivist philosophy is John Dewey. Dewey's perspectives on education, originally published in his 1938 work *Experience and Education*, critically looked at both traditional and progressive education. He was of the position that traditional education has offered not enough consideration for the learner's interests; and progressive education was too individualized (John Dewey on Education: Theory & Philosophy, 2015). This he believed that it would only encourage students to be passively receptive and easily acceptive, fostering an ambience where students are edged on to listen and learn, but not helping them to necessarily reason out for themselves, because of the fixed requirements of standards and conducts. So, not fully aligned with either philosophy, Dewey proposed a new paradigm in the educational enterprise, which gave more illumination to the role experience plays in education. He posited that education needed to concentrate on the quality of the experience more than it shifted attention on the information being presented. His perspective was largely founded on the ideology that learning happens through activities and needs hands-on situations that are contextual to the student. Finally, Dewey proposed that learners should be involved in authentic, practical experiences for which they would be able to bring to bear their ideas through creativity and collaboration.

After reviewing the work of Dewey, Sikandar (2015) drew attention to the fact that the responsibility of the teacher was paramount in that he/she has to plan favourable and constructive ambiences for the learners. Sikandar noted that this will foster favourable educative experiences for learners. Sikandar also believes that such ambiences should be founded on collaboration of both teachers and learners where they experiment effective instructional methods of teaching and learning. Research and Literature have demonstrated that the use of concrete TLMs is proven to be one the effective ways of teaching and learning mathematics in a constructivist classroom (see for example: McDonough, 2016; Strom, 2009). McDonough (2016, p. 3) observed that:

> Although the use of manipulatives can be helpful for student development of mathematical understanding, it is the crucial role of the teacher in setting up appropriate learning opportunities, asking key questions and encouraging students to explain their thinking that makes learning with manipulatives powerful.

Furthermore, Wenglinsky (2003) as cited in Mutodi, and Ngirande (2014), posited that students learning mathematics should make use of concrete objects so as to link and verbalize their learning experiences. In that regard, they learn to solve problems. Mutodi and Ngirande (2014) argued further that concrete materials should be utilize to scaffold learners cognitively up to the point where they can develop capacity to reason at the abstract level and be able to draw generalization from concepts to concepts. This is in line with Piaget's cognitive developmental stages of children from birth to adolescence. Mathematics teachers, therefore, needed to appropriately utilize concrete materials to enhance students' comprehension at their developmental levels. Researchers like Hattie (2013) and Thoron (2014) as cited in Mutodi, and Ngirande, (2014) have shown that at least 80% of secondary school students are more active in the concrete operational stage than the formal operational stage. This implies that teachers need to improve their mathematical pedagogies in teaching and learning in our classrooms and schools. In view of this, secondary school teachers should resolve to use appropriate instructional technologies such as concrete materials to enhance retention, and make mathematics more meaningful to the learners.

Durmus and Karakirik (2006), in their work on virtual manipulatives in mathematics education asserted that:

> Meaningful educational activities and cognitive tools might improve students' active involvements in the teaching-learning process and encourage their reflections on the concepts and relations to be investigated. It is claimed that usage of manipulatives not only increase students' conceptual understanding and problem-solving skills but also promotes their positive attitudes towards mathematics since they supposedly provide "concrete experiences" that focus attention and increase motivation (p. 1).

Teaching and learning materials (TLMs) are, therefore, very important in the teaching-learning processes if we, as mathematics educators, ever imagine to make mathematics learning meaningful to our students. The implication is that when a student touches or feels, manipulates or uses TLMs to perform an activity, the child tends to understand the processes and sometimes come out with his or her own thoughtful insights or knowledge construction.

Self-Efficacy Theory

The fundamental argument underlying self-efficacy theory is that people's belief in their competences to accomplish a set target or to deliver on a job is what influences their behaviour and choices to do so. So, the perception of people in regard to their self-efficacy could possibly affect their daily decisions on a task.

The implication for the current study is that the perceptions of SHS mathematics teachers towards the use of concrete materials could be influenced by their self-efficacy beliefs. According to Bandura (1994, p. 1), perceived self-efficacy denotes "people's belief about their capabilities to produce designated levels of performance that exercise influence over events that affect their lives." It means that a teacher who believes that he/she has the required competences to use concrete materials in teaching and learning mathematics will do so confidently with perseverance till a successful end.

Bandura further argued that self-efficacy beliefs contributed to the way people feel, think, motivate themselves and behave. This seems to suggest that people who are efficacious will tend to have a strong sense of tenacity with the needed zeal and positive mental attitude towards successful execution of the task. Such people also seem to have self-regulated behaviour that aid them to succeed to the end of the task. It is believed that people who are highly efficacious quicken their fulfilment and well-being in diverse ways (Bandura,1994). Such people have high aspirations and believed that they are capable. So, they see difficult situations as opportunities to be faced with rather as threats to be ignored. Another concern is that people who are highly efficacious tend to be less stressed and anxious on the task because they are resilient and innovative. They ascribe failure to their ill-preparedness or lack of an in-depth knowledge and skills which are learnable.

Bandura (1994) noted four processes as activator of people's self-efficacy beliefs. These are: cognitive, motivational, affective and selection processes. The roles self-efficacy beliefs play in people's lives can not be ignored. Maddux (2002, p. 1) in a review of self-efficacy theory reiterated that "these efficacy beliefs play a crucial role in psychological adjustment, psychological problems, physical health, as well as professionally guided and self-guided behavioral change strategies." This gives a summary of the four processes identified by Bandura (1994). A brief illustration of the four processes is that, a highly efficacious mathematics teacher using TLMs in the classroom teaching and learning process, will first start with setting of a specific goal for the lesson. This goal is a result of a mental picture envisaged by the teacher. Because of the teacher's strong sense of self-efficacy, he/she gathers enough courage and master control over all the classroom challenges thereby persevering to fulfil the goal of the lesson. Again, because of the tenacity of the teacher, he/she is able to manage well his/her stress and anxiety levels which helps him/her to make the appropriate choices in selecting the right TLMs throughout the lesson to affect students' learning outcomes positively. The converse is what ensues when the teacher perceived low self-efficacy for his/her self.

It is observed that teachers' experiences over time in their field of pursuit help them to build self-efficacy beliefs. Maddux (2002) pointed out five basic sources of information that can influence people' self-efficacy beliefs: "performance experiences", "vicarious experiences", "imagined experiences", "verbal persuasion", and "physiological/emotional states". Performance experience is about people's successful attempts of mastery control over their environment (Bandura as cited in Maddux, 2002). A teacher's successful mastery over threatening activities in his/her classroom will give a positive information to enhance his/her self-efficacy beliefs. So, a teacher who receives this information about the effectiveness and appropriateness of his/her use of TLMs to improve upon the learning outcomes of his/her students will have his/her self-efficacy beliefs greatly developed. Maddux (2002) considered vicarious experiences as information that affect people' self-efficacy beliefs through their observations of others' behaviour and the effects of such behaviours. It is acknowledged that the extent to which we believe to have been influenced by the persons we have observed helps us to build our own behaviours and its outcome effects. Bandura (1997) as cited by Maddux (2002) asserted that performance experiences comparatively prove to have stronger influence on people's self-efficacy expectations than vicarious experiences.

Imagined experiences is actually about mental picturing of oneself or others demonstrating desired behaviours successfully or otherwise on a given task. Such imagery information helps to shape or alter our perceived self-efficacy (see: Maddux, 2002). Verbal persuasion is another source of self-efficacy which concerns social interactions. Maddux (2002, p. 8) accentuated that "Efficacy beliefs are influenced by what others say to us about what they believe we can or cannot do." This presupposes that people we hold in high esteem because of their expert knowledge and experiences and by virtue of our interactions with them will have great influence on our self-efficacy. In regards to physiological/emotional states as a source of self-efficacy, Maddux (2002, pp. 8-9) maintained the view that:

> Physiological and emotional states influence self-efficacy when we learn to associate poor performance or perceived failure with aversive physiological arousal and success with pleasant feeling states. When I become aware of unpleasant physiological arousal, I am more likely to doubt my competence than if my physiological state were pleasant or neutral. Likewise, comfortable physiological sensations are likely to lead me to feel confident in my ability in the situation at hand. Physiological indicants of self-efficacy expectancy, however, extend beyond autonomic arousal.

The implication for the current study is that a mathematics teacher who is depressed and feel anxious in taking effective control over his/her classroom lessons when utilizing TLMs will have his/her perceived self-efficacy beliefs dampened. This might in a way influence this teacher's perception towards the use of concrete materials in his/her mathematics lessons. The converse is true for a teacher who feels confident and highly motivated and believes in his/her competence to manage his/her classroom lessons effectively when using TLMs will have his/her self-efficacy beliefs deepened. Research has proven that teachers' use manipulatives in their mathematics lessons as a teaching strategy depends on their self-efficacy beliefs (e.g., Carbonneau et al., 2018). In this study, teacher' self-efficacy was defined operationally to mean teacher's competence, confidence and motivation towards the use of concrete materials.

Utility of Concrete TLMs in Mathematics

‘Concrete materials’ and ‘manipulatives’ have been used interchangeably in several ways since ancient times to accomplish same functions in mathematics. For instance, Bakkaloğlu (2007) cited Hynes (1986) by stating that the terms ‘concrete materials’ and ‘manipulatives’ were terms regularly used to represent concrete objects that appeal to many senses and make use of mathematical concepts. These materials are such that pupils can handle and operate round. The difference, however, is that ‘manipulatives’ can be grouped as concrete manipulatives or virtual manipulatives; whereas ‘concrete materials’ are used to imply concrete TLMs in mathematics teaching and learning. According to Carbonneau and Marley (2012) as cited in Carbonneau et al. (2018), manipulatives are frequently regarded as concrete or virtual items that can be used as a bridge to an abstract mathematics concept when learners physically manipulate the item. For the purpose of this study, the two terms would be used interchangeably to mean the same concept operationally.

The utilization of concrete TLMs in mathematics teaching has gained more attention in literature for many decades basically because its utilization is hinged on the constructivist theory of human learning propounded by cognitive psychologists and researchers like Jean Piaget, Jerome Bruner, John Dewey and Lev Vygotsky. In the Ghanaian context, the MoE and its partners in education, through the mathematics curricula at all levels of education have placed more emphasis, especially for the pre-tertiary schools, on the utilization of concrete TLMs by teachers to promote meaningful hands-on and engaging learning experiences for students (NaCCA, 2020). Largely, the use of concrete materials in mathematics lessons by teachers in the classroom would depend on their perceived views or self-efficacy beliefs towards it.

In similar vein, Mutodi and Ngirande (2014) also have contended that the utilization of concrete TLMs in disseminating mathematical concepts is "deeply rooted in the teacher's ability to select, organise and make appropriate linkages" (p. 449). Therefore, the mathematics teachers' competence and knowledge in instructional content and pedagogical deliveries will go a long way to influence their perceptions towards a particular instructional delivery strategy. After thoroughly reviewing literature, the following factors were considered as seemingly accounting for the perception of SHS mathematics teachers towards the use of concrete TLMs.

Empirical Review

Mutodi and Ngirande (2014) conducted research in Limpopo, South Africa to investigate the perception of mathematics teachers towards the utilization of concrete materials. The study highlighted that 100% of mathematics teachers sampled reported their positive support for the utility of concrete materials. Mutodi and Ngirande have also reported that teachers have held unto diverse views regarding the usage of concrete materials as TLMs. The main finding revealed that 86.7% of teachers believed that teaching experience and expertise are determinant factors when they consider to utilize concrete materials as TLMs. It was also reported that males and females significantly perceived the usage of concrete materials differently. The study further established that teachers' experience has no significant influence on their perceptions towards the use of concrete materials.

Kabutey (2016) conducted a study to explore the availability of mathematics teaching materials in SHS in the Western Region of Ghana. The study used 84 teachers and 16 store keepers. The study found that the level of availability of the mathematics resources were low; the materials were not of good quality or not workable with. Teachers had positive perceptions about the contribution of the use of the mathematics resources in teaching. The study also revealed that teachers had limited access to the resources; so, they were not using them very frequent. It further revealed that school categories did not differ in terms of availability of teaching materials. The study however showed that the utilization of materials across school categories differed significantly. The study establish that teachers' sex and academic qualifications had no significant impact on teachers' use of teaching materials.

Liggett (2017) conducted a research comprising 43 students with ages ranging from six to eight. The study investigated the effect of manipulatives on the performance of grade 2 students and their attitudes, from a rural town in Saskatchewan. Students were randomly assigned to control and experimental groups. Findings from the results obtained highlighted that the experimental group outperformed their counterpart in the control group. It is evident that the use of the teaching and learning aids might have influenced the treatment group positively. Hence, its usage should be encouraged to foster and catalyze the learning processes of learners in order to construct or conceptualize a mathematical meaning.

McClung (1998) conducted a study to evaluate the effects of manipulatives on high school students' performance in Algebra I in Lewisburg, West Virginia. Forty-seven students were sampled and randomly assigned to two groups (control and experimental) by using a computer. The results from the pre-test depicted that the two groups were homogeneous before the intervention (use of algeblocks manipulatives). After the post-test, findings have revealed that the control group students outperformed their peers in the experimental group. This could be that the researcher did not have effective and efficient handling of the manipulative lessons; or personal errors during intervention and instrumentation timing.

Larbi and Okyere (2016) studied the impact of algebra tiles manipulatives on JHS mathematics students' performance in the Komenda Edina Eguafo Abirem municipality, in the Central Region of Ghana. Fifty-six students were sampled purposively from two schools within the municipality and were assigned to control and experimental groups. The groups were taught for four weeks: the control group received the conventional way of teaching whilst the experimental group received the Algebra tiles manipulatives treatments. Findings suggested that the usage of the algebra tiles manipulatives proved superior; the experimental group students excelled more than their peers who received the conventional teaching method.

Pham (2015) also conducted a study in Toronto District Elementary Schools on mathematics teachers. The study investigated teachers' use of manipulatives in order to enhance students' understanding in mathematics. Findings from qualitative data gathering and analysis have shown that manipulatives could potentially promote students' learning experiences; and, also assist teachers shorten the gap between concrete and abstract mathematics.

Olatunde (2010) carried out a study to examine the availability of mathematics resource items and its effects on students' achievements in some selected secondary schools in Southwestern Nigeria. The study discovered that 75% of teachers reported to have a good perception towards the utility of mathematics resource objects in the schools. The results also indicated that students who were exposed to concrete experiences excelled better (65%) than their compatriots who did not experience this exposure. This study brings into my recall, the experiences that my mathematics students have had during mathematics tutorial lessons in the ICT laboratory in my school. It was always obvious for students to express their interest, love and zeal for mathematics when exposed to mathematics resources such as reported by Olatunde.

Golafshani (2013) conducted a research to investigate teachers' beliefs and their utilization of manipulatives in teaching mathematics. The study comprises of four Grade 9 applied mathematics teachers. The project adopts a qualitative methodology in data collection. Teacher questionnaires and observation field notes were used. The study lasted for over the course of more than 20 weeks. After a pre-test-post-test administration and classroom observations, the study revealed that teachers have reported a growing love for manipulatives utilization.

It was also reported that teachers perceived manipulatives usage as beneficial to how students learn mathematics, more importantly, the weak ones. On the matter of factors to consider when utilizing manipulatives in mathematics classroom teaching, teachers reported the following as factors to be considered: “Difficulty of classroom control and noise level”, “Lack of availability of manipulatives”, “Time factors”, “Lack of teachers’ competency”, “Difficulty with the clean-up of the manipulatives”, “Benefits students’ learning”, and “Students enjoy manipulatives”.

In another vein, teachers reported the following as what hinders them using manipulatives the manner they would love to in their teaching: “Lack of confidence”, Lack of time to practise”, “Low comfort level”, Lack of time to prepare”, “Lack of space”, “Lack of own classroom”, “Lack of a class set of manipulatives”, “Lack of knowledge of variety of uses”, and “Difficulty with classroom management”.

Concerning the kind of support teachers would need in order to incorporate manipulatives in mathematics lessons to achieve students’ success, they indicated the following responses: “Availability of a class set of manipulatives”, “Specific training on when and how to use the manipulatives”, “Support from administration”, “Administrative support in training for and purchasing the manipulatives”, “Methods for keeping all students on track (especially students who missed a critical class)", and "Presence of a student helper".

In this current study, all these factors identified by Golafshani have been put into seven sub constructs: availability of materials, cost of materials, time constraints, classroom management constraints, mathematics achievement in the use of concrete materials, relevance and importance of use of concrete materials, and teacher's self-efficacy beliefs.

Moyer (2001) investigated teachers' use of manipulatives in teaching mathematics. The study used qualitative means to explore how and why 10 middle grades mathematics teachers utilize manipulatives in teaching the way they did for one full academic year. Interviews and observations were used for data collection. The results have highlighted teachers' and students' views of manipulatives as used for "math fun". Teachers reported that the utility of manipulative in mathematics lessons provided the students with some sort of intrinsic enjoyment. It was also shown that some teachers perceived manipulatives usage in mathematics lessons as rewards to students since they believed that it provided them with some excitements. It was further discovered that teachers' beliefs and knowledge of the use of manipulatives affect how and why they use it. Teachers, therefore, demonstrated that manipulatives were for fun, but not a necessity for mathematics teaching and learning.

Carbonneau et al. (2018) conducted an investigation to study how prospective mathematics teachers perceive the efficacy of manipulatives and if these perceptions affect their intended future use and their mathematics self-efficacy. The study sampled 97 preservice mathematics teachers. Findings depicted that preservice teachers viewed manipulatives as highly effective for increasing learners' performance, conceptual knowledge and affect. They also indicated high degree of their future intentions to utilize manipulatives. Another revelation is that preservice teachers who are highly experienced in mathematics content and teaching knowledge self-efficacies tended to utilize manipulatives less in their mathematics instructions. The study also showcases that preservice teachers' mathematics teaching self-efficacy moderates the relationship between teachers' perceptions of manipulative utility and their future intended utilization.

Marshall and Swan (2008) designed a research to explore the utilization of mathematics manipulative items by primary and middle school teachers in Western Australia. The study adopted a survey and follow-up interviews approach to gather data from 820 teachers from 250 schools. The researchers reported that over 95% teachers believed that the utilization of manipulatives promotes students learning of mathematics. It was also noted that teachers teaching lower classes (year two and below) utilize manipulatives more than those teaching older students. Teachers also indicated that the availability and cost of materials, time constraints, classroom management challenges, organization of materials, and lack of professional training on manipulatives usage were factors which could influence their use of manipulatives.

Apondi (2015) conducted a research to investigate the impact of instructional materials on learners' mathematics achievement in Public Primary schools in Siaya County, Kenya. The study adopted an experimental design with sample sizes of 392 students and 8 teachers. The study concluded that the incorporation of instructional materials in mathematics lessons meaningfully was beneficial to learners to understand concepts better with less difficulty.

Kontas (2016) studied the effect of mathematics concrete learning materials on secondary school students' achievement and attitudes towards mathematics in a public school in Southeastern Region of Turkey. The study adopted quasi-experimental design with 24 students in each group. The study highlighted an improvement in students' mathematics achievement and their attitudes towards mathematics after the intervention was implemented.

Vizzi (2016) carried out a study to probe into teachers' perceptions of mathematics manipulatives utilization at the middle school in Colorado school district. The study used qualitative means to explore and gather data on 12 teachers who have taught mathematics for over five years. The study found that teachers have reported their need for professional development on utilization of manipulatives. It also revealed that teachers have indicated their low self-efficacy concerning mathematics manipulative utilization in mathematics lessons.

Tchordie (2017) performed a research on senior high students in the Ho municipality to examine the effects of incorporating instructional materials in teaching-learning process in Agricultural science. The sample was made up of 500 students and 30 Agricultural science teachers who were randomly selected from government-owned senior high schools. The study also reported that there existed a strong linear correlation between available resources and its usage; and students' academic performance.

Availability and Cost of Concrete TLMs in Mathematics Teaching

Firstly, availability and cost of TLMs have been identified as factors contributing to the perception of teachers towards their use of TLMs in mathematics teaching and learning. Literature have revealed that the availability and cost of manipulatives in the teaching and learning of mathematics in the classroom were largely attributable to its perceptive utilization by mathematics teachers (Golafshani, 2013; Marshall & Swan, 2008; Olatunde, 2010). For instance, an investigation carried out by Golafshani (2013) on teachers' beliefs and teaching mathematics with manipulatives has revealed that teachers have reported lack of availability of manipulatives as one of the factors affecting their usage of manipulatives in the classroom. This, therefore, implies that when there are adequate supply of concrete teaching and learning resources to all schools by authorities responsible for education and also the materials made accessible to teachers, it could help to positively affect teachers' perception towards its usage in the classroom. This point was reaffirmed by a mathematics teacher who was interviewed and reported in a research carried out by Pham (2015).

Similarly, the cost of purchasing commercially made concrete TLMs was also reported in literature as one of the factors militating against the use of concrete TLMs in teaching mathematics in our schools. As a mathematics teacher, I occasionally had to buy the concrete TLMs or create an improvised one for students to appreciate the mathematical concepts being taught. It behooves on teachers also to be innovative in improvising concrete TLMs that are not readily available or that which they cannot afford so that they can remain as effective as possible in their teaching profession.

Time and Classroom Management Constraints in using Concrete TLMs

Secondly, time and classroom management constraints are deemed as very important factors to be considered when it comes to mathematics teachers' decisions to use TLMs in teaching and learning. The challenge of managing time and classroom effectively by teachers pertaining to their use of manipulatives in and out of the classroom is an interesting issue as has been highlighted in literature. It has been showcased in literature that some teachers have reported spending a lot of time preparing, selecting and organizing, and delivering their lessons with manipulatives. Teachers, therefore, especially for many of the inexperienced ones, have perceived the use of manipulatives as time consuming. For example, Pham (2015), in a research to investigate teachers' perceptions on the use of mathematics manipulatives, indicated how beneficial manipulatives were, but was hesitant to use them because of its availability and time constraints. Pham has also reemphasized the necessity for teachers to allocate time to pick the correct concrete materials and pilot test them before incorporating them in their lessons to learners. Likewise, classroom management has been perceived by teachers (and students in some cases) as a factor that discourages them from utilizing concrete materials in their classroom teaching-learning process. Some of the reasons being that they find it difficult or challenging to control or handle students' behaviour issues; systematically arranging the materials to follow through the lesson as planned; and more importantly clearing the working tables and arranging or packing back the manipulatives after usage.

Mutodi and Ngirande (2014) also identify classroom management as another factor that hinders the utilization of concrete objects by teachers. They made an assertion that when lessons are not appropriately planned with TLMs it could results in greater challenges in managing classrooms. In another instance, Ormrod (2014), as cited by Mutodi and Ngirande (2014), also noted that the usage of manipulatives was perceived as a way where learners could be let loose of as they perhaps get too excited operating with concrete items. This will seemingly heighten the classroom management challenges.

Mathematics Achievement in using Concrete TLMs

Another factor that seems to affect mathematics teachers' perception towards the utilization of TLMs is its achievement purposes in teaching and learning. Marshall and Swan (2008) have affirmed in their research that teachers have held perceived views or beliefs that mathematics manipulatives usage promoted pupils' mathematics learning. Likewise, Mutodi and Ngirande (2014) indicated in their research that 100% of respondents have reported their positive support for the usage of concrete manipulatives in teaching mathematics simply because it will promote students' cooperative learning. Cuisenaire (n.d.) has also alluded to the fact that from ancient dispensations, humans of several diverse civilizations have utilized concrete materials to assist them to find solution to everyday mathematics problems. Because of that, these manipulatives have been regarded as indispensable ingredients in teaching mathematics at the elementary school stage. He continued to posit that manipulatives can be essential tool for rendering effective, active and engaging instructions in the mathematics classroom teaching; and its usage also enables learners invigorate their mathematical reasoning competences.

Relevance and Importance of using Concrete TLMs

Furthermore, the relevance and importance of using TLMs is also considered as a factor when selecting and incorporating TLMs in mathematics lessons by teachers. It is worthwhile to stress that when concrete teaching and learning materials are appropriately utilized in the teaching-learning process, it fosters learners an enhanced comprehension of the content materials and improves their learning outcomes (for example, Chappell & Strutchens, 2001; Sebesta & Martin, 2004). It is therefore relevant and very important to incorporate concrete mathematical objects into the teaching-learning process to support concrete learning experiences of our students. The role played by manipulatives in mathematics teaching and learning in the classroom cannot be underestimated.

Many educational experts have made strong justification of the utilization of relevant and appropriate instructional manipulatives in the teaching-learning process. They believed that its usage will gear towards enhancing and concretizing the mathematical experiences of students at all levels of education. For example, Olahimola as cited by Igwe (2016) made a revealing proclamation that various subjects at varied stages in the educational sector demonstrate that instructional manipulatives utilized by teachers serve to present concepts and ideas real. Concrete teaching and learning materials make mathematics learning more fun, interesting, interactive, real and lively.

So, therefore, manipulatives usage in teaching and learning of mathematics should be seen as very relevant and important. Some of the important functions played by instructional resources in the teaching-learning process as affirmed by Okwudibia (2005) as cited in Iwge (2016) are enumerated as follows:

1. offer growing interest in learning;
2. sustain the student's attention;
3. grant the student with privileges of interacting with their social and physical environment (excursion);
4. provide pupils platform for independent and individualized learning;
5. render concept foundation for conceptual thinking;
6. supply the platform for students to cultivate their abilities and skills;
7. support the acquisition and lengthen retention of knowledge.

Teachers' Self Efficacy Beliefs in Utilizing TLMs in Mathematics

Lastly, teachers' self-efficacy beliefs play a very critical role when it comes to their choices of selection and utilization of TLMs in mathematics lessons. Bandura (1997) as cited by Carbonneau et al. (2018), posited that self-efficacy epitomizes people's beliefs in their competency to do a certain task. To him, self-efficacy is a potent drive that catalyzes behaviour, reasoning, emotions and induces people's motivation, perseverance and performance. In real essence, persons who have great positive self-beliefs in their abilities are noted for their propensity to excel thereby persevering in it till the end. Better still, teacher self-efficacy stands for teachers' belief about their potential to impart knowledge and enhance learning effectively (Carbonneau et al., 2018). Carbonneau et al. (2018, p.3) also argued that:

> when confronted with a challenging problem, high self-efficacy teachers may be better equipped to regulate their anxiety and stress and to engage meta-cognitive awareness and reflection regarding their teaching. This may lead to teachers' choosing effective and appropriate instructional strategies for students. Low-efficacy teachers, however, may become anxious, frustrated, or stressed by the problem, thus getting distracted from finding better solutions or strategies for their teaching.

According to Mutodi and Ngirande (2014), researchers have shown that teacher competence in utilizing concrete mathematical objects was considered as an important factor in promoting conceptual retention. It appears true that teachers who are knowledgeable in both content and pedagogy are full of confidence and tend to be efficacious in their delivery in the classroom. They also tend to be highly motivated and innovative in creating the needed teaching and learning ambiences for free interactions in the classroom. Such teachers too are very flexible, versatile and can easily adjust to new encounters in the classroom making them effective managers of classroom, time and instructional resources.

Teaching Experience and Qualification as Background Factors

Birgen (2005) as cited by Kabutey (2016), noted that experience and qualification are necessary factors for executing a task. It presupposes that a well-trained and qualified teachers have the requisite skills and knowledge through experience to successfully teach in their area of expertise. In the same vein, a mathematics teacher who is well trained and qualified is believed to have good mastery over both content and pedagogy. This helps the teacher to effectively apply both teaching and learning philosophies in his/her practices in the classroom to positively affect students' learning outcomes. For this reason and many others, in Ghana, it is expected that teaching mathematics at the SHS level one needs to possess at least first degree certificate preferably, professional one. The qualification of mathematics teachers at the SHS level are first degree non-professional, first degree professional, postgraduate non-professional and postgraduate professional. Birgen (as cited in Kabutey, 2016) reported that 98.25% of SHS mathematics teachers had professional training. This suggests that teachers have the requisite competences and confidence to utilize the appropriate instructional materials to improve students' performance in mathematics.

Experienced and qualified teachers also have the belief that they possess what it takes to select, prepare and organize teaching and learning resources to meaningfully engage their students in the learning process without fear (e.g., Carbonneau et al., 2018; Mutodi & Ngirande, 2014). Mutodi and Ngirande, (2014) revealed in their study that 86.7% teachers have the perceptions that their use of concrete materials in mathematics lessons was determined by their experience and expertise. This finding highlights the importance mathematics teachers place on their qualification and experience when considering the utilization concrete materials. In contrast, Kabutey (2016) observed that mathematics teachers' qualification had no significant contribution towards their use of instructional materials. This indicates that mathematics teachers across the levels of qualifications perceived the use of instructional materials the same way.

Summary

This current study is hinged on the constructivist theory of teaching and learning of mathematics and supported by self-efficacy theory in regards to teachers' use of concrete materials. The tenets of constructivism believe that learners are not just empty vessels to be filled with knowledge in the teaching and learning process by the teacher. But they are rather active learners who seek to construct their own knowledge in their socio-cultural environments. They believe that reality is ascertained by ones' own experiences encountered in his/her environment. Based on this, the teacher is considered as the facilitator of the learning process whereby the learner is placed at the centre of the learning (NaCCA, 2020).

Piaget (1952) argued that children cannot understand mathematical symbols and languages at younger stages in life so easily. Therefore, they needed to be taught with concrete mathematical representations at the concrete operational stage before the formal operational stage. He believed that when children are taught in this manner, they can better appreciate mathematical symbols and languages in a more meaningful way because of their previous concrete mathematical experiences. He also proposed that learners' cognitive tasks should match with their cognitive developmental stage for meaningful learning experiences. As a result of Piaget's (1952) theory, many scholars and literature have supported the utilization of concrete materials in teaching and learning of mathematics to enhance learners' mathematical insight and attitudes towards mathematics (Durmus & Karakirik, 2006; Golafshani, 2013; Marshall & Swan, 2008; Mutodi & Ngirande, 2014; NaCCA, 2020; Pham, 2015).

It was also revealed in literature and researches that teachers' self-efficacy beliefs played a major role in influencing their instructional decisions (see: Carbonneau et al., 2018). For example, Carbonneau et al. (2018) revealed that teachers who are highly efficacious in both mathematics content and teaching knowledge tend to use manipulatives less in their future intended lessons.

Through extensive review of literature, seven factors have manifested in the foregoing discussions as factors which could possibly predict the perception of SHS mathematics teachers towards the utilization of concrete materials in mathematics lessons in the Cape Coast Metropolis in the Central Region of Ghana. These factors are: Availability of materials, Cost of materials, Time constraints, Classroom management constraints, Mathematics achievement in using concrete materials, Relevance and importance of using concrete materials, and Teacher's self-efficacy beliefs.

It can be concluded from the foregoing discussions that teaching-learning resources or manipulatives when effectively and efficiently selected and utilized, could bring about the narrowing of the gap between concrete mathematics and abstract mathematics experiences. Hence, mathematics manipulatives serve as enhancers or boosters of students' construction of mathematical meaning.

CHAPTER THREE

RESEARCH METHODS

Overview

This study is focused on investigating SHS mathematics teachers' perception towards the use of concrete teaching and learning materials in the Cape Coast Metropolis of Ghana. This chapter discusses how the study was carried out. The chapter is subdivided into eight sections, sub headed: research design, population, sample and sampling procedures, data collection instruments, data collection procedures, ethical issues, validity and reliability of instrument, data processing and analysis, and finally, the summary of the chapter.

Research Design

According to Creswell (2014), research designs are kinds of investigation embedded in qualitative, quantitative, and mixed methods models that offer clear and precise focus for procedures in a research. Creswell opined that the combination of both the qualitative and quantitative methods allow for a comprehensive investigation of the problem under study better than either approach alone. In this regard, the current study adopts a mixed method approach. Specifically, the explanatory sequential mixed method approach whereby the quantitative approach is the dominant one followed by a less dominant qualitative approach.

In explanatory sequential mixed method, the researcher collects quantitative data, organizes and analyzes it, interprets the results and writes reports on the findings first. It is then followed by the second phase, the qualitative approach which is conducted with the aim of explaining further the findings emerging from the quantitative phase (e.g., Ary, Jacobs, Sorensen, & Razavieh, 2010; Creswell, 2014). According to Ary et al. (2010), the findings from the qualitative phase might adduce information that triangulates to support with evidence for (or contradict) the reported findings in the quantitative phase. They also put forward the argument that triangulation aims at arriving at a converging evidence from multiple methods which helps to investigate the same phenomenon. For example, this study used qualitative data from interviews of mathematics teachers to explain further the findings from quantitative data using questionnaires for better understanding of the problem under investigation (see Appendix B). The interview questions were targeted on the following phenomenon: importance and relevance of using TLMs, factors which accounts for teachers' perceived use of TLMs, and the kind of training that will promote teacher' self-efficacy towards the use of TLMs.

Descriptive survey was employed since the focus of the researcher is to gather data on the target population at a particular point in time (Cohen, Manion & Morrison, 2007). Creswell (2014) noted that survey research gives a quantitative description of patterns, dispositions, or views of a population by carrying out inquiry about that population's sample. Similarly, McMillan and Schumacher (2010) also asserted that a descriptive survey focuses on gathering data on stated social happenings at an appointed time to ascertain the associations that existed among variables of interest. These definitions support the choice of the researcher to employ the descriptive survey design simply because, in this study, samples were drawn with the aim of making generalization about the population based on the sample results from analysis. Primarily, it is desirable to adopt this design in that the researcher seeks to capture the views of SHS mathematics teachers with respect to their perceptions towards the use of concrete TLMs in teaching and learning.

Labaree (2013) observed that descriptive survey lends to many benefits because it presents multiple strategies. One benefit is that it costs less when the instruments are administered by the researcher. Also, for a large population, a survey design is appropriate and useful to study the entire characteristics of that population. This helps to draw very large samples for rigorous statistical analysis rendering the results statistically significant. This suited the current study because large sample sizes were required for robust statistical analyses like factor analysis, correlational and regression analyses, and analysis of variances (ANOVA).

However, Labaree (2013) has stipulated some weaknesses of descriptive survey: one, the confidentiality of respondents may not be fully guaranteed. Two, respondents may not always be truthful since they would want to say or do what the researcher will feel happy with. For this reason, Lietz and Keeves as cited in Cohen et al. (2007) suggested that descriptive surveys demand attention to be concentrated on sampling, to guarantee that the information on which the sample was founded is comprehensive. Cohen et al. (2007) further contended that there is a danger that some potential respondents perhaps might fall out of the study, thereby weakening the sample, or that some participants may not answer specific questions or, knowingly or unknowingly, provide incorrect answer. Again, measurement error may also transpire if the instrument is faulty, for example, selecting inappropriate metrics or scales.

In view of these weakness, the researcher made sure that the purpose and benefits of the study was thoroughly communicated to participating mathematics teachers. They willingly participated in the study. So, none of them opted out of the study. The main scale used was a Likert scale which the researcher explained to the teachers who took part in the study. The instruments used were thorough checked and scrutinized for any error by the supervisor, researcher and a peer review team before the final development and administration.

Despite these weaknesses, the researcher deemed this design best fit for finding answers to the questions posed in the study. Also, the researcher studied the phenomena as they existed by collecting data to answer the research questions and hypothesis posed in this study.

Population

The population for the study includes all SHS mathematics teachers in the Central Region of Ghana. According to MoE (2019), there are 67 public SHSs and 36 private SHSs in the Central Region. Of these, Cape Coast Metropolis contains ten public SHSs and two private SHSs. The target population is, however, made up of all public SHS mathematics teachers in the Cape Coast Metropolis with an estimated population of 180. The study sampled 132 teachers made up 26 female and 106 males. Of these teachers, 81 are first degree professionals, 18 are first degree non-professionals, 31 are postgraduate professionals and two are postgraduate non-professional. The average age of teachers in the Metropolis is approximately 34 years (SD = 7.10) ranging from 20 to 56 years; and that of their teaching experience is 8years (SD = 6.16) ranging from 4 months to 31years.

Sampling Procedure

Stratified sampling technique was employed in this study. This technique was adopted because all the ten (10) public SHSs in the Cape Coast Metropolis have been classified into three categories: A, B, and C (MoE, 2019). From MoE's (2019) categorization of public SHSs in the Metropolis, there are five category A schools with 111 mathematics teachers; three category B schools with 47 mathematics teachers; and two category C schools with 22 mathematics teachers. The estimated number of mathematics teachers in the Metropolis is 180 as reported by the various Heads of Mathematics Departments (HOD).

According to Krejcie and Morgan (1970), for a population of size 180, the researcher needed a sample of size 123 for a valid and meaningful statistical analysis. Literature has also provided a guiding principle for sample size determination for any rigorous inferential statistical analysis (see for example: Ary et al., 2010; Cohen et al, 2007; Pallant, 2016; Tabachnick & Fidell, 2013). Tabachnick and Fidell (2013) posit that for testing multiple correlation, the "simple rule of thumb" is to use $N \geq 50 + 8m$ (where N is the sample size and m represents the independent variable: use of concrete materials, teaching experience, sex). They further proposed that, for a test of individual predictors, the rule is to use $N \geq 104 + m$. It was based on this premise that the current study used a sample size 132 for the quantitative data.

Thereafter, simple random sampling techniques was used to select proportionate samples from each stratum. Consequently, 81 mathematics teachers were drawn from category A; 35 teachers from category B; and 16 teachers from category C. Ary et al. (2010) have the view that when the researcher is interested in studying the main characteristics of the entire population, proportionate stratified sampling was applied. They advanced their assertion that, this was to allow for representativeness of all the samples and would warrant generalizability of the results about the target population.

Subsequently, in the qualitative phase, samples were drawn purposively from each stratum for the interview data collection. Ary et al. (2010) and Cohen et al. (2007) guideline for sampling qualitative data was followed. Five teachers were selected from the various strata for the interview session. The sample size was dependent on the point of data saturation during sampling process as suggested by researchers (Ary et al., 2010; Cohen et al., 2007; Creswell, 2014). According to Charmaz (2006) as cited in Creswell (2014), the researcher needed to end the collection of further data when the ideas captured (or themes) are saturated: a point where further data collection yields no new insightful information or themes. Creswell (2014) indicated, from his experience of reviewing qualitative studies, that case studies usually comprise four to five samples. He further recommended the idea of saturation as another viable approach to be followed.

Data Collection Instruments

Two different data collection instruments were used to collect data in the study. These are teachers' perception scale questionnaire and semi-structured interview guide.

Questionnaire: SHS mathematics teachers' perception questionnaire was developed by the researcher under the supervision of the supervisor and two other senior colleagues at the Department of Mathematics and ICT Education, University of Cape Coast. SHS mathematics teachers' perception towards the use of concrete TLMs in teaching and learning is not directly observable. It is rather inferred from behaviour, but may be influenced by many factors. Therefore, self-reported questionnaires were used to collect the quantitative data (see Appendix A). The questions were closed ended and grouped into two sections: section A comprises five questions on teachers' demographic data (age, sex, experience, qualification and school category); and section B was made up of 49 questions, eliciting information on mathematics teachers' perceived utility of concrete TLMs in teaching and learning. It consists of seven subscales: Availability of TLMs, Cost of TLMs, Time constraints, Classroom management constraints, Mathematics achievement in using TLMs, Relevance and importance of using TLMs, and Teacher's self-efficacy beliefs in using TLMs. Likert scale was the dominant scale used in the literature reviewed on teachers' use of mathematics manipulatives. Therefore, it was used for the quantitative study. With the Likert scale, teachers were requested to say or indicate whether they strongly disagree (SD), disagree (D), not sure (N), agree (A), or strongly agree (SA) with statements as indications of their perception towards the use of concrete TLMs. The statement was either positive or negative.

Semi-structured Interview Guide: Subsequently, semi-structured interview guides were developed by the researcher and used to collect the qualitative data (see Appendix B). The instrument comprises nine questions and made up of two parts: part A captures the biographic data of teachers; and part B elicited information on SHS mathematics teachers' views on the factors that they perceived as influencing their usage of concrete materials in teaching and learning of mathematics.

Data Collection Procedures

The initial data collection process started with obtaining permission from the Department of Mathematics and ICT Education, Faculty of Science and Technology Education, College of Education Studies, University of Cape Coast and the schools where the data was collected. Ethical clearance was further sought from University of Cape Coast Institutional Review Board (UCCIRB). The identification number of the researcher was given as UCCIRB/CES2021/117. The various heads of schools and mathematics departments were consulted and the purpose of the research explained to them. The rationale for the research was then communicated to participants. After establishing rapport with respondents and securing their consent, the researcher sought the assistance of heads of departments to administer the instruments and collected the data in person from each school. Because of the double-tracking system that is being ran at the SHS level, some teachers were not present in school as at the time of data collection.

So, their HODs communicated to them to seek their consent on participating in the study before giving the researcher their contacts. The researcher, on receiving their consent, forwarded an online google forms questionnaire to them to respond to.

The process of gathering data started from 16th November to 16th December, 2021. The quantitative data took about three weeks to complete since participants might need a day or more to successfully complete their self-reported questionnaire. The researcher ensured that teachers complete their questionnaires voluntarily at their convenient times since they might be engaged in school activities. The completed questionnaires were collected from teachers personally and in some instances, through the HODs of the various schools. In all, 26 teachers responded to the online google forms and 106 teachers also responded to the physically administered questionnaires making a total of 132.

The interview session followed the outcome of the results from the quantitative data analysis. To allow for quality of the data and internal consistency, the researcher himself conducted the interview using a standardized semi-structured interview guide question. The researcher provided friendly atmosphere for the interviewees to freely express their thought. The researcher also ensured an incidence free ambience during the interview. Interviewees were given adequate time to express their thought on issues. Time spacing was allowed between questioning to enable the researcher to take written notes and audio recordings. The researcher thanked the interviewee after each interview session. The qualitative data gathering lasted for about 5 days since teachers had different schedules. In all, five teachers were purposively sampled for the interview session. After the fifth interviewee, data saturation point was reach. So, there was no need for further interviews.

Ethical Issues

This study is not to invade respondents' privacy. The initial data collection process started with obtaining permission from the Department of Mathematics and ICT Education and the Institutional Review Board, University of Cape Coast; and the schools where the data was collected. The purpose of the research was explained to the participants before the beginning of the survey. This is to ensure and guarantee some rapport with the respondents and safeguard their dignity throughout the study. The researcher also ensured that the demands of questions on both interview guides and questionnaires were void of any tendency that will seek to marginalize respondents. This was duly checked during the validation stage of the instruments with the Supervisor, experts and peer review team.

The researcher ensured further that the consent forms (see Appendix C) for the participating schools/respondents were signed accordingly before data collection started. The respondents were asked to voluntarily participate in the survey or decline. The researcher assured them of not reporting any aspect of the information they were providing in any form that would identify them. To achieve this, respondents were strictly assigned pseudo names (reference codes or serial numbers as on the questionnaires) so as to maintain their anonymity and confidentiality.

Furthermore, the researcher did not expose respondents to any potential risk in the data collection process. Teachers were allowed to fill their questionnaires at their convenient time without any stress. Interview sessions too were conducted in conducive and well-ventilated environments devoid of fear and intimidation. Participants were treated with outmost respect during data collection. The COVID-19 health and safety protocols were strictly adhered to throughout the study.

Validity

The face and content validity of the instruments were assessed by my supervisor who is a senior tutor and has an in-depth knowledge in developing instruments, at the Department of Mathematics and ICT Education, University of Cape Coast; and a peer review team. Their suggestions were adhered to and the necessary corrections were effected before the final instrument was developed.

The developed instrument was pre-tested on seventeen teachers who were not part of the main survey but who had similar characteristics outside the Metropolis of Cape Coast. The Cronbach alpha reliability co-efficient value was computed for the instrument using the Statistical Package for the Social Sciences (SPSS) version 21 and an alpha value of .88 was recorded. The instrument proves to be reliable and acceptable as accentuated by Mutodi and Ngirande (2014).

Reliability

The forty-nine Likert scale items were subjected to principal component analysis (PCA) to explore the internal consistency of the items loadings as suggested by Pallant (2016); and Tabachnick and Fidell (2013). Specifically, exploratory factor analysis (EFA) was done purposely to also reduce the large data set to a small set of summary variables (subconstructs). Another aim is to validate the construct validity of the instrument used. Four factor solution was obtained.

The four factors retained explained a total variance of 47.95%. In all, 39 items loaded strongly onto the four factors measuring the following constructs: “Teachers’ efficacy/Benefits" which is a combination of three subscales (Teachers’ self-efficacy beliefs, Achievement of TLMs and Importance of TLMs,); “Availability”; “Time/Classroom” which is a combination of two subscales (Time and Classroom management constraints; and “Cost”. Table 2 shows the results from the reliability test.

Table 2: Cronbach Reliability Coefficients Values of the Factors Identified

Identified Factors	Number of Items	Alpha Value (α)
Teachers’ efficacy/Benefits	23	.95
Availability	6	.70
Time/Classroom	5	.70
Cost	4	.64
Total	38	.87

Source: Fieldwork (2021)

From Table 2, the overall Cronbach alpha reliability of the instrument used was found to be .87 which is in line with literature. The benchmark Cronbach alpha reliability co-efficient value that ranges from .70 to .90 suggested to be good and allowable by Mutodi and Ngirande (2014) was retained.

Trustworthiness

Ary. et al. (2010) and Creswell (2014) have suggested the use of at least two of the following approaches to ensuring and improving the trustworthiness of a qualitative research: triangulation, member checking, peer debriefing, external auditing, audit trial, replication logic, stepwise replication, code-recoding, inter-rater comparison, self-reflection, prolonged engagement, using detailed description, and presenting contradictory information.

To achieve this, the researcher applied triangulation, member checking, external auditing, code-recoding (intra-rater agreement), and self-reflection. The researcher collected data from different sources for the purpose of triangulation and to better understudy the problem. This was done using close-ended questionnaire, semi-structured interview guide with audio recordings and field notes. The results were carefully scrutinized for emerging associations. Member checking was done by sending the interviewees the verbatim transcription of the interview data for them to review and validate it. The necessary revisions of the report were made through their feedbacks. For external auditing, one senior colleague and my supervisor were given the report to examine the findings, discussion and conclusions to ascertain whether the interpretations were supported by the data gathered. Coding of the transcribed interview data was achieved at three different times before the researcher realizing the emerged factors (themes). Throughout the study, the researcher remained objective to the research protocol through self-reflection. This helped to ensure that the interviewees sampled were part of the main quantitative study as cautioned by

Ary et al. (2010) and Creswell (2014). It also helped to ensure that the researcher was not biased towards any respondent in the study.

Data Processing and Analysis

The quantitative data gathered was processed and managed first by coding and editing where appropriate, and entering the data into the appropriate software (Statistical Package for the Social Sciences, version 21) to generate results. Any negative question item on the teachers' perception scales was reversely coded from SD = 1, D = 2, N = 3, A = 4 and SA = 5 to SD = 5, D = 4, N = 3, A =2, SA = 1 as suggested by Pallant (2001, 2010, 2016). This is to transform all negatively worded question items to positive question items before the date was thoroughly screened for any unwanted entry values unnoticed during inputting. The data was further reduced to a small summarized data set by using PCA. Four factor solutions resulted from the EFA. This was done because the focus of the study was to determine the factors which influence the perception of SHS mathematics teachers towards the utilization of TLMs in teaching and learning in the Cape Coast Metropolis. It was also to validate the construct validity of the perception scale instrument.

The first research question that guided the study was, "What are the possible factors influencing SHS mathematics teachers' use of concrete teaching and learning materials?" To answer this research question, the processed data was subjected to data reduction method, specifically, exploratory principal component analysis (EPCA). This was done to achieve a smaller set of summarized data which could possibly be identified as factors influencing SHS mathematics teachers' use of concrete teaching and learning materials. Parallel analysis was employed together with the PCA as proposed by Pallant (2016) to achieve an objective four factor solution. The four factors identified were named according to the variable (question item) loadings under each of them. The identified factors were: "Teachers' efficacy/Benefit", "Availability", "Time/Classroom", and "Cost". The assumptions for PCA were not violated. Sample adequacy and factorability of the correlation coefficients matrix assumptions were met. Kaiser-Meyer-Olkin (KMO) was .82 and Bartlett's test of sphericity was also statistically significant ($p < .001$) (Pallant, 2016; Tabachnick & Fidell, 2013).

The second research question that guided the study was "What is the perception of SHS mathematics teachers towards the use of concrete teaching and learning materials?" This question demands that statistical means and standard deviations are used to establish the extent to which SHS mathematics teachers have perceived the utilization of TLMs in teaching and learning in the Metropolis. Boone and Boone (2012) asserted that it was appropriate to analyze Likert scale data at the interval measurement level using descriptive statistics. The data was transformed and computed into five composite perception scores (sum or mean) as suggested by Pallant (2001, 2016); and Boone and Boone (2012). These five composite perception scores are "Total perception scale", "Teachers' efficacy/benefit", "Availability", "Time/Classroom", and "Cost".

So, to answer the research question one, the scales were screened thoroughly for normality, extreme values, and skewness by using descriptive statistics, frequencies, percentages, histograms with fitted normal curves, box-and-whisker plots, and normal Q-Q plots. Three responses were detected to have extreme values through the data cleansing and screening process. This resulted in excluding three respondents with ID numbers 43, 58 and 104 from the final analyses. For this reason, 129 respondents were used for the final analyses instead of 132. The final analyses have given enough evidence that the five subscales were approximately normal and without any extreme outliers (see Appendix F).

In line with the work done by Addae and Agyei (2018), the analyzed scores from the result were interpreted as follows: 1 as the lowest possible score, which represents unfavourable perceptive use of concrete TLMs, and 5 as the highest possible score which represents favourable perceptive use of concrete TLMs in teaching and learning of mathematics.

The qualitative data was analyzed thematically. The audio data recorded and notes taken from the semi-structured interview sessions were transcribed to text as suggested in literature (Ary et al., 2010; Creswell, 2014). The text data was organized and prepared for coding into identified themes through thorough reading and scrutiny of raw data. The emerged themes were aggregated into the various factors as deemed appropriate as influencing the perceptions of the SHS mathematics teachers towards the use of concrete materials in teaching and learning mathematics. Verbatim quotations and excerpts from the qualitative data sources were utilized to triangulate evidence to corroborate findings in the quantitative phase.

The third research question that guided the study was, “To what extent do these factors identified and teaching experience predict SHS mathematics teachers' use of concrete teaching and learning materials?" Since this research question sought to find the best predictive factor that influences SHS mathematics teachers' perception towards their use of TLMs, correlational and multiple regression analyses were used to answer this question. This is because the aim of the researcher is to study the strength of the factors which predict their perceptions towards the use of TLMs.

First, correlational analysis is a statistical tool that helps to establish enough evidence as to whether or not two or more continuous variables (one dependent and the other independent) are linearly correlated. Once, this is statistically proven to be significant, the two dependent and independent variables could be regressed to study the predictive strength of the independent variable(s). This is what this research question sought to achieve. The five subscales used in this study have satisfied the conditions for the use of correlational and regression analyses through rigorous testing.

The test results revealed that the sample size was large enough, the subscales were normal, the variables were continuous, there were linear relationships amongst the variables, there was no presence of covariates, and there were no outliers. Pearson's product-moment correlation coefficient (r) was used to determine the strength of the linear relationships because the variables were continuous. Variance inflation factor (VIF) and tolerance values were also used to further assessed the suitability of multiple linear regression analyses.

The research hypothesis that guided the study was, "There is no statistically significant differences between teachers' qualifications and their perception towards the use of concrete materials in mathematics lessons". Since this hypothesis sought to find if there were any significant differences that existed between the four levels of teachers' qualifications, one-way analysis of variances (ANOVA) was employed for the analyses to answer the hypothesis. This was appropriate for the researcher because the "Total perception scale" as the dependent variable was continuously normally distributed and the independent variable (teachers' qualification) had four levels to be compared on the perception scale. All statistical analyses were fixed at 5% significant level throughout the study. There were no violations of the tests for one-way ANOVA use.

Chapter Summary

This study is focused on investigating SHS mathematics teachers' perception towards the use of concrete teaching and learning materials in the Cape Coast Metropolis in Ghana. The study adopted explanatory sequential mixed methods approach to research design. This approach was more preferable in this study because the researcher sought to gather both quantitative and qualitative data to better understand the phenomenon under investigation. Questionnaires and semi-structured interview guides were utilized for the collection of both quantitative and qualitative data respectively. Both instruments were constructed by the researcher and validated by two senior colleagues, my supervisor and UCCIRB. The quantitative data collected was analyzed using graphs, frequencies, descriptive and inferential statistics (correlational, regression and principal component analyses) while the qualitative data was analyzed using thematic analyses and verbatim quotations to triangulate and corroborate findings in the quantitative analyses.

The fact that only ten public SHSs in the Cape Coast Metropolis were used could limit the generalizability of the result to other parts of the region and the country as a whole. The design, instruments, statistical tool used and the time of instrumentation are all limitations to the study. Also, human error plays a key role in the validity of any project. Notwithstanding all these limitations, the researcher ensured that all the research protocols were strictly adhered to.

CHAPTER FOUR

RESULTS AND DISCUSSION

Overview

This study sought to investigate SHS mathematics teachers' perception towards the utilization of concrete teaching and learning materials in the Cape Coast Metropolis. To accomplish this task, the researcher adopted explanatory sequential mixed methods approach to research design. One hundred and thirty-two (N=132) teachers were sampled through proportionate stratified sampling technique from all the ten public SHSs in the Metropolis. It was however 129 teachers who were used in the final analyses of the first phase of the study after thorough data screening. Five teachers were purposively selected for the second phase of the study. The researcher used 4 weeks for data collection. The data collected were analyzed using frequencies, graphs, descriptive and inferential statistics for the interpretation of results.

The results and their interpretations have been presented according to research questions and hypothesis that guided the study. The results of the first phase were presented first followed by the second phase. The discussion of results was also done in like manner with some implications. The chapter ends with a summary of key findings from the study.

Background Information of Teachers

The biographic data gathered on SHS mathematics teachers' perception towards the utilization of concrete teaching and learning materials in the Cape

Coast Metropolis included their ages, sexes, school categories, teaching experience and qualifications.

The result from the data gathered on sex of the participating mathematics teachers is displayed in Table 1. The main purpose was to know the dominant sex in the Metropolis with respect to mathematics teachers.

Table 3:Sex of Teachers

Sex	Frequency	Percentage (%)
Female	26	20.2
Male	103	79.8
Total	129	100.0

Source: Fieldwork (2021)

It can be seen from Table 3 that the male teachers were the dominant representatives which amounted to 79.8% of 129 teachers sampled in this survey. This result indicates that there are fewer SHS female mathematics teachers in the Metropolis than male teachers.

Data was also gathered on the categorization of SHS mathematics teachers to ascertain how they were distributed in each category. The data collected on school category of participating mathematics teachers is presented in Table 4.

Table 4: School Category of Teachers

Category	Sex				Total	
	Male		Female			
	F	%	F	%	F	%
A	61	47.3	18	14.0	79	61.2
B	30	23.3	5	3.9	35	27.1
C	12	9.3	3	2.3	15	11.6
Total	103	79.8	26	20.2	129	100.0

Source: Fieldwork (2021)

From Table 4, 79 (61.2%) of the participating mathematics teachers are teaching in category A schools. It can be inferred from Table 4 that majority of teachers are from category A schools. This is because category A has five schools out of the total of ten SHSs in the Metropolis. Next is category B schools which are three in number in the Metropolis. This is made up of 35 (27.1% of) mathematics teachers who took part in the study. The least reported number of teachers was recorded in category C schools. This represents 15 (11.6%) participating mathematics teachers. Table 4 also reveals that there were more male participating mathematics teachers than were female mathematics teachers in the study. The result specifically shows that 103 (79.8%) of the respondents were male mathematics teachers whiles 26 (20.2%) of them were female mathematics teachers.

Furthermore, to understand whether or not the qualification of mathematics teachers could influence their perceptions towards the use of TLMs, data was gathered on the qualification of the respondents in this study. The result from the analyses of the data gathered on teachers is reported in Table 5.

Table 5: Qualification of Teachers

Qualification	Frequency	Percentage (%)
First Degree Non-professional	18	13.95
First Degree Professional	78	60.47
Postgraduate Non-professional	2	1.55
Postgraduate Professional	31	24.03
Total	129	100.00

Source: Fieldwork (2021)

The result in Table 5 depicts that 109 (84.5%) of the teachers who took part in this study were professionally trained. This is made up of 78 (60.47%) first degree and 31 (24.03%) post graduate professional mathematics teachers. It presupposes that these teachers might have some sort of knowledge on the utilization of TLMs in teaching and learning of mathematical concepts. The result also revealed that 20 (15.5%) of the teachers have no professional training in tertiary school. This seems to suggest that these teachers might have limited or no knowledge on the use of TLMs in teaching and learning of mathematical concepts.

Results from Analyses

This section presents the results from data analyses in accordance to the research questions and hypothesis which guided the study.

Factors Influencing SHS Mathematics Teachers' use of TLMs

The first research question that was applied in the study was "What are the possible factors influencing SHS mathematics teachers' use of concrete teaching and learning materials?" To answer this question, the forty-nine Likert scale items were subjected to principal component analysis (PCA) to identify the factors which could possibly influencing the perception of SHS mathematics teachers towards the use of concrete TLMs. Specifically, exploratory factor analysis (EFA) was done purposely to also reduce the large data set to a small set of summary variables (subconstructs). Prior to the PCA, the assumptions for using this data reduction method were assessed. Inspection of the correlation matrix showcased that many co-efficient values of .3 and above were retained (Pallant, 2016). The Kaiser-Meyer-Olkin (KMO) value was .82 which was above .6 and Bartlett's Test of Sphericity also reached statistical significance value ($p < .05$), allowing for the suitability of the factorability of the correlation matrix (see for instance: Pallant, 2001, 2016; Tabachnick & Fidell, 2013).

PCA revealed that 12 components (factors) were present using Kaiser's criterion of only retaining components with eigenvalues greater than one. The twelve components explained 70.92% of the total variation. Since twelve factor solution was not practicable for this study, the scree plot was employed. See Figure 1 below. Figure 1 revealed two breaks; the first one after the fourth factor and the second one after the sixth factor. For an objective solution, Pallant (2016) proposed the use parallel analysis.

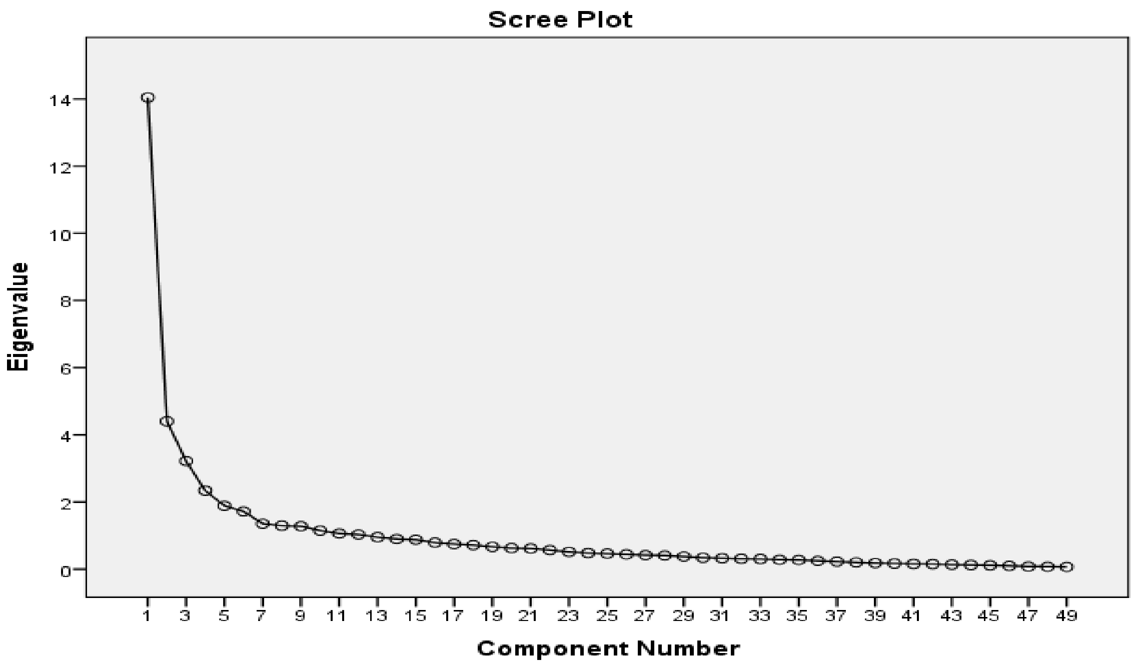

Figure 1:The Possible Factors Influencing Teachers' use of TLMs

Parallel analysis (Watkins, 2000) was employed together with the PCA to achieve a four-factor solution. Table 6 shows the results from the PA and PCA for the first six components. From Table 6, only components with eigenvalues from PCA greater than that of PA are retained (Pallant, 2016). Thus, four factor solution was achieved using Table 6.

After this, the procedure for PCA was repeated for only four factors. To ascertain the nature of the factors, varimax rotation was applied. This resulted a rotated component matrix showing the unique item loadings for each component. Table 7 shows the summary of the unique loadings of the factors identified. From

Table 7, twenty-three items uniquely loaded on component 1; six items on component 2; and five items each on component 3 and 4.

Table 6:Results from PCA and PA

Component	Eigenvalues from PCA	Eigenvalues from PA	Decision
1	14.044	2.4343	Accept
2	4.400	2.2676	Accept
3	3.216	2.1461	Accept
4	2.336	2.0473	Accept
5	1.885	1.9597	Reject
6	1.715	1.8777	Reject

Source: Fieldwork (2021)

Table 7: Summary of Unique Item Loadings onto Components

Component 1			Component 2	Component 3	Component 4
Q20	Q30	Q31	Q6	Q10r	Q12
Q32	Q33	Q34	Q7	Q22r	Q14
Q35	Q36	Q37	Q8r	Q26r	Q17
Q38	Q39	Q40	Q16	Q27r	Q18
Q41	Q42	Q43	Q19	Q29r	Q21r
Q44	Q45	Q46	Q24		
Q48	Q49	Q50			
Q52	Q54				
	23 Items		6 Items	5 Items	5Items

Source: Field Survey (2021)

The four factors retained explained a total variance of 47.95%. In all, 39 items loaded strongly unto the four factors measuring the following constructs:

"Teachers' efficacy/Benefits" which is a combination of three subscales (Teachers' self-efficacy beliefs, Achievement of TLMs and Importance of TLMs); "Availability"; "Time/Classroom" which is a combination of two subscales (Time and Classroom management constraints); and "Cost". This result has highlighted that there are uniquely four factors that could possibly influence SHS mathematics teachers' perception towards the usage of concrete TLMs.

Perception of SHS Mathematics Teachers towards the use of TLMs

The second research question that guided this study was "What is the perception of SHS mathematics teachers towards the use of concrete teaching and learning materials?"

To provide answers to this question, the perception subscale scores were subjected to rigorous tests to check for the presence of extreme outliers (values). Three extreme outliers were detected and deleted from teachers' responses before the analyses. Thereafter, normality tests were carried out on the five subscale scores. The test results revealed that the scores were approximately normally distributed as suggested by Pallant (2001, 2010, 2016). Descriptive statistics were then computed on the perception subscale scores as were recorded from teachers' responses. The interpretation of results follows that a mean score of 3.0 on the perception scale means that teachers were indecisive or neutral. Any perception scale score greater than 3.0 indicates teachers' positive perception towards the use of concrete TLMs. Conversely, any mean score less than 3.0 shows teachers' negative perception towards the use of concrete TLMs. The results are reported in Table 4 as follows.

Table 8:Means (M) and Standard Deviations (SD) for Mathematics Teachers' Perception Scales

Scales	M	SD
Teachers' efficacy/Benefits in using TLMs	4.20	.481
Time/Classroom constraints in using TLMs	3.73	.707
Cost of TLMs	3.23	.774
Availability of TLMs	2.79	.696
Total Perception Scale	3.79	.366

Source: Fieldwork (2021); N = 129

Table 8 indicates that SHS mathematics teachers in the Cape Coast Metropolis have reported their highest favourable perception towards the use of TLMs in regards to Teachers' efficacy/Benefits in using TLMs ($M = 4.20,\ SD =$ .481). This assertion is stemmed from the fact that teachers had a mean score of 4.20 with standard deviation of $.481$ on the perception subscale Teachers' efficacy/benefits in using TLMs. This means that SHS mathematics teachers have strong self-efficacy beliefs in their capabilities and skills in using TLMs appropriately, and acknowledging how relevant and important its usage was to students' academic achievement in teaching and learning mathematics. It also seems to highlight that teachers have reported their profound knowledge in using TLMs, for the fact that, they perceived its usage as beneficial to students' mathematics learning.

The results in Table 8 depict that SHS mathematics teachers possess high positive perception towards Time/Classroom management constraints in using TLMs ($M = 3.73,\ SD = .707$) in their lessons. This result seems to suggest that SHS mathematics teachers consider the time they allocate to preparing and delivering mathematics lessons with TLM as crucial; and it does affect their decisions positively to utilize TLMs irrespective of the challenges they were faced with managing their classrooms. This opinion of mathematics teachers towards the utility of TLMs in the classroom may suggest that teachers in the study were effective managers of their classrooms and time. This is because majority of them were professionally trained. They have demonstrated this by obtaining a mean score of 3.73 with standard deviation .707 on the perception subscale Time/Classroom management constraints in using TLMs.

SHS mathematics teachers have also demonstrated that the cost of TLMs ($M = 3.23,\ SD = .774$) has influenced their perception positively towards its usage in mathematics lessons. It can be inferred from this result that SHS mathematics teachers believed that the cost of TLMs was not anything to stop them from using it in their lessons. This might also be because of their professional knowledge in how to improvise for expensive TLMs since majority have the capability to do so.

The results in Table 8 have however revealed that the least reported perception towards the use of TLMs by teachers was reported in the availability of TLMs ($M = 2.79,\ SD = .696$). This might suggest that TLMs are not readily available or teachers have no access to even the available TLMs in the schools in the Metropolis. Notwithstanding this unfavourable situation teachers are faced with, the overall perception ($M = 3.79,\ SD = .366$) of SHS mathematics teachers towards the use of TLMs was positive. It indicates that mathematics teachers in the Cape Coast Metropolis have favourable intention towards the utilization of TLMs since they have acknowledged its many benefits to students' learning. It can be concluded that SHS mathematics teachers in the Cape Coast Metropolis of the Central Region of Ghana have agreed that the utilization of TLMs in teaching and learning was beneficial and should be upheld.

Factors that Predict SHS Mathematics Teachers' Perception

The second research question was "To what extent do these factors identified and teaching experience predict SHS mathematics teachers' use of concrete teaching and learning materials?" To address this question, a correlational analysis was carried out first to establish whether or not there were linear relationships between the factors (independent variables) and the total perception scale (dependent variable). The assumptions for correlational analysis were met through rigorous testing. The test revealed that all variables were continuous, normal, without outliers, and the sample size was large enough for the analysis. The results are presented in Table 9 as follows:

Table 9: Correlation between the Factors influencing Mathematics Teachers' use of TLMs and their Total Perception Scale

Scales		Teaching Experience	Teacher efficacy/ Benefits	Availability	Time/ Class	Cost
Total Perception	Pearson Correl.	-.053	.850*	.409*	.413*	.457*
	p-value	.572	.000	.000	.000	.000
	N	118	129	129	129	129

Source: Fieldwork (2021); *Correlation is significant at $p = .000$ < .01(2-tailed).

The results from Table 9 reveal that teaching experience has a weak negative linear relationship with the total perception of mathematics teachers towards the use of TLMs. This is an indication that as a teacher remains longer in active service, the lesser he/she perceives the usage of TLMs in teaching and learning mathematics. This was, however, not significant ($r = -.053, p = .572$).

The results further depict that the correlations were significant and positive between the total perception of mathematics teachers and their perceived factors that influence their choice of use of TLMs in teaching and learning. The highest Pearson's product-moment correlation coefficient was recorded in Teachers' efficacy/Benefits in using TLMs ($r = .850, p < .001$). It shows a strong positive correlation between the two variables. This means that as teachers' self-efficacy beliefs and their views about the benefits of TLMs increase, their perception towards the use of TLMs also increases. The coefficient of determination ($R^2 = .850 \times .850 = .723$) explains that 72.3% variance is shared between the two variables. It highlights that Teachers' efficacy/Benefits in using TLMs explains 72.3% of total variability in the total perception scale.

Similarly, the results show moderate and positive correlations between the other three factors and the total perception scale. It can also be inferred form the results that as each factor is increased, the total perception scale also increases moderately. The results are as follows: cost of TLMs $(r = .457, p < .001)$; Time/Classroom management constraints $(r = .413, p < .001)$; and Availability of TLMs $(r = .409, p < .001)$. The total variability explained by each factor in the total perception scale are as follow: Cost of TLMs (20.1%); Time/Classroom management constraints (16.2%); and Availability of TLMs (16.7%).

To determine the best predictor of the SHS mathematics teachers' perception towards the use of TLMs, multiple regression analysis was employed to further explore the dimensions under investigation. The assumptions underlying the use of regression analysis were met. More precisely, preliminary test results reveal that normality, linearity, multicollinearity and homoscedasticity assumptions were met. For instance, all the independent variables that were entered into the model had tolerance values greater that $.10$ and variance inflation factor (VIF) values less than 10; the correlations between dependent variable and the independent variables all exceeded the $.3$ threshold; also, the correlations among the independent variables did not exceed .7; and there were no major deviations from normality as required in literature (eg. Pallant, 2001, 2010, 2016). The test result for normality is displayed in Figure 2.

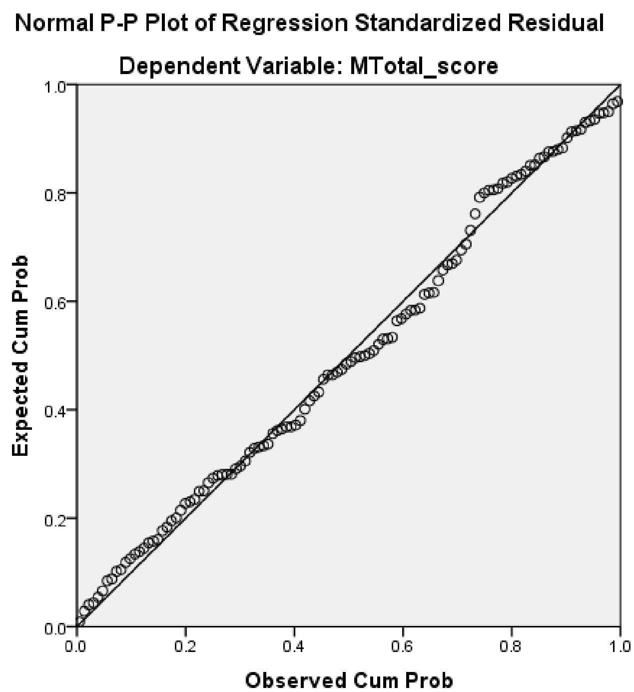

Figure 2: Normal P-P Plot of Regression Standardized Residual

Figure 2 depicts the graph of the normal p-p plot of regression standardized residual. The plot reveals no major violations of multiple regression analysis since all the points lie reasonably on the line diagonally from the bottom left to top right.

Since teaching experience shows no significant relationship with teachers' use of concrete TLMs, it was excluded in the main regression analysis. Thus, the four factors identified: Teacher's efficacy/Benefits in using TLMs, Availability of TLMs, Time/Classroom management constraints and Cost of TLMs were entered into the regression model. This is to discover how best they fit the model and also look out for the best predictor of teachers' perceptions towards the use of TLMs. The result is presented in Table 10.

Table 10: Summary of Regression Analysis of Teachers' Perception towards the use of TLMs

Subscale	Coefficients			ANOVA		Collinearity Stat.	
	B	β	P	F	P	Tolerance	VIF
Constant	.016		.549	5329.947	.000*		
Teacher/ Benefits	.586	.772	.000*			.972	1.029
Availability	.158	.302	.000*			.888	1.126
Time/Class	.138	.267	.000*			.943	1.060
Cost	.108	.229	.000*			.856	1.169

Source: Fieldwork (2021); * Significant at p < .05
$R = .997,\ R^2 = .994,\ adjR^2 = .994;\ std.error\ of\ estimate = .0282$

Table 10 shows the results for the regression analysis. The results in Table 10 indicate that the total variability accounted for by the model as a whole was 99.4% ($R^2 = .994$). The F-test results also show that the model fit was significantly a good predictor [$F(4,124) = 5329.947, p < .001$)] of the perception of mathematics teachers by the four factors. Using the standardized coefficients which is a measure of the strength of each predictor, the predictive model is given by:

$$\text{Perception}_{positive} = .772\text{Teacher-efficacy/Benefits} + .302\text{Availability} + .267\text{Time/Classroom} + .229\text{Cost}.$$

The model highlights that Teachers' efficacy/Benefits in using TLMs is the strongest predictor of the perception of SHS mathematics teachers towards the use of TLMs in the Cape Coast Metropolis among the four factors. The next highest predictor is the Availability of TLMs; followed by the Time/Classroom management constraint; and the least predictor of the mathematics teachers' perception is the Cost of TLMs.

The Influence of Mathematics Teachers' Qualification on their Perception

The hypothesis that guided the study was "There is no statistically significant difference between mathematics teachers' qualifications and their perception towards the use of concrete materials". Before the main testing of the hypothesis, the assumptions for one-way ANOVA were verified. The test of homogeneity of variances $(p = .929 > .05)$ was not violated. The ANOVA results are presented in Table 11.

Table 11: Mean difference between the Perception of Mathematics Teachers and their Qualifications

Qualification	M	SD	N	F-value	p-value
First Degree Non-Professional	3.74	.326	18	1.474	.225
First Degree Prof.	3.81	.383	78		
Postgraduate Non-professional	3.30	.526	2		
Postgraduate Prof.	3.77	.325	31		
Total Perception	3.79	.360	129		

Source: Fieldwork (2021); N = 129; p > .05 not significant.

The descriptive statistics results in Table 11 indicate that first degree professionals (M = 3.81, SD = .383) perceived the use of TLMS more than the three other groups: postgraduate professionals (M = 3.77, SD = .325); first degree non-professionals (M = 3.74, SD = .326); and postgraduate non-professionals (M = 3.30, SD = .526). This means that first degree professionals reported the highest favourable perception when it comes the utilization of TLMs in mathematics lessons as compared to the other groups. But, a further look at the results in Table11 demonstrate that the mean differences between the groups were not significant [F (3, 25) = 1.474, p = .225 > .05]. This result suggests that teachers' qualifications have no significant effect on their perceptions towards the use of TLMs in teaching and learning mathematics. It can be concluded that SHS mathematics teachers' qualifications have no significantly positive influence on their decision to utilize TLMs in teaching and learning in the Cape Coast Metropolis.

Presentation of Qualitative Results

To better understand and explain further the results in the first phase, qualitative data was gathered through interviews. Five teachers were interviewed. They were purposively chosen based on the fact that the analysis of the results from the first phase revealed four factors were influencing Teachers' use of TLMs; teachers had positive perception towards the use of TLMs; the strongest predictor being Teacher's efficacy/Benefits in using TLMs; and that the demographic factors (teaching experience and teacher's qualification) were not significantly affecting teachers' use of TLMs. Among these interviewees, two were Heads of Departments of Mathematics. The interview result is summarized in Table 12 and 13.

Table 12: Thematic Analysis of the Factors which influence SHS Mathematics Teachers' Perception towards the use of TLMs

Teacher	Biodata	Themes Identified	Counts
TB1	Female; First Degree	Importance/Achievement	3
	Prof.; 9 years of	Classroom management Const	1
	experience;	Teacher' self-efficacy	1
	category B	Non-Availability	1
TA1	Male; Postgraduate	Importance/Achievement	2
	prof; 10 years of	Class sizes	1
	experience;	Time management const.	1
	category A	Teacher' self-efficacy	1
		Non-Availability	2
		Cost of TLMs	1
TA2	Male;	Importance/Achievement	3
	First Degree Non-prof;	Teacher' self-efficacy	1
	10 years of experience;	Non-Availability	1
	category A	Cost of TLMs	1
TC1	Male;	Importance/Achievement	3
	First Degree prof;	Teacher' self-efficacy	1
	9 years of experience;	Non-Availability	2
	category C	Cost of TLMs	1
		Class sizes	1
		Time management	2
TA3	Male;	Importance/Achievement	3
	First Degree prof;	Teacher' self-efficacy	2
	10 years of experience;	Non-Availability	1
	category A	Cost of TLMs	2
		Time management	1

Source: Fieldwork (2021); N =5

Table 12 shows that all the five teachers (representing 100%) have agreed that these themes: Importance/Achievement of using TLMs, Non-availability of TLMs, Teachers' efficacy and Cost of TLMs had great influence on their use of TLMs in teaching and learning mathematics. It can also be seen from the Table 12 that four (representing 80%) out of the five teachers claimed that Time management challenges was a factor they would consider when it comes the use of TLMs. Furthermore, three (60%) of the five teachers interviewed indicated that Class sizes/Class control challenges affect their decision to utilize TLMs in teaching and learning.

To facilitate easy explanation and understanding of the first phase results using the findings from the second phase, the results in Table 12 have been summarized in Table 13. Table 13 shows the factors that emerged from the interview data analysis. The following themes: Importance/Achievement of using TLMs and Class sizes/Classroom control challenges in using TLMs have been summarized as Benefits of using TLMs and Classroom control constraints in using TLMs respectively. Each factor was counted as "Counts" and corresponding "Percentages" were computed for each teacher during the analysis of the transcribed data from the audiotapes and field notes. The result is presented in Table 13.

Table 13: Summary of the Factors which influence SHS Mathematics Teachers' Perception towards the use of TLMs

Factors Identified	Counts	Percentages (%)
Benefits of using TLMs	14	35.90
Non-Availability	7	17.95
Teachers' self-efficacy	6	15.38
Cost of TLMs	5	12.82
Time management constraints	4	10.26
Classroom management Constraints	3	7.69
Total	39	100.00

Source: Fieldwork (2021); N = 5

The result in Table 13 highlights that six factors have emerged strongly from the interviews with the teachers. These are Benefits of using TLMs, Teachers' self-efficacy in using TLMs, Non-Availability of TLMs, Cost of TLMs, Time and Classroom management Constraints. Examination of the results have indicated that mathematics teachers have perceived highly the utilization of TLMs as beneficial to teaching and learning; based on their self-efficacy beliefs; depending on the availability and the cost of the materials. Teachers have also acknowledged that time and classroom management constraints are of a concern to them when they have to consider using TLMs in teaching and learning mathematics.

The interview sessions were guided by the research questions posed in this study. The results in Table 112 and 13 were gathered through the responses teachers gave to the four semi-structured interview guide questions. These were streamlined towards identifying the factors which influence teacher's perceptions towards the use of TLMs in teaching and learning mathematics.

The first question was "How important is the use of TLMs in mathematics lessons is to you as a Mathematics teacher?" All the five teachers' responses to this question suggested that they strongly support the use of TLMs in teaching and learning mathematics. For example, TB1 and TA1 have these to say:

TB1: It is highly important because it enhances understanding in the sense that students see the practicality of what you are teaching. Sometimes they see you demonstrating; ... so they see the lesson being demonstrated; visual representation of lesson sometimes too. There is this adage that; "I see and I *forget, aha, but when I touch, I remember". So. get them involve. The use of TLMs makes the lesson leaner-centred.*

TA1: Very important; it makes teaching/learning process easier; the children have hands-on activities so they understand the concept better than just given them theories and facts.

It can be deduced from the views that teachers gave that they have aligned themselves with the constructivist's philosophy of teaching and learning mathematics by the use of TLMs to enhance students' learning of mathematical concepts. Teachers strongly believed that the use of TLMs enhances students' understanding; gets them involved in the lesson; offers them diverse learning opportunities; makes students' learning appears real and practical to them; resulting in permanent learning for students. It also aids students to remember what they have learnt. This finding throws more lights on the first findings in the quantitative phase.

The second question was "In your view, does the use of TLMs in mathematics lessons impede or enhance students' formation of deep mathematical conceptual understanding? Please, could you explain?" In response to this question, teachers have expressed the following views:

TA2: *... it rather enhances their deep understanding of the concepts. At times, if you are teaching without those things, ...things [teaching and learning] become more abstract. So, some of the things you say, the students are not getting it clearly. But, when you are using those TLMs and they can have a feel or touch of* *what you are using, they begin to appreciate the thing [teaching and learning] more and therefore enhance their deeper understanding of the concepts.*

TC1: *It does not impede. …I am saying it does not impede. When you use the TLMs, they see it as a real-life situation; you see that they tend to appreciate the lesson more and then they will be interested in the class. But, when the TLMs are not being used, some of them will be thinking about the thing [concepts] like something that is abstract – very far from them. Meanwhile, the thing [concept] is very simple, but they will be looking at it very abstract. So, you see some of them will lose interest to participate; but, if they see the things [TLMs] that this is sometimes what we have been doing in the house … are mathematics, they relate to those things; and they become interested in whatever you are teaching. They will like to learn more, even if the period [lesson] is over; you will see they themselves will be there saying let us continue. It [therefore] improves students' attitudes towards mathematics.*

In the current study, teachers have reported that the use of TLMs in teaching and learning of mathematics makes the lessons rather more interesting and this does not impede students' deep mathematical conceptual understanding. They believed that this helps to some extent to eliminate students' problem of assimilating the abstract mathematical concepts thereby improving their attitudes towards mathematics learning.

The third question was "In your evaluation of teaching and learning of mathematics, which factors do you consider to have contributed to the biggest challenges or difficulties, if any, that teachers face when utilizing TLMs in their lessons?" All the five teachers mentioned the following factors as contributing to their challenges towards the use of TLMs. The factors are: classroom management problems, non-availability of TLMs, cost of TLMs, time management constraints, and large class sizes. For example, three teachers expressed their views that:

TA1: *I will say, the first one is class sizes we deal with: some 50, 60, 70, average class sizes; it is difficult to get TLMs to use; implies non availability of TLMs; and if it is group work too, the time is also a factor. You need more time; time for the period [duration] for the curriculum to be completed is small; so, if you want to do a lot of activity work, it affects the completion of the syllabus. The last thing I will say is finance; cost effect; most of the things [TLMs] you have to get them yourself; so, you have to bear the cost.*

TA2: *The availability of the things [TLMs] is not there; yeh and even if they are there, not in large quantity; and teachers are teaching simultaneously. You see, sharing becomes very difficult; so, at times, teachers have to improvise to continue; you can't wait.*

TB1: *Yes, class control becomes a big challenge; ... students at the end of the day are not able to relate the TLMs directly to the concepts being taught; and this might result in misconceptions on the part of students. Can I give you an example? Like using the "sipaa" [pack of playing cards], the cards to teach probability in a class full of boys. Yes, it may create chaos; ... they may have fun, but, at the end of the day, they may say that the teacher is not creative.*

Teachers have raised their candid concerns about the increasing number of students in their classes which is worsening their classroom control challenges when considering utilizing TLMs. Teachers asserted for example that a class size of 50, 60 or70 students was challenging to teach even when they are put into groups simply because of the scanty TLMs sometimes available for teachers within the limited time allocated for lessons. One teacher (TB1) even pointed out that this might lead to students' misconceptions and chaos in the classroom.

The final question posed to the interviewees was "What kind of training or help do you suggest teachers would need in order to equip them with the necessary skills to confidently and effectively incorporate TLMs in their mathematics lessons?" This question generated many suggestions and views from teachers. The number one concern for teachers was in-service training on some selected topics on how to use TLMs to teach those topics efficiently. They expressed their views that the authorities responsible for mathematics education should make adequate provisions for TLMs that the activities in the curriculum required. They have also made an appeal to professional training institutions responsible for the training of mathematics teachers to streamline their training on how and when to effectively and efficiently incorporate TLMs in mathematics lessons. The following excerpts demonstrate teachers' views:

TC1: *What I will suggest is the topics; like the topics if it could be possible, there should be in-service training on topics; treating topic by topic and then we are taken through the type of TLMs that we will need and how to use it well to teach if that can be done. Another thing, I don't know, when they are designing* *the curriculum, they have the TLMs that would be used for learning activities, but the supply to the schools don't come. They need to supply the TLMs to support the teaching and learning [activities] in the curriculum.*

TA3: *I can also say that, one, in-service training for teachers because some of them, the process of using the TLMs is also a factor. If they don't know how to use it, then they need an in-service training. This is because it is not very one teaching has done a course in how to use TLMs. Not all of us have done professional course. Some of us have BSC. (Mathematics) where we don't use TLMs, but only the concepts [and theories]. So, that one, the process of using is another factor. So how to use it is very important. Another help is financial support from the management of schools or government/authorities of education to encourage teachers.*

Discussion of Findings

The discussion of findings is based on research questions and hypothesis posed in this study. The discussion was focused on three major findings with their implications.

Factors Identified as Influencing Mathematics Teachers' use of TLMs

The first thing that this study sought to achieve was to identify which factors are possibly influencing SHS mathematics teachers' use of concrete TLMs. The finding has demonstrated that there are four unique factors ("Teachers' efficacy/Benefit in using TLMs", "Availability of TLMs", Time/Classroom management const. in using TLMs" and "Cost of using TLMs") that affect teachers' perception towards the use of TLMs. This finding is not different from what have been reported in literature (Carbonneau et al., 2018; Golafshani, 2013; Kabutey, 2016; Larbi & Okyere, 2016; Marshall & Swan, 2008; Moyer, 2001; Mutondi & Ngirande, 2014; Vizzi; 2016). For example, Mutondi and Ngirande (2014) reported that the one factor that teachers considered as important to them when it comes the use of concrete TLMs was their competence and (or) knowledge of the use of the materials. So, teachers' self-beliefs in their competences and knowledge regarding the use of TLMs is an important factor. Other researchers (Golafshani, 2013; Kabutey, 2016; Larbi & Okyere, 2016; Marshall & Swan, 2008) have similarly revealed that the benefits of using TLMs; availability and cost of TLMs; and time and classroom management constraints in using TLMs were factors teachers claimed important to them when they are considering to use these materials. The implication is that the identified factors are key to teachers' utilization of TLMs in their mathematics lessons.

Mathematics Teachers' Perception towards using TLMs

The second task of this study was to determine the degree to which SHS mathematics teachers' perceptions were influenced towards the use of TLMs in teaching and learning. The finding from the quantitative phase have highlighted SHS mathematics teachers' overall positive perceptions towards the use of TLMs in teaching and learning. The results from the qualitative phase have given further evidence to explain and understand this finding in the quantitative phase. The reason is that all the five teachers interviewed accentuated that the utilization of TLMs in teaching and learning mathematics was very important to them because they claimed its usage benefited both teachers and students greatly. For instance, teachers acknowledged that the use of TLMs makes their lessons real and practical to students; teaching and learning became more learner-centred; and students' interests, motivation and attitudes were improved towards mathematics learning. This finding is supported by what other researchers have found in literature (Carbonneau et al. 2018; Golafshani, 2013; Marshall & Swan, 2008). Golafshani's study found that teachers had developed a growing love for use of manipulatives at the end of the study; and perceived strongly that manipulatives usage had some direct effect on students' mathematics learning especially, on weak students.

This study also indicated that teachers had their highest positive perception towards the use of TLMs in respect of "Teachers' efficacy/Benefits in using TLMs". This result is indicative that teachers had high hope in their abilities and were confident in using TLMs teaching and learning mathematics since majority of them were professionally trained. This might be the reason for their high favourable perceptions reported regarding the value they place on the mathematics achievement in using TLMs; and importance of using TLMs. This result was confirmed by the result gathered from the analyses of the second phase. It was established that all the five teachers (100%) interviewed believed that their knowledge and skills in using TLMs was good enough for teaching and learning Mathematics. Even though they have this believe, they still believed that they needed in-service training on specific usage of some TLMs on how and when to use them. This is because they believed strongly that the use TLMs was very beneficial to them and students.

Teachers have also demonstrated that "Time/Classroom management constraints" was the second highest factor that influence their decision positively as to whether to incorporate TLMs in their lessons. Similarly, teachers indicated that the "Cost of TLMs" was another factor that positively influence their perception towards the utilization of TLMs in mathematics lessons. Furthermore, findings have revealed that teachers have registered unfavourable perceptions towards the use of TLMs in regards to the "Availability of TLMs" as a factor.

The qualitative results showcased that teachers are of the view that the timeline for the completion of the mathematics curriculum was limited and coupled with the large class sizes they have to manage while teaching with TLMs. Although teachers seemed comfortable with the challenges of managing their time and classrooms and the cost of TLMs in the first phase study, they tend to highlight more on these three factors as militating against their implementation of the curriculum goal of using TLMs in mathematics lessons in the qualitative study. This was largely due to the large class sizes that teachers were dealing with now.

Again, the finding that teachers had a negative perception towards the use of TLMs pertaining to its availability in the first phase was fully confirmed by the finding from the second phase. The five teachers interviewed asserted that the TLMs that supported the curriculum activities were not available in their schools; and even if it were available, it was scanty to utilize in their classrooms due to large class sizes. They mentioned for example non-availability of mathematics text books, notebooks, graph books, calculators, solid models, a pair of compasses, protractors, white maker boards with graph grids, rulers, and board makers.

These findings, in relation to research question one, are congruent to what some researchers have found in their studies (eg: Apondi, 2015; Carbonneau et al., 2018; Golafshani, 2013; Kontas, 2016; Liggett, 2017; Marshall & Swan, 2008; Moyer, 2001; Mutodi & Ngirande, 2014; Olatunde, 2010; Pham, 2015). For example, Marshall and Swan (2008) in their research on the utilization of mathematics manipulatives found that the availability and cost of materials, time constraints, classroom management challenges, organization of materials, and lack of professional training on manipulatives usage were factors which influence teachers' use of manipulatives. They also highlighted that over 95% of teachers believed that the utilization of manipulatives promotes students learning of mathematics.

Similarly, Carbonneau et al. (2018) also found in their study that 90% of preservice teachers reported high favourable perceptions towards manipulatives utilization in their lessons. Conversely, the current study is inconsistent with what was found in the study carried out by Vizzi (2016) to probe into teachers' perceptions of mathematics manipulatives usage. The result revealed that teachers had low self-efficacy regarding using manipulatives in their mathematics lessons. Vizzi's study also found that teachers had reported their need for professional training on the use of manipulatives. This particular aspect of Vizzi's finding is in conformity with the current study.

There are some implications of this first finding for educators and authorities in education. The fact that SHS mathematics teachers in the Cape Coast Metropolis have perceived the use of TLMs positively high in their lessons, it is an indication that they are ready to implement the constructivist ways of teaching and learning mathematics whereby they employ hands-on and minds-on activities to enhance students learning experiences. This is in line with the Ghanaian mathematics curriculum (MoE, 2010; NaCCA, 2020) for pre-tertiary schools. The fact that teachers in this study have professed to have positive disposition towards the use of TLMs does not guarantee their full implementation of the curriculum goals regarding the use of TLMs that afford learners engaging and meaningful learning experiences. So, there is the need for regular monitory and supervisions of teachers' activities in and out of the classrooms by authorities in education.

Another observation made is that teachers in the current study have shown their commitment towards improving upon their self-efficacy beliefs through in-service training and professional development. They have acknowledged the importance and relevance of TLMs in teaching and learning mathematics to effect students' academic achievement and attitudes towards mathematics. The implication is that authorities in education should make some provisions or incentives available towards this training.

Similarly, SHS mathematics teachers in the Metropolis need adequate provisions of TLMs that support the activities in the curriculum so that they can fully align themselves with the constructivist teaching and learning philosophy as dictated by the curriculum. If the materials are not readily available to teachers and students, there cannot be any meaningful teaching and learning in our schools. It implies that our schools need supply of adequate TLMs for effective teaching and learning to go on.

The implications for time and classroom management constraints as reported by teachers needs some considerations. Teachers seem not to have enough time to prepare students thoroughly with the use of TLMs which will result in long lasting learning. They rather want to finish the syllabus fast to aid students write their major examinations and past forgetting about if these students would be able to apply whatever knowledge they have acquired after completion of school.

It has been confirmed by teachers that large class sizes pose bigger classroom management challenges and hinders the effective and efficient usage of TLMs in teaching and learning. This implies that in a class of large size, all students might not benefit fully from the teaching and learning process. If this issue is addressed, it will greatly minimize teachers' challenges of managing their limited time to complete the syllabus and large class sizes when utilizing TLMs in their lessons.

Predictor Variable of SHS Mathematics Teachers' Perceptions

The study also sought to discover the factors which could predict the perceptions of SHS mathematics teachers towards the utilization of TLMs in the Cape Coast Metropolis. The result revealed that teachers' teaching experience correlated negatively with their perceived use of TLMs in teaching and learning of mathematics. It suggests that the more experienced the mathematics teacher was the less he/she perceived the utility of TLMs. It also means that teachers who have taught mathematics for several years will tend to have less favourable considerations towards the use of TLMs in their lessons. Further check of results shows that teachers' teaching experience was statistically insignificant. This is indicative that teachers' teaching experience is not a determinant of the teachers' perceptions towards the utilization of TLMs. This finding is in variance to what Mutodi and Ngirande (2014) found in their study. They discovered that teachers' teaching experience was a determinant for teachers' use of TLMs.

Furthermore, results from the study have showcased a significantly strong positive correlation between Teachers' efficacy/Benefits in using TLMs and the total perception scale scores. The results also highlighted a significantly moderate positive correlation between the total perception scale scores and the factors: Availability of TLMs, Cost of TLMs, and Time/Classroom constraints. These results demonstrate that the more teachers perceived these factors, the more it influences their choice of use of TLMs in their mathematics lessons. These findings are aligned with some studies done by Mutodi and Ngirande (2014); and Tchordie (2017). According to the findings of Mutodi and Ngirande (2014), time constraints and cost or availability of TLMs are very important determinants for teachers' use of TLMs in the classroom. Tchordie (2017) also reported the existence of a strong relationship between availability and the utilization of instructional materials and the performance of students.

The study also found that the best predictor of the perceptions of SHS mathematics teachers in the Cape Coast Metropolis was the Teachers' efficacy/Benefits in using TLMs. This result was further explained and understood based on findings from the qualitative phase. It has been shown in the qualitative phase that teachers reiterated severally the need to develop their knowledge and skills on how, why and when to utilize TLMs in their mathematics lessons. Teachers in the study subscribed to in-service training on some specific topics in the SHS mathematics syllabus to build them with the needed knowledge and skills on the utilization of appropriate TLMs. Teachers did not only stress on the necessity for improving on their self-efficacy beliefs through in-service training, but they have also professed that the utilization of TLMs in mathematics lessons was very important and relevant for attainment of students' academic excellence and improving students' attitudes towards mathematics.

This result is in agreement with what Carbonneau et al. (2018) and Vizzi (2016) asserted in their studies. For instance, Carbonneau et al. acknowledged that teachers who have high self-efficacy beliefs tend to take up challenging tasks and are better equipped to manage their teaching environments. These teachers are also capable to make the right decision of selecting effective and appropriate pedagogies for learners. The study of Vizzi (2016) also noted that teachers have considered the need for development of their self-efficacy towards the use of TLMs through professional training. Teachers have reported this variable as very important to their teaching and learning regarding the use of manipulatives. This seems to be the reason why teachers in this current study have reported this factor as the best predictor of their perceived use of TLMs in the Metropolis. The implication for this result is that the authorities of education at the SHS level need to focus more on improving teachers' self-efficacy beliefs through support training programmes towards the utilization of TLMs effectively and efficiently.

It has been established from the study that the next best predictor of teachers' perceptions towards the use of TLMs was the availability of TLMs. According to teachers' responses in the qualitative study, the TLMs that supported the activities in the SHS mathematics curriculum are limited in supply in their schools. This result is similar to what many researchers have reported (Golafshani, 2013; Kabutey, 2016; Marshall and Swan, 2008) in their studies concerning the lack of available TLMs. This implies that, if the TLMs are adequately available to teachers in their schools, it could facilitate their usage of the materials to enhance students' academic achievement. This is because teachers in this study believed that when TLMs are utilized appropriately in mathematics lessons, it enhances students' deep mathematical conceptual understanding and fosters favourable students' attitudes towards their studies.

Teachers have revealed in the study that time and classroom management constraints are very important factors to them when it comes to the use of TLMs in their mathematics lessons. They claimed that the duration for completion of the mathematics curriculum before any major examination was limited. They are also confronted with the challenge of managing large class sizes with inadequate TLMs. According to the findings, the cost of TLMs was the least perceived predictor of SHS mathematics teachers' use of TLMs. This means that teachers have acknowledged the cost of TLMs as a factor they will consider last when it comes to incorporation of TLMs in their mathematics lessons. It may imply that teachers could afford to improvise for TLMs that are not readily available to them. That might be one of the reasons why they placed much emphasis on the need for in-service training and professional development of teachers to enhance their capacity on the utilization of TLMs. This result is similar to the findings of Golafshani (2013); and Marshall and Swan (2008). Both studies affirmed that teachers' utilization of TLMs were affected by the cost of TLMs; and the challenges they faced managing their time and classrooms. The only difference is that both studies could not establish the predictability of these factors.

The implication is that more attention should be given to the first two factors that best predict teachers' use of TLMs in the Metropolis. There is/are currently no or limited empirical research to support these findings in respect to which factor best predict SHS mathematics teachers' perceptions towards the use of TLMs in the Cape Coast Metropolis.

Contribution of Teachers' Qualification towards their use of TLMs

The study also sought to explore if there were any significant differences between teachers' qualifications and their perceptions towards the use of TLMs. Findings have indicated that first-degree professional teachers had the highest perception score; followed by postgraduate professionals; the next being first-degree non-professionals and lastly by postgraduate non-professionals. This means that first-degree professional teachers will comparatively be more ready to incorporate TLMs in their lessons than postgraduate professionals, postgraduate non-professionals and first-degree non-professionals. In like manner, postgraduate professionals would be comparatively be more ready to incorporate TLMs in their lessons than postgraduate non-professionals and first-degree non-professionals. Further enquiries have shown that these differences were not statistically significant. This implies that teachers' qualification is not a determinant of their perceived utilization of TLMs.

This result is aligned to the finding of Kabutey (2016) who found that teachers' qualifications had no significant difference between their use of instructional materials in their mathematics lessons. However, this study is in disagreement with the finding of Mutodi and Ngirande (2014) who found that teachers' expertise was a determinant for their use of TLMs in mathematics lessons. The implication is that teachers in this study with different qualifications can teach mathematics the same manner to students with TLMs.

Chapter Summary

Three major findings have emerged from the current study. The findings were that there are four key factors that affect SHS mathematics teachers' use of TLMs in the Cape Coast Metropolis; and they have also reported high perceived usage of TLMs in their lessons. The study has discovered that Teachers' efficacy/Benefits in using TLMs was the strongest predictor of teachers' perceptive use of TLMs. This was followed by the availability of TLMs. However, the least predictor variable was found to be the Cost of TLMs. The study also brought to light that demographic factors like teachers' teaching experiences and academic qualifications were not significant determinants of teachers' perceived usage of TLMs.

CHAPTER FIVE

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

Overview

This chapter summarizes the study and illuminates the methods adopted in collecting and analyzing data so as to arrive at the major findings. Based on the major findings, conclusions are reached and appropriate recommendations are made.

Summary

The study sought to investigate the perception of SHS Mathematics teachers towards the use of TLMs in teaching and learning in the Cape Coast Metropolis. This research is guided by three research questions and one research hypothesis. These are: What are the possible factors influencing SHS mathematics teachers' use of concrete teaching and learning materials?; What is the perception of SHS mathematics teachers towards the use of concrete teaching and learning materials?; To what extent do these factors identified and teaching experience predict SHS mathematics teachers' use of concrete teaching and learning materials?; and There is no statistically significant difference between mathematics teachers' qualifications and their perception towards the use of concrete materials.

Sequential explanatory mixed method approach to research design was employed in this study. The target population was made up of mathematics teachers from ten public SHSs in the Cape Coast Metropolis. Stratified proportionate sampling technique was applied. Questionnaire was used to gather data from 132 teachers for the first phase of the study. The forty-nine Likert scale items on the questionnaire were subjected to PCA. Specifically, exploratory factor analysis was adopted to aid the extraction of four factor solutions representing the various mathematics teachers' perception constructs. The four-factor solution was arrived at successfully through the application of Watkins' (2000) parallel analysis.

The quantitative data was analyzed using graphs, frequencies, percentages, means, standard deviations, ANOVA, correlational and multiple regression analyses were the main statistical tools used. Thereafter, qualitative data was gathered through interviews using semi-structured interview guide for the second phase. The qualitative data from field notes and audio tapes were transcribed and thoroughly screened, organized and analyzed thematically. Interpretation of the results was done using verbatim quotations from the interview data to support the findings from the first phase.

The study found four unique factors as key to teachers' use of TLMs; and the overall perception of SHS mathematics teachers was positive towards the use of TLMs. It was also established that mathematics teachers in this study have perceived positively three factors (Teacher's self-efficacy/Benefits in using TLMs, Time/Classroom management constraints in using TLMs and Cost of TLMs) as influencing their use of TLMs in teaching and learning. They however perceived negatively one factor (Availability of TLMs) as influencing their use of TLMs.

The study revealed that the best predictor variable of SHS mathematics teachers' perceptions towards the use of TLMs in teaching and learning was Teacher's self-efficacy/Benefits in using TLMs. The next highest predictor was Availability of TLMs; followed by Time/Classroom management constraints in using TLMs. The least predictor was the Cost of TLMs. The study also revealed that teachers' teaching experiences made no statistically significant contributions to the perceptions of teachers' use of TLMs.

The findings have demonstrated that there were no significant differences between teachers' qualifications and their overall perceptions towards the use of TLMs.

Conclusions

First, it was discovered that SHS mathematics teachers involved in this study considered four factors as key to them; and they generally have positive perceptions towards the utilization of concrete teaching and learning materials in establishing mathematical concepts in the Cape Coast Metropolis. It is concluded that the overall perceptions of SHS mathematics teachers was influenced by four factors: the most profound one being their perceived views towards Teachers' self-efficacy and Benefits in using TLMs; the next factor was time and classroom constraints in using TLMs; followed by the cost of TLMs; and the least reported factor was the availability of TLMs.

It was revealed that Teachers' self-efficacy and Benefits in using TLMs was the best predictor variable of the overall perceptions of SHS mathematics teachers in the Metropolis. The next predictor variable was Availability of TLMs;

followed by Time and Classroom constraints in using TLMs; and least predictor variable was the Cost of TLMs. It was also concluded that SHS mathematics teachers' teaching experience had no significant relationship with their overall perceptions towards the utility of TLMs. It was therefore noted that the predictability of teachers' overall perceptions towards the use of TLMs was solely determined by the four factors discovered. The demographic factor, however, made no significant contributions to the predictability of the overall perceptions of teachers towards their usage of TLMs.

It was concluded that SHS mathematics teachers' qualifications for teaching was not a determinant factor of their use of TLMs in constructing mathematical understanding in the Cape Coast Metropolis.

Recommendations

The following recommendations were made based on the findings in this study: one, since SHS mathematics teachers have demonstrated positively their overall willingness to and support for the use of TLMs, the authorities in education, especially mathematics education, should make the necessary provisions and resources available to teachers. These they would need to fully implement and incorporate TLMs in their lessons as spelt out by MoE (2010) and NaCCA (2020) in the Ghanaian Mathematics Curriculum.

It was also established that Teachers' self-efficacy/Benefits in using TLMs was the best predictor of the perception of teachers' use of TLMs in the Cape Coast Metropolis. Since teachers in this study have recognized the importance and relevance of using TLMs to accomplish students' academic achievement in mathematics, it is recommended that in-service training should be organized regularly for practising mathematics teachers in the Metropolis. This will help to boost teachers' confidence, interest, competence, skills and knowledge in using TLMs. Once teachers' self-efficacy beliefs are increased, their perceived usage of TLMs is also increased as confirmed by the study. It is again advised that Ghana Education Service (GES) with collaboration from its partners in education like School Management and Boards, Old Students' Associations and Parents and Teachers Associations (PTA) come together to plan and execute such in-service training programmes effectively and efficiently. Another recommendation is that GES should make adequate supply of TLMs that support the mathematics curriculum available to the schools. They should follow up with regular inspections, supervisions and monitoring to ensure that teachers and students are putting the instructional resources into efficient and judicious use in their lessons. This is because the availability of TLMs stands out as the second highest predictor of teachers' perceived use of TLMs in their lessons in the Metropolis.

GES should also give more attention to class sizes of SHSs in the Metropolis. Class sizes of more than 40 students should be reconsidered since this seems to increase teachers' plight of managing their classrooms and time effectively and efficiently when incorporating TLMs in their lessons. As teachers have indicated that the cost of TLMs influenced them positively to use TLMs, it is recommended that authorities in mathematics education should make some funds readily accessible to schools for teachers' use for improvisation of non-available or inadequate TLMs.

Suggestions for Further Research

The study recommended the following areas for further studies:

1. A similar study should be replicated in other parts of Ghana so as to compare the study findings;
2. Further studies should also include students in the study to comprehensively ascertain the perceptions of both teachers and students to better understudy the problem; and
3. Another study should also look at different methods of data collection procedures like classroom lessons observations, observations of artefacts, etc, to gather enough evidence to support findings of the study.

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APPENDICES

APPENDIX A

SHS Mathematics Teachers' Perception Questionnaire

UNIVERSITY OF CAPE COAST

COLLEGE OF EDUCATION STUDIES

FACULTY OF SCIENCE AND TECHNOLOGY EDUCATION

DEPARTMENT OF MATHEMATICS AND ICT EDUCATION

QUESTIONNAIRE ON SENIOR HIGH SCHOOL TEACHERS' PERCEPTION TOWARDS THE USE OF CONCRETE MATERIALS IN TEACHING AND LEARNING MATHEMATICS

Dear Respondent,

The purpose of this study is to investigate the factors that influence the perception of senior high school mathematics teachers towards the use of concrete materials (TLMs) in teaching and learning mathematics in the Cape Coast Metropolis. This questionnaire has been prepared with strict adherence to the code of conduct of research at the University of Cape Coast. Your honest response to each item is highly expected and would be of a great help to successfully investigate into the abovementioned topic. It may take you about 15 to 25 minutes to complete this questionnaire. Please, be assured that the information you would provide, would be used purely for academic purposes; and that your anonymity and confidentiality are therefore assured.

Serial Number: ……… Date: ………………….

Please provide accurate answers to the questions below by writing in the appropriate spaces or ticking the appropriate boxes against each item.

SECTION A: Background information of teacher:

1. Sex

Male [ ]

Female [ ]

2. Age in years…………

3. Highest academic qualification (***Tick only one as applicable***)

First Degree Non-Professional [ ]

First Degree Professional [ ]

Postgraduate Non-Professional [ ]

Postgraduate Professional [ ]

Other: Specify…………………………..

4. School category

Category A [ ]

Category B [ ]

Category C [ ]

5. How many years have you been teaching SHS mathematics? ……..

SECTION B: Factors that influence SHS teachers' perception towards the use of concrete materials (TLMs) in teaching and learning mathematics

Indicate your level or degree of agreement or disagreement on each of the following statements by ticking only one of the responses in each box: Strongly

Disagree (SD) = 1, Disagree (D) = 2, Not sure (N) = 3, Agree (A) = 4 and Strongly Agree (SA) = 5.

Availability of TLMs	**SD**	**D**	**N**	**A**	**SA**
6. My school always provides me with adequate TLMs to use for mathematics lessons					
7. I have always had enough TLMs for my students during mathematics lessons					
8. I always desire to use TLMs in my lessons but they are not readily available					
9. Ghana Education Service has always supplied my school with adequate TLMs so I often use them in my mathematics lessons					
10. I am sometimes discouraged to use TLMs in mathematics lessons because I always feel uncomfortable sharing the scanty resources that we have with others					
11. All mathematics lessons can be taught effectively without TLMs					
Cost of TLMS	**SD**	**D**	**N**	**A**	**SA**
12. The cost of TLMs is too expensive to buy so I don’t use it often in my mathematics lessons					
13. My school is able to buy the TLMs that are needed for my mathematics lessons					

14. The cost of TLMs cannot stop me from using it in my mathematics lessons					
15. I always love to do improvised TLMs for my mathematics lessons because they are less expensive to get					
16. I am always encouraged to do improvised TLMs for mathematics lessons since my school has devoted funds for that purposes					
17. The cost of maintenance of mathematics TLMs is not anything that can stop me from using them in my lessons					
Time Management Constraints	**SD**	**D**	**N**	**A**	**SA**
18. Using TLMs always in mathematics lessons, does not delay me in completing my content on time					
19. I have often had enough time to prepare mathematics lessons with TLMs					
20. The use of TLMs in mathematics lessons is not a waste of time because it enhances students' conceptual understanding					
21. It takes much time for me to organize TLMs for a single mathematics lesson					
22. I need to conduct specific number of class tests, exercises and home works within a semester so I do					

not have enough time to use TLMs in my lessons					
23. It doesn't take me too much of my time to select the appropriate TLMs for mathematics lessons					
Classroom and Space Management Constraints	**SD**	**D**	**N**	**A**	**SA**
24 I always have enough space in my classroom to enable me use mathematics TLMs in my lessons					
25. I am able to control my class appropriately when using TLMs in my mathematics lessons					
26. The use of TLMs in mathematics lessons takes away students' attention from the teaching and learning process					
27. Students sometimes play with the TLMs during lessons making classroom management difficult					
28. It is always not difficult to pack back the TLMs after usage for mathematics lessons					
29. Students make a lot of noise when I am using TLMs in my lessons so I am discouraged to use them					
Mathematics Achievement in using TLMs	**SD**	**D**	**N**	**A**	**SA**
30. The use of TLMs enhances students' retention of mathematical concepts					
31. The use of TLMs helps improve students' communications in mathematical language					
32. The appropriate utilization of TLMs quickens the					

understanding of students in learning mathematical concepts					
33. The use of TLMs helps improve students' academic performance					
34. The use of TLMs in mathematics lessons instils positive attitudes in students towards mathematics study					
35. The use of TLMs increases students' concentration level					
36. The use of TLMs creates confidence in students to aspire to read mathematics further in life					
37. The use of TLMs enhances students' problem-solving abilities					
Relevance/Importance of using TLMs	**SD**	**D**	**N**	**A**	**SA**
38. The use of TLMs fosters good communications between the teacher and students					
39. Using TLMs make mathematics lessons fun for learners					
40. The use of TLMs makes it easier to teach from concrete to abstract					
41. When TLMs are used appropriately, it makes mathematics so real					
42. TLMs act as a supplement to the teacher's efforts					

in the teaching-learning process					
43. When TLMs are used appropriately in lessons, it brings about some level of excitement between the teacher and his/her students					
44. Using TLMs in mathematics lessons, makes students feel accomplished since it appeals to their diverse learning modes/styles					
45. Using TLMs in mathematics lessons helps students to explore mathematical meaning for themselves					
46. Using TLMs in mathematics lessons creates the opportunity for students to visualize what they are doing and to have hands on experiences					
Teacher self-efficacy belief in using TLMs	**SD**	**D**	**N**	**A**	**SA**
47. I believe I am very confident using TLMs in mathematics lessons effectively					
48. I believe I am very competent using TLMs in mathematics lessons to accomplish any mathematics task					
49. I believe I have the knowledge to teach every mathematics content in the syllabus with the appropriate use of TLMs					
50. I am sure I can prepare my own mathematics					

lessons with TLMs efficiently					
51. I am always motivated to use TLMs in my mathematics lessons because I know I have had adequate training on how to use it appropriately					
52. I feel comfortable to use TLMs in my mathematics lessons					
53. I lack the pedagogical knowledge of the variety of usage of TLMs so I am always afraid to use them in my mathematics lessons					
54. I believe I am very capable of making mathematics lessons meaningful to my students by using the right TLMs					

Your time and cooperation are very much appreciated. Thank you.

APPENDIX B

Semi-Structured Interview Guide

UNIVERSITY OF CAPE COAST

COLLEGE OF EDUCATION STUDIES

FACULTY OF SCIENCE AND TECHNOLOGY EDUCATION

DEPARTMENT OF MATHEMATICS AND ICT EDUCATION

Serial Number/ Pseudo Name…………………… Date…………….

SECTION A: Background information of teacher:

1. Sex………………..
2. Age in years…………
3. Highest academic qualification…………………………….
4. School category……………………..
5. How many years have you been teaching SHS mathematics? ……..

SECTION B: Factors that influence SHS teachers' perception towards the use of concrete materials (TLMs) in teaching and learning mathematics.

6. How important is the use of TLMs in mathematics lessons is to you as a mathematics teacher? **Allow 30 seconds briefing space.**

7. In your view, does the use of TLMs in mathematics lessons impede or enhance students' formation of deep mathematical conceptual understanding? Please, could you explain?

Allow 30 seconds briefing space.

8. In your evaluation of teaching and learning of mathematics, which factors do you consider to have contributed to the biggest challenges or difficulties, if any,

that teachers face when utilizing TLMs in their lessons? **Allow 30 seconds briefing space.**

9. What kind of training or help do you suggest teachers would need in order to equip them with the necessary skills to confidently and effectively incorporate TLMs in their mathematics lessons?

Your time and cooperation are very much appreciated. Thank you**.**

APPENDIX D

Introductory Letter

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

Telephone: 0332096951
Telex: 2552, UCC, GH
Telegrams & Cables: University, Cape Coast
Email: dmicte@ucc.edu.gh

University Post Office
Cape Coast, Ghana

Your Ref:

Our Ref: DMICTE/P.3/V.3/039

Date: 1st November, 2021

TO WHOM IT MAY CONCERN:

Dear Sir/Madam,

RESEARCH VISIT

The bearer of this letter, **Mr Samuel Gameli Wordui,** with registration number ET/MDP/19/0031 is an MPhil. (Mathematics Education) student of the Department of Mathematics and ICT Education, College of Education Studies, University of Cape Coast.

As part of the requirements for the award of a master's degree, he is required to undertake a research visit at your outfit with the purpose of collecting data on the topic "**SENIOR HIGH SCHOOL TEACHERS' PERCEPTION TOWARDS THE USE OF CONCRETE MATERIAL IN TEACHING AND LEARNING MATHEMATICS**".

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

Thank you for your usual support.

Yours faithfully,

Dr (Mrs) Christina Boateng
HEAD

APPENDIX E

UCC RIB Approval Letter

UNIVERSITY OF CAPE COAST

INSTITUTIONAL REVIEW BOARD SECRETARIAT

TEL: 0558093143 / 0508878309
E-MAIL: irb@ucc.edu.gh
OUR REF: UCC/IRB/A/2016/1183
YOUR REF:
OMB NO: 0990-0279
IORG #: IORG0009096

7TH DECEMBER 2021

Mr. Samuel Gameli Wordui
Department of Mathematics and ICT Education
University of Cape Coast

Dear Mr. Wordui,

ETHICAL CLEARANCE – ID (UCCIRB/CES/2021/117)

The University of Cape Coast Institutional Review Board (UCCIRB) has granted Provisional Approval for the implementation of your research titled ***Senior High School Teachers' Perception Towards the use of Concrete Materials in Teaching and Learning Mathematics.*** This approval is valid from 7th December, 2021 to 6th December, 2022. You may apply for a renewal subject to submission of all the required documents that will be prescribed by the UCCIRB.

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

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

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

Yours faithfully,

Samuel Aseidu Owusu, PhD
UCCIRB Administrator

ADMINISTRATOR
INSTITUTIONAL REVIEW BOARD
UNIVERSITY OF CAPE COAST

APPENDIX F

Normality Graphs of SHS Mathematics Teachers' Perception Scales

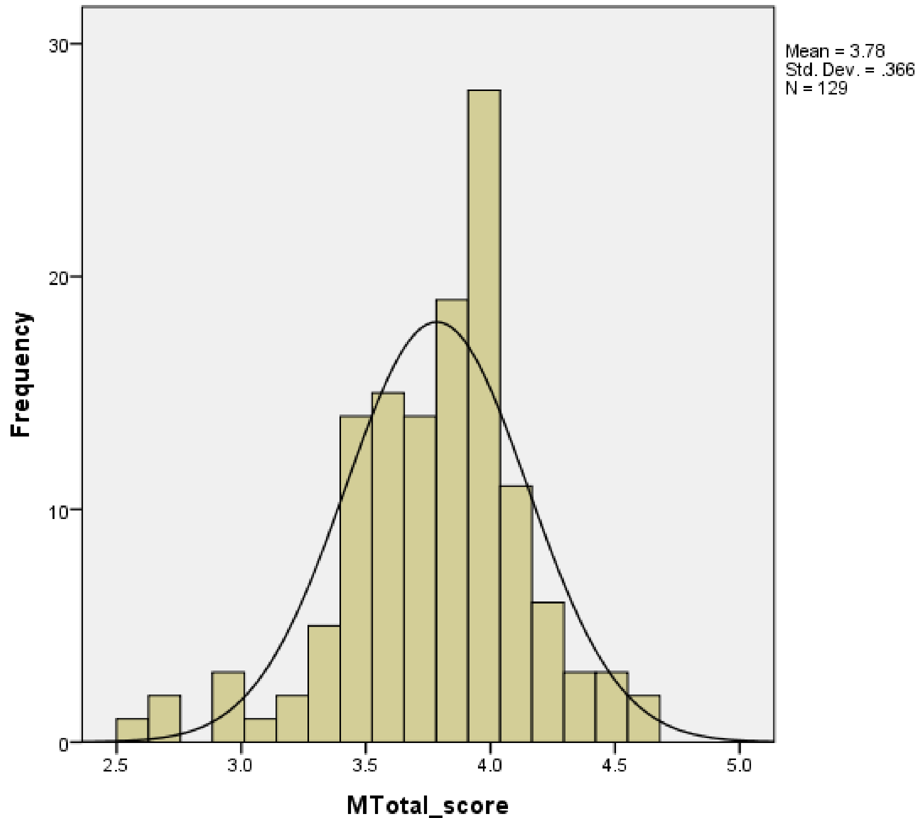

Figure 3: Normal Distribution of the Mean Total Perception Scale

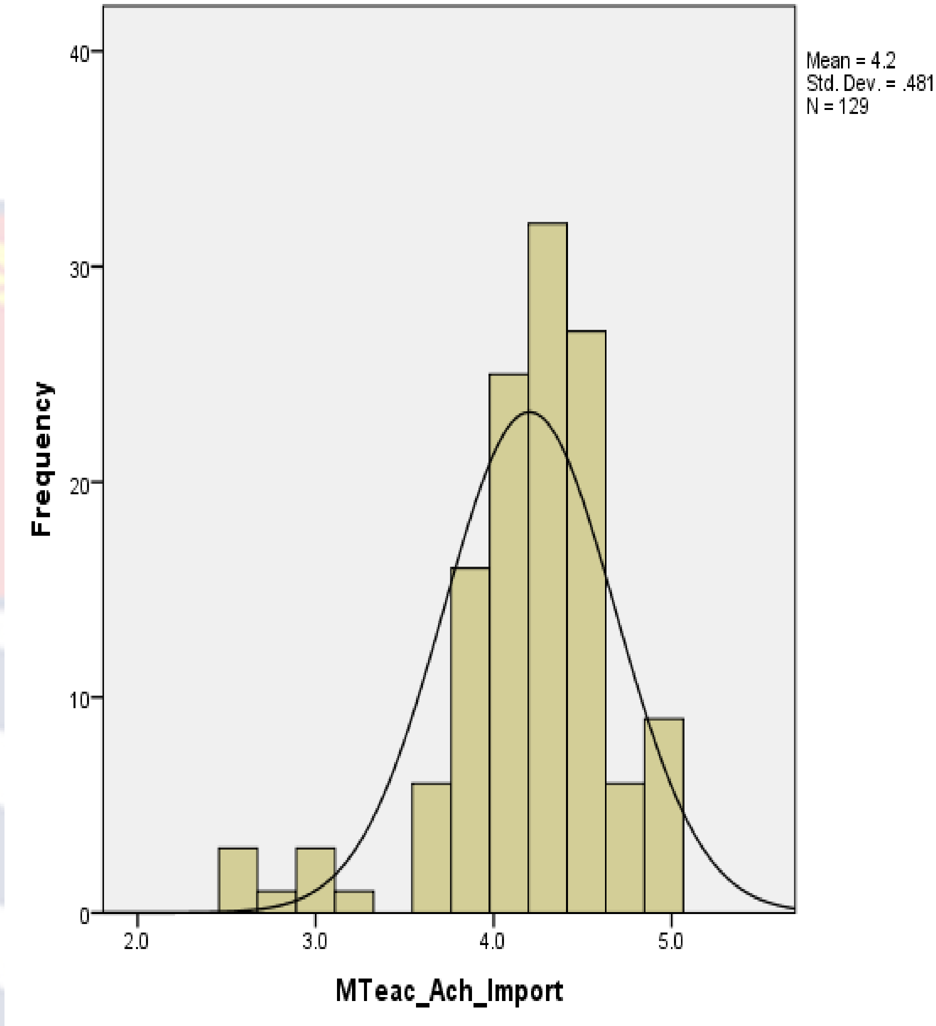

Figure 4: Normal Distribution of the Mean Teachers' efficacy/Benefits in using TLMs Scale

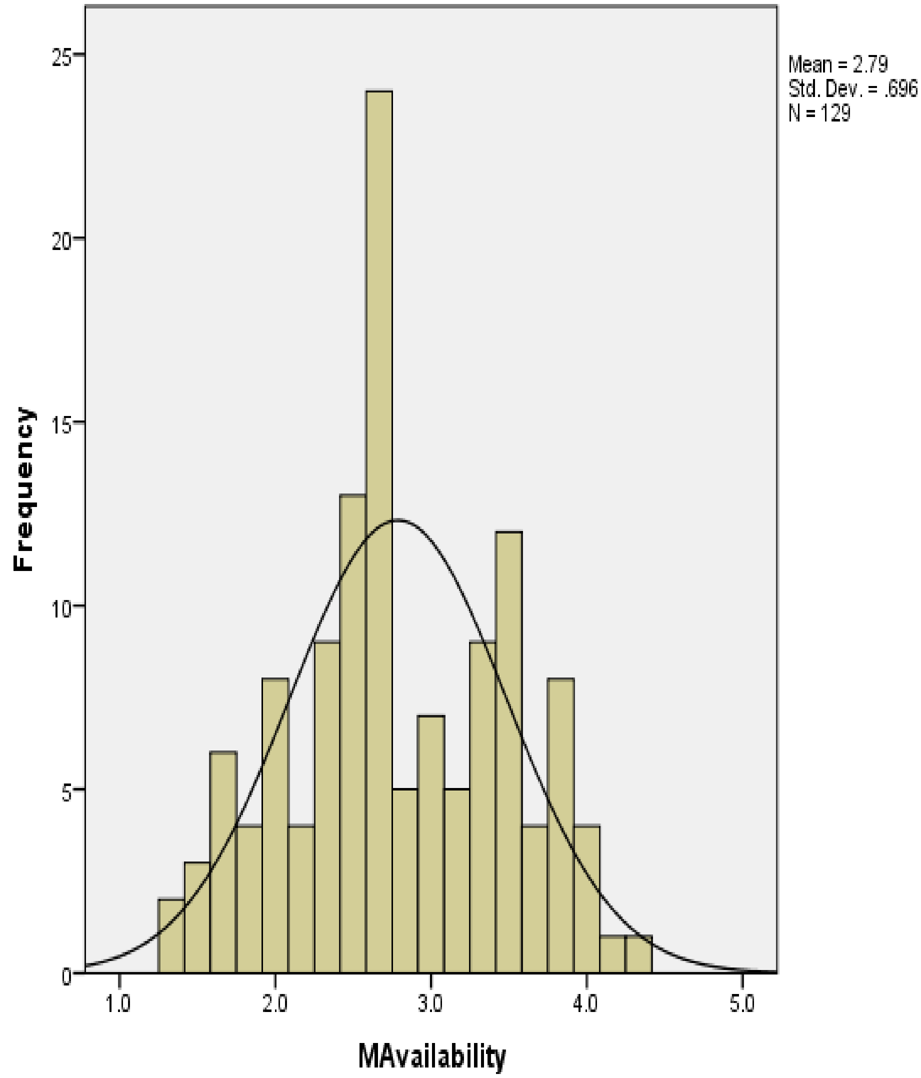

Figure 5: Normal Distribution of the Mean Availability of using TLMs Scale

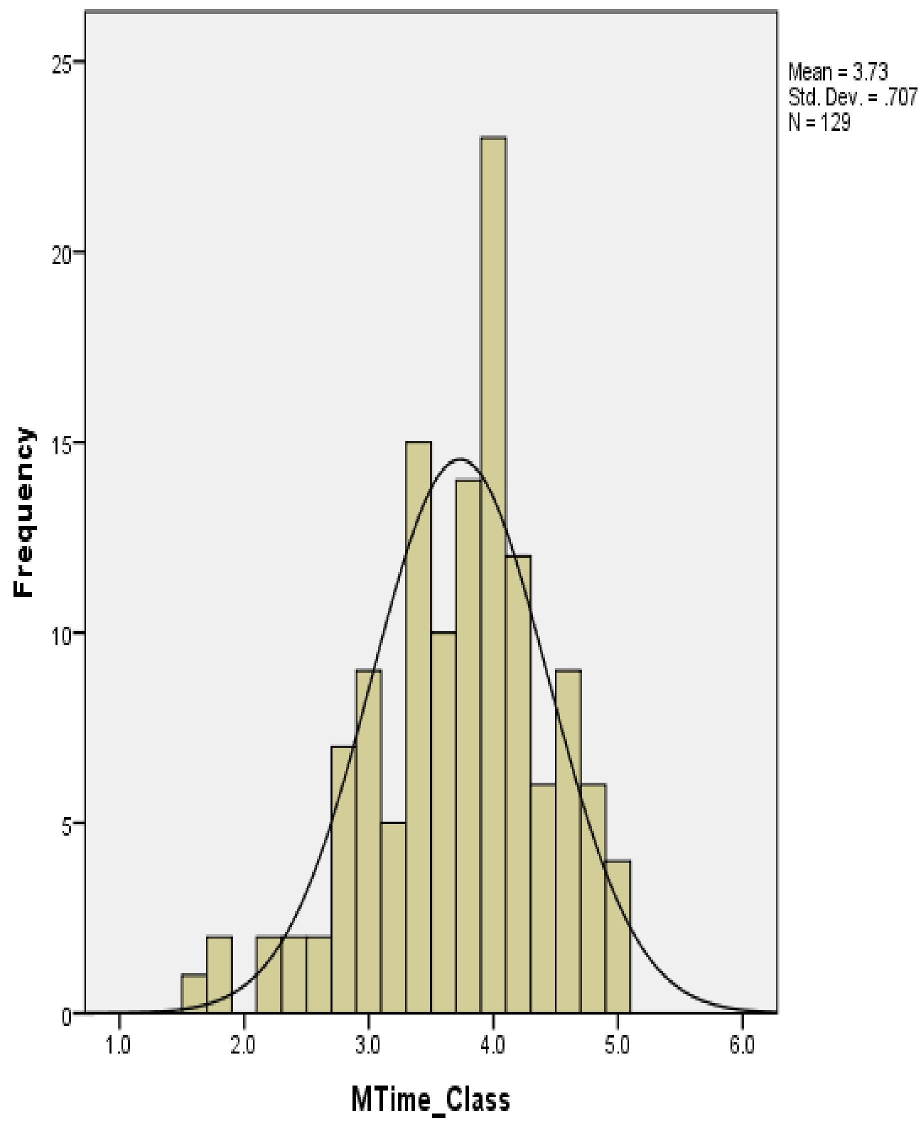

Figure 6: Normal Distribution of the Mean Time/Classroom Constraints in using TLMs Scale

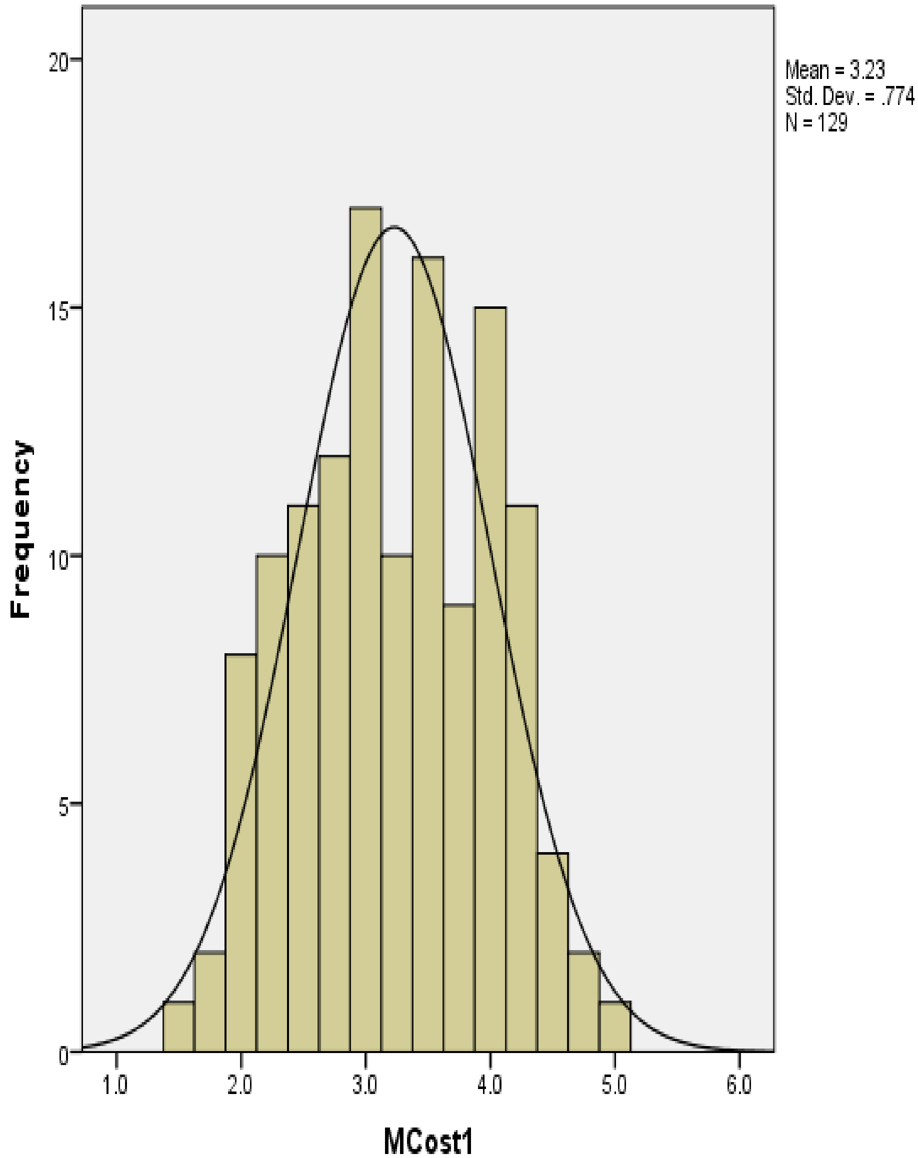

Figure 7: Normal Distribution of the Mean Cost of using TLMs Scale

APPENDIX G

Results of the Four Identified Factors from the PCA

Rotated Component Matrix[a]

Items	Component			
	1	2	3	4
Q6		.680		
Q7		.658		
Q13		.651		.332
Q14				.632
Q16		.692		
Q17				.649
Q18				.481
Q19		.710		
Q20	.547			
Q24		.431		
Q25	.350	.322	.400	
Q28				
Q30	.688			
Q31	.749			
Q32	.655			
Q33	.743			
Q34	.706			
Q35	.708			
Q36	.611			
Q37	.771			
Q38	.780			
Q39	.712			
Q40	.844			
Q41	.759			
Q42	.623			
Q43	.594			
Q44	.633			
Q45	.736			
Q46	.720			
Q47	.653			-.320
Q48	.638			

Items	Components			
	1	2	3	4
Q49	.463			
Q50	.529			
Q51	.517	.469		
Q52	.614			
Q54	.629			
Q8r		.461		
Q10r			.453	
Q12r				.614
Q21r				.321
Q22r			.672	
Q26r			.645	
Q27r			.713	
Q29r			.723	

Extraction Method: Principal Component Analysis.
Rotation Method: Varimax with Kaiser Normalization.[a]
a. Rotation converged in 7 iterations.

Figure 8: Four Factor Rotated Component Matrix from PCA