UNIVERSITY OF EDUCATION, WINNEBA

EXAMINING SENIOR HIGH SCHOOL MATHEMATICS TEACHERS‟ AND STUDENTS‟ PERCEPTION OF MATHEMATICS DISCOURSE IN GHANA

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JULY, 2016

DECLARATION

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I, SAMUEL APPAU DECLARE THAT THIS THESIS, WITH THE EXCEPTION OF QUOTATIONS AND REFERENCES CONTAINED IN PUBLISHED WORKS WHICH HAVE ALL BEEN IDENTIFIED AND DULY ACKNOWLEDGED IS ENTIRELY MY OWN ORIGINAL WORK, AND IT HAS NOT BEEN SUBMITTED, EITHER IN PART OR WHOLE, FOR ANOTHER DEGREE ELSEWHERE.

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SUPERVISOR'S NAME: DR. CHARLES K. ASSUAH.

SIGNATURE…… DATE……

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Thank you to my friends and family for their invaluable support and encouragement. I could not have written one page of this dissertation without their love and support.

DEDICATION

I dedicate this dissertation to my three children, Gyimah Appau, Akosah Appau and Akosua Konadu Appau.

Their never-ending support made this journey worthwhile. I am forever grateful for their love. Each of them makes me a better person every day.

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ABSTRACT

This research investigates Mathematics discourse as practiced by Senior High School Mathematics teachers and students in Ghana. Mixed-method design was used to collect data for the study. The study involves 110 teachers and 120 students. Descriptive statistical analysis was used to analyse the quantitative data while thematic analysis was used to analyse the qualitative data. Convenience sampling was used to select the area of study whiles purposive sampling was used to select participants. Factors that motivate Mathematics teachers to facilitate discourse practices, the role Mathematics discourse plays in students Mathematics learning, the level of understanding of Mathematics discourse by both teachers and students and the challenges teachers encounter when engaging students in Mathematics discourse were examined. Results suggest that factors that motivate Mathematics teachers to facilitate discourse include: listening to students effectively; using open-ended questions; repeating or stressing student ideas; scaffolding and expanding on wrong answers. The results further suggest that Mathematics discourse helps students in the following ways: It improves students‟ mathematical reasoning; it motivates students; it makes students confident and it helps to establish friendly relationship among students. An important implication of this study is that teaching and learning become inspiring when discourse involves courteous exchange of ideas, when teachers make sure that exchange in class involve all students, and when ideas being discussed are proportionate to mathematical principles and curricular objectives. Finally, teachers should attach more significance to discourse in the classroom and should act more as facilitators than just mere transmitters of knowledge.

CHAPTER ONE

INTRODUCTION

1.1 Overview

This chapter deals with the introduction of the study. It discusses the background to the study, statement of the problem, purpose of the study, significance of the study, objectives of the study, research questions, limitation, delimitation and organisation of the study.

1.2 Background to the Study

Nowadays, the teaching and learning of mathematics should be done in such a way that students can understand and realise its significance to the world. However, mathematics is seen as a set of practices to be carried out to answer a label examination questions (Bolt & Hobbs, 2005). The result of such teaching and learning of mathematics is that students are unable to apply these ideas outside the course book. In addition, the enthusiasm for learning becomes mostly reliant on getting the tricks in obtaining the right answers and has little to do with any basic interest in the subject or whether or not the answers are significant (Bolt & Hobbs, 2005). In modern time, mathematics education has aimed to move away from rote learning and memorisation toward providing more demanding, multifaceted work with an emphasis on deeper thinking and having an interdisciplinary, rather than a departmentalised focus (Ozdemir, 2006).

The knowledge gained in the study of Mathematics is broadly used in all field of human life. Mathematics plays a key role in determining how individuals deal with the various aspects of private, social, and civil life (Walshaw & Anthony, 2008). Githua and Mwangi (2003), state that life without mathematics leads to hopelessness and that it would be

difficult to live a normal life in many parts of the world. The National Council of Teachers of Mathematics [NCTM], (2000) posits that those who appreciate and can do mathematics will have considerably better opportunities and options for determining their future. Mathematics in general is an indispensable subject for technological development of every nation. It is part of our existence without which we cannot function (Nabie, 2002). Mathematics is the means of sharpening an individual‟s mind, influencing his reasoning capability and developing his personality, hence its immense contribution to the universal education of the people of the world (Asiedu-Addo & Yidana, 2004).

The whole world has become digital and this digital advancement is irreversible. It has become the world tradition, which is progressing at a great speed for good. Any person, community or country that opposes or refuses to join these forces of advancement will be left behind and deserted to suffer in ignorance and backwardness (Talabi, 2003).

Social, economic, and industrial changes of the past decades are making education and preparation of students in mathematics more fundamental than ever. However, educational systems at different levels are under pressure to afford mathematics educational prospects for all, to offer their students with the necessary knowledge and abilities in mathematics for developing marketplaces and complicated living environments, and to prepare citizens for lifelong learning (Talabi, 2003). To meet these challenges, Ghanaians have to focus alongside on increasing access, improving internal effectiveness, encouraging the quality of teaching and learning of mathematics, and improving system supervision (Asiedu-Addo & Yidana, 2004).

Knowledge in mathematics is seen as fundamental to the success of the Ghanaian economy and to the sustained quality of the nation‟s social and cultural life. Ghana‟s

capability to develop a tradition of innovation, to advance in mathematics and scientific discovery and to develop technologies for business purposes will determine its prospect in the global economy. To be prolific in such an environment, Ghanaian citizens need to be well knowledgeable and capable of applying ideas and skills acquired in the study of mathematics in their personal lives as well as in their work places (Talabi, 2003). In the last few years, expansions of reputable industries and the development of new industries (oil and gas) utilising advanced technology have strengthened the demand for high level skills in engineering and other mathematics-related careers. While mathematics education is recognised to have a basic role to play in building a tradition of continuous innovation and in developing technically literate citizens, the number of students participating in science related courses at the senior secondary level has to be increased in order to satisfy the manpower needs of the country. Therefore the teaching of mathematics is crucial to the development of the economy (Talabi, 2003).

With increased necessities on students to expand a deep and unified understanding of mathematical concepts, more weight is being placed not only on students‟ capability to understand the facts in mathematics, but also on their capability to do mathematics. There is the need for both policy makers and educators to strengthen their knowledge and understanding of the teaching and learning of Mathematics (Talabi, 2003).

It is therefore regrettable, that in modern times many students struggle with Mathematics and achieve terribly low grades in their final examinations in most countries. In Ghana, students‟ performance in Mathematics at the Senior High School has not been encouraging of late. Candidates are reported to display poor understanding of Mathematical concepts and are unable to form the suitable Mathematical representations

which could be tackled with the necessary skills, Chief Examiner‟s Report (2007). In the Trends in International Mathematics and Science Study [TIMSS], (2003) mathematics test, it was reported that out of the 46 countries that participated, Ghana finished 45th. Ghanaian students scored 276 compared to the international average of 466, (Anamuah-Mensah; Mereku & Ghartey-Ampiah, 2004). With the lagging achievement scores, educators need to find a way to make mathematics education more attractive and accessible for students. Presently, mathematics teaching typically follows a direct instruction technique with memorisation of methods and practice on worksheets. According to Mereku (2004) mathematics lessons in most classrooms generally follow the model that can be described as teacher centered class discussion. As a result of this, students should be involved in Mathematics lessons so that they will have the chance to discuss their views and work together in order to build a deeper understanding of mathematics concepts (Mereku, 2004).

It has also been realised that many students have developed high level of hatred towards the study of Mathematics. It is an irrefutable fact that for students to be successful in the learning of Mathematics, factors such as school, classroom, student and teacher all impinge on the learning of Mathematics. In particular, the gravity or otherwise attached to the teaching of Mathematics consistently affects students‟ performance (Talabi, 2003). Ever since Mathematics became part of the school curriculum, it has helped to develop cognitive skills, but has always been viewed as a trouble area for students‟ school lives. The fact that students have difficulty in mathematics cannot be only related to its being subject of numbers but also related to students‟ mathematical capability, understanding

and approach, along with teachers‟ mathematical ability, knowledge and teaching methods (Mereku, 2004).

Student learning variables are defined in terms of the knowledge, skills, and abilities that they have attained as a result of their involvement in the teaching of Mathematics. Student learning is predisposed by the experiences they go through in the classroom. Therefore, it is not only the materials themselves that impact on learning, but also how the teachers help the students to practice the materials. These practices can be through instructional tasks as well as through teacher-to-student communications or student-to-student communications in the classroom.

Discourse is the mathematical communication that occurs in a classroom. Discourse is defined as decisive talk on a Mathematics topic in which there are legitimate contributions and interaction (Truxaw & DeFranco, 2007). Efficient discourse occurs when students express their own ideas and seriously consider their peers‟ mathematical views as a way to build mathematical understandings. Assisting students to build their own mathematical understanding through dialogue is an effective way to teach mathematics, since the role of the teacher has changed from being a source of knowledge to one who facilitates mathematical tasks. Tutors of mathematics nowadays bear this understanding out by putting the limelight directly on the social aspects of mathematical development (Ball, 2003).

That is why the government of Ghana has made it a core course from the basic to the Senior High School level. The conviction is that students‟ active involvement with mathematical ideas will lead to the expansion of specific student ability. It is this ability that is presumed to make a positive impact on students‟ life chances and their future civic

contribution (Ball, 2003). Recent mathematics teaching have legitimised this kind of thinking by calling for changed classroom environment in which learning convention for manipulating symbols gives way to learning to discuss mathematics. This new program replaces traditional classrooms with learners talking to each other or expressing their opinions in whole class discussions (Sfard, Forman, & Kieran, 2001). Talking about mathematics becomes satisfactory in the classroom, and mathematical discussion, clarification, and justification of ideas become important features of a quality mathematical experience. Discourse activities should therefore be fused with the teaching of mathematics for students to understand concepts. Discourse activities are learning activities which allow students to use discussion and argumentation as part of their learning (Hufferd-Ackles, Fuson & Sherin, 2004). Strategies that produce discussion in the mathematics classroom give students the chance to explain their own mathematical thoughts, and make considerable contributions that can be questioned and built upon by other learners (Hufferd-Ackles, Fuson & Sherin, 2004).

Nowadays, improving students‟ Mathematical discourse has become the main purpose for Mathematics teachers (Walshaw & Anthony, 2008). The educational goal is that students are involved in learning societies in which all participants have opportunities to take part in productive mathematical discourse (Manoucheri & St John, 2006). Teachers are confronted to develop classrooms as learning communities that promote learning conversations and learning corporations and where challenges, reactions and support are readily available (Ministry of Education, New Zealand, 2007).

Discourse not only helps the development of teaching and learning of mathematics but also adds to the scrutiny of mathematics by the teacher as well as the students

(Manouchehri & St. John, 2006). Mathematical ability is a significant aspect of schooling for today's youth. In order to be victorious in today's world students need to have more developed Mathematics abilities. The circumstances where students are encouraged to take part actively in classroom dialogue are very essential to the teaching and learning of Mathematics (William & Baxter, 1996; Baxter, 2005). In the classroom students are learning to think positively in a mathematical way with an understanding that there are many different ways to an answer and sometimes more than one right answer to be balanced in a classroom dialogue (Lampert & Cobb, 2003). Thus, the classroom discourse is an important platform where students have the chance to focus, involve and reflect on the strategies used for finding out a problem. The NCTM (2000) claim that discussing mathematics with others presents opportunities for students in swapping and reflecting on ideas; hence, discourse is a basic component of mathematics.

Stein (2007) posits that Mathematics instruction must be made beautiful so that students will be optimistic to use mathematical conversation to make conjecture, talk, question, and agree or disagree about problems in order to find out vital mathematical concepts. Truxaw and DeFranco (2007) view engaging students in conversation in the Mathematics classroom as a significant method for the teaching and learning of Mathematics and also for theoretical understanding. They observe that communication in Mathematics is central for ideas to become matters of reflection, refinement, dialogue and amendment. Kabasakalian (2007) supports this idea by stating that the vehicle that supports understanding of mathematical concepts is the capability to communicate mathematically. The NCTM (2000) also calls for instructional curriculum to enable

students, to use the language of mathematics to articulate mathematical ideas accurately, communicate their mathematical thinking logically and clearly to their colleagues, teachers, and others and to categorise and combine their mathematical thinking through communication. Davis (2008) is of the view that discussion is an important feature of mathematics and formal mathematical expression is an indispensable component of this discussion, stressing on the significance of discussion in the mathematical process.

Thompson (2000) stresses that it is imperative for students to be aware of the meaning of mathematics words, whether written or spoken, in order to better comprehend and communicate mathematical thoughts. In learning mathematics, it is imperative for students to use the right mathematical language, learn how to interpret mathematical expressions into verbal problems and how to interpret verbal problems into mathematical language that can be easily be worked with (Askey, 1999). By so doing students will then be engaged fruitfully in mathematical discourse while solving problems by suggesting, devising, conjecturing, and explaining mathematical ideas and by appraising the mathematical ideas of their colleagues. By heartening learners to articulate what they mean and replicate what their classmates have said, instructors can make it easier for nervous students to contribute during classroom dialogue (Manouchehri & St. John, 2006). This is based on the principle that openly referencing and building on the ideas of others, is a characteristic of academic and proficient discussions (Choppin, 2007).

Teachers play a central role in sustaining classroom interactions and directing classroom discussions by asking appropriate questions for students to carry out discourse (NCTM, 2000). Teachers who coordinate fruitful mathematical dialogue in the classroom need to

make sure that their involvement during the discussion can develop an adaptive method of teaching, as their decision-making is reliant upon a number of issues, such as moving back and forth between the position as a participant in the discussion and the role as a catalyst of the discussion. Teachers must make fragile decisions about when to let students struggle in making sense of a concept, when to ask leading questions, and when to put in mathematical ideas during the conversation. Teachers encourage discussions by instituting a classroom culture that is inquiry-oriented in which everyone's thought is valued by both the teacher and students. By replicating problem solving, searching appropriate situations, and giving students‟ time to discover, build, converse, argue, conjecture, and investigate, teachers arouse deeper student insight and understanding (Frykholm & Pittmann, 2001). By instituting a discourse community, teachers adopt new teaching approaches, and require students to make changes as learners. Members of the dialogue community are supported to take control of the discourse at hand. Therefore, students have to be more autonomous and take the task for each other‟s learning (Frykholm & Pittmann, 2001). Classroom culture is recognised in the discourse community through cooperation, in which interpretation and arguing about mathematical meanings is the custom (O‟Connor & Anderson, 2003). Clearly, the quality of talk is important, but it must be guaranteed that greater students talk must have a constructive impact on learning.

Thus, communication involves more than talk. It entails the stuff that are spoken, how members make sense and respond to what has been said, the wealth of the opinions being expressed, and who has the right to share particular concepts at a given time. All of these

stuff help to explain the type of dialogue being exchanged. The purpose of the discussion influences the way in which it is conducted in the classroom (Frykholm & Pittmann, 2001).

Most expectedly, students and the teacher have mostly been exposed to discussion in traditional classes that have a univocal function that is to pass on ideas from the teacher to students. Teachers can execute whole class discussion to help students learn efficiently. The rationale for the whole class discussion is to produce meaning, and it is assumed that students make sense of concepts being discussed while listening and speaking. Although the teacher is a member, student ideas help channel the direction of the discussion. The heart of the learning is on the procedure, not just the final solution, as thoughts are shared and discussed. Classroom discourse takes into consideration the idea that students make sense of their learning in the framework of their own experiences and know-how. It gives time for them to struggle with new thoughts and judge others‟ points of views, while considering their teachers experiences and skill. This type of discussion also puts the task for learning more directly on students‟ to bear, because they share the power with the teacher for authenticating ideas, rather than exclusively relying on the teacher as the person who decides whether or not a suggestion is correct. Students are expected to draw on their understanding in the classroom to find out the genuineness of ideas (Casa & Casa, 2007). Mathematics classroom discourse can facilitate student learning in classes that call for students to reason and validate their ideas. The aims of such teaching should be based on the potency of understanding for a limited number of concepts, rather than thin review of many concepts. It should be understood that, several actions could support any single point to encourage a more rich understanding of a

concept. Activities that are unrestricted, which may have several solutions from different scopes, can provide a strong basis for mathematics discourse.

The activities should be important to students, so that they will be encouraged to take part rather than being forced to follow instructions. The responsibilities should be challenging enough so that the discussion serves the purpose of taking into consideration and analysing various resolutions (Casa & Casa, 2007). The tasks should be developed in such a way that the discourse provides students with a basis for contributing their views. The teacher and students take on exact roles when taking part in discourse. The primary duty of the teacher is to facilitate the discourse in a way that promotes useful thinking.

To achieve this goal, the teacher must centre on how students understand the ideas that are being argued, while assisting, clarifying and expanding on their thoughts, challenging them to regard their own and other students‟ viewpoint, and encouraging them to present their points of view. The teacher should cautiously consider the value of sharing the power for determining the value of ideas with students. This does not signify that students decide the right solutions to all questions, or that the teacher cannot oppose students‟ ideas; rather, evidence-based notions from the theme under discussion should be used as a guide (Casa & Casa, 2007). In the same way, there are times when it is suitable for the teacher to provide students with information that they would not otherwise obtain. The teacher should carefully scrutinise all ideas that are being expressed to verify which ones are creditable of discussion and in line with the lesson aims.

Learners also take on precise roles as partakers in the classroom discourse. They listen carefully as much as necessary to make sense of ideas, question concepts, and react

considerately to classmates and the teacher. They are also accountable for contributing ideas, suggesting solutions, and defending their viewpoints by using evidence-based activities. Students are expected to take on a very active role in the discussion. Teachers and students who are concerned in the classroom discourse must understand some of the fundamental principles that make best use of the value of the discussion. Casa and Casa (2007) discuss few of these principles as follows:

Effective communication is a class goal: It should be obvious to students that one of the main goals of classroom discourse is general participation in the classroom discussion. The characteristics of the discussion should be shared with students so that they will welcome their roles. Any input will not be accepted just like that but rather, the thoughts verbalised should be ones that add to a richer understanding of the area being discussed.

Divergence views are part of the classroom discourse: Some students may think that having a diverse viewpoint from the teacher, or those of other students, is not acceptable. This could not be distant from the reality. Meaningful discussions involve both agreement and disagreement because it supports students to think decisively. Disagreements should be presented as readily as ideas that everyone admits, they need to be defended in terms of valid perspectives from the area under discussion. Since the heart of the discussion is on the process of finding a solution, not only the solution is necessary, disagreements improve this process.

Respect of each student"s view is vital in classroom discourse: Some of the students may feel uneasy at times with the whole class discussion, mostly when different points of views are presented. It is vital to focus on the thoughts, rather than on the person contributing the idea. That is, the disagreement should be about the point under

discussion, not the one who is presenting it. In the same way, when someone is speaking, whether it is the instructor or the students, that person should have the attention of the participants. This can be verified by making eye contact, watching the person speaking, and not involving in other activities.

Every student must be involved in the classroom discourse: During the discussion, students know what tasks they are expected to complete; however, they might not recognise the importance of being participants in the discussion. Teachers should make sure that the discussion is treated as a prime assignment and, therefore, be expecting every student to be an active member throughout the discussion. It is important to talk to any student who may not feel happy participating and to build up a plan for engagement on a normal basis.

Discourse is a whole class-discussion with but not only centred on the teacher: Communication presupposes that all participants are contributing to the conversation, so it involves more than a discourse between the teacher and a student. The whole class should be involved in the learning process by listening with the aim of making sense of the ideas being discussed and to contribute to the discussion as a main participant. In facilitating the conversation, the teacher has to make decisions about two other features of the classroom environment. That is, equitable and equal involvement needs to be taken into account. Equal involvement means that each person will contribute the same amount, whereas equitable involvement allows all students to contribute to some part of a given discussion. As an alternative of tracking the amount of ideas contributed by students, equitable involvement places greater emphasis on the quality of views that are offered. It also gives confidence to the deprived students to contribute so that one or two students do

not control the discussion. Secondly, the teacher has to consider the relative advantage of the discussion to the whole class in relation to the benefit obtained by an individual student. There could be a given dialogue where one student contributes much more than others, but the dialogue may be so rich that the rest of the class seriously enjoys.

From the background of this study one can deduce that if classroom discourse is understood very well by both teachers and students, it could be a great tool for teaching and learning.

1.3 Statement of the problem

Mathematics classroom discourse plays a key role in determining students‟ mathematical abilities and dispositions (Walshaw & Anthony, 2008). Mathematics discourse is defined as decisive talk on a Mathematics topic in which there are legitimate contributions and interaction (Truxaw & DeFranco, 2007). Neill (2006) also defines discourse as asking strategic questions that elicit from students both how a problem was solved and why a particular method was chosen. Truxaw and DeFranco (2007) posit that for thorough understanding of Mathematics concepts, students must actively engage in meaningful discussions with their teacher and classmates.

In an effort to reform Mathematics instruction, some Mathematics educators have investigated strategies and processes and have identified communication as an important Mathematical activity (Walshaw & Anthony, 2008; NCTM, 2000). Also, policy documents from the New Zealand Ministry of Education (2007) and the NCTM (2000) show statements and pronouncements which support the significance of classroom

discourse. The NCTM (2000) notes that discourse play a vital role in promoting student learning. De Fina (2011) posits that individual‟s progress through discourse because it improves cognitive growth and social improvement. Furthermore, Yackel, Cobb and Wood (1991) stress that discussion extracted from classroom situation encourage and support students to work together to construct knowledge. Similarly, Rowe and Bicknell (2004) posit that discourse help lift the level of cognitive talk amongst students that would not have been achieved without group interaction. Discourse allows students to expand their mathematical thinking and scrutinise skills by working together with one another to talk about healthy mathematical problems. Middleton and Jansen (2011) posit that discourse motivates students to learn by suggesting that teachers should make efforts to involve their students in class by persuading them that contributions will help progress the class‟s knowledge.

For students to utilise lively discussions, teachers have the significant task of creating an important, worthwhile, and wealthy problem. A wealthy mathematical problem is a challenging problem that compels students to put into effect profound mathematical thinking. Thus, the problem should be challenging, yet attainable. The intention of wealthy tasks is to give confidence to all students to critically examine mathematics, keenly participate, and efficiently engage in solving problems. Teachers‟ capacity to use classroom discourse to scaffold concepts and to intensify student learning through sustained discussion are considered vital to increasing students‟ intellectual growth (Freebody & Luke, 2003). Sustaining classroom talk of high intellectual excellence has been recognised as an essential method for teaching. Additionally, it is connected to the personal and social capabilities as well as the serious thinking necessities for the teaching

and learning of mathematics (Alexander, 2006). To facilitate understanding in mathematics by means of classroom discourse, teachers should believe that learning is built through discussion, so they should be able to use different forms of discussion to organise students‟ learning.

In a study of American classrooms, Alexander (2006) found that effective communication which promotes students‟ capacity to reason is lacking in many classrooms. It is quite probable that such problems would also be encountered in Ghanaian classrooms. Nowadays, teaching and learning engage students in solving procedural mathematical problems using prescribed methods rather than allowing students‟ ideas to dominate discussions (Herbel-Eisenmann & Cirillo, 2009). The motivation to carry out this study emerged from a real classroom situation that the researcher daily faced as a teacher. Only few students, time and again, dominated all discussions in my Mathematics class while the rest of my students hardly ever contributed to classroom discussions. This was a source of worry to me because, students‟ active involvement is vitally important to their learning (Hufferd-Ackles, Fuson & Sherin, 2004). Seeley (2005) observes that when students have the chance to come out with an approach to a problem; discuss, argue, and justify their thoughts; and struggle with challenging mathematics, they are truly occupied with their learning. Consequently, students who were unable to take part in the classroom discussion are missing important opportunity to learn. Base on this, the researcher investigated how mathematics teachers and students understand discourse in the Senior High Schools in the Subin sub-Metro of the Kumasi Metro.

1.4 Purpose of the study

The purpose of this study was to investigate how mathematics teachers and students understood Mathematics classroom discourse in the Senior High Schools in the Subin sub-Metro of the Kumasi Metro. Specifically, the purpose of this study was designed to examine the factors that aid teachers to facilitate discourse in the Mathematics classroom, the role discourse play in students learning of mathematics and the challenges teachers go through in facilitating discourse. The researcher conducted this study because he felt that students must be given more opportunities to develop and share their ideas with their peers as well as with the teacher. The researcher's aim was to create a learning environment that encouraged students to voice their views. In order to do so, students must be given assurance that they were in a classroom where it was safe to speak and they should feel comfortable sharing their ideas.

Another purpose of this study was that the researcher wanted to share this information with other mathematics teachers so that they will involve their students in the teaching and learning process.

1.5 Objectives of the study

The following objectives were considered in this study.

1. To examine the level of understanding of Mathematics discourse by both Mathematics teachers and students.

2. Analyse student Mathematics discourse and examine the role it plays in students Mathematics learning.

3. To investigate the extent at which Mathematics teachers facilitate Mathematics discourse in the classroom.

4. To investigate the challenges teachers go through when engaging students in Mathematics discourse.

1.6 Research questions

The main aim of this study is to investigate how discourse in the mathematics classroom is understood by both teachers and students. The key research questions underpinning this study are:

1. What level of understanding of Mathematics discourse do Mathematics teachers exhibit in their teaching?

2. What factors motivate Mathematics teachers to facilitate Mathematics discourse in the Senior High School mathematics classrooms?

3. What level of understanding of Mathematics discourse do students‟ exhibit and what role does it play in students Mathematics learning?

4. What challenges do Mathematics teachers encounter when engaging students in Mathematics discourse?

1.7 Significance of the study

This research is required to discover effective strategies and programs to help more students participate in learning mathematics in order to help them pass their examination. Students leaving Senior High School without the self-confidence and skills needed to use mathematics efficiently in their everyday lives could have less access to opportunities and information that can develop their lives. This includes chances for continued schooling and employment, and access to information that can help them make dependable and healthy choices in their lives. This research could benefit students and society by helping more future citizens gain access to information and opportunities with regard to

mathematics that can improve their lives. This research would also provide additional insights concerning the use of student discourse as an intervention for low ability level students. Again, this study would be seen as an important platform where students may have the opportunity to focus, explain, interact, and reflect on the strategies used for finding out a problem.

Furthermore, through discourse students would realise that their ideas are valued and as a result have more authority over their learning and engage in more voluntary participation. The study could assist students during teaching to take the role as active listeners and participants.

The study would also benefit schools by providing them with more information about instructional choices that are supported by scientific evidence. This might lead to new and better choices for schools and teachers seeking to improve student success in mathematics, and also contribute more generally to the mission of providing a high quality education for all students.

This research would contribute to the body of knowledge regarding classroom discourse and inquiry-oriented mathematics teaching. By investigating how teachers construct and manage classroom discourse in the Senior High School, the study would develop important new knowledge about teachers‟ practice. Consequently, the result of this study would be of great significance to the research society and will inform the future professional learning of mathematics teachers. The result of the study would also provide a source for improving Mathematics teaching in Ghana. The outcome of the study will also direct policy making and formulation processes by considering the factors that yield successful Mathematics teaching and learning. Stakeholders in education will be

informed about current ingredients for effective teaching and learning of Mathematics. By making the report of this study available to educators and policy-makers who are in charge for developing teachers, it could act as a vehicle for ensuring that innovations are actually needed to help handle the complex nature of teaching.

1.8 Limitation

The findings are not based on a true experimental design because the sample is a purposive one. In fact, participants could not be selected randomly as this would compromise the expertise of the participants and in turn provide participants with lower expertise than those purposefully selected.

Since this study was conducted in only the Kumasi Metro findings cannot be generalised to all the schools in Ghana. This study is also limited to only senior high school form three students in the Kumasi Metro as a result of the limited time for the study.

Another limitation of this study is that, although interviewees were requested to tell what they really thought or what the real situation was, there might have been interviewees who did not expose reality.

Absence of classroom observations might be regarded as another limitation of this study. That is teachers and students were not observed during classroom interaction.

1.9 Delimitation

The study was delimited to only the Senior High Schools in the Subin sub-Metro of the Kumasi Metropolis. The researcher would have wished to use all the Senior High Schools in the Kumasi Metro; this would have afforded him the opportunity to compare varied results and present wider assessment of the problem at hand. However, due to logistics and time constraints, the study was restricted to only the Subin sub-Metro.

1.10 Organisation of the Study

This research is made up of five chapters. The first chapter discusses the background to the study, purpose of the study, statement of the problem, significance of the study, research questions, limitation, delimitation and organisation of the study. The second chapter discusses the literature review which highlights related views and ideas on the topic from other authors. The third chapter discusses the research methodology which included research design, sample and sampling techniques, instrumentation used and mode of analysis of data. The fourth chapter discusses analysis of data and its findings and the fifth chapter discusses the conclusion, suggestions and recommendations of the study.

CHAPTER TWO

LITERATURE REVIEW

2.1 Overview

This chapter focuses on the diverse views on what other authors have written concerning this study. The literature reviewed was under the following headings; theoretical framework, what is learning? Classroom discourse, how teachers facilitate discourse, the role Mathematics discourse plays in student learning, the challenges teachers encounter when engaging students in discourse and a chapter summary.

2.2 Theoretical Framework

The theory behind classroom discourse originates from sociocultural visions of learning. When students learn together they are able to reach new understandings that they possibly may not attain if they work single-handedly. Social constructivist learning theory is of the view that learners enthusiastically build knowledge and make individual meaning from their collective experiences by drawing on their previous knowledge and by interacting with their teachers, colleagues and the surroundings (Geertz, 1973; Vygotsky, 1978). Vygotsky (1978) describes sociocultural theory of learning as a continuous process where individual learning and improvement is facilitated by interaction within social and cultural contexts. Vygotsky (1978) emphasises that to progress through learning, students mind must function in a social environment where every purpose in the student‟s cultural growth appears. The aim of constructivist learning is to help students rebuild their everyday understandings of ideas by taking part in activities that challenge their understandings whilst operating within their mental growth

(Driver et al., 1994; Traianou, 2007). Sociocultural theory highlights learning and development in socially and culturally fashioned circumstances. The classroom strengthens a culture for discussing tasks with group members, making meanings, and evaluating results. In working together with colleagues, students interact with each other, the teacher, mathematical tasks, and classroom apparatus within the social environment of the classroom. These interactions are recognised by social expectations and classroom rules. A significant constituent of a sociocultural viewpoint is that learning is reconciled by means of language and cultural tools. For example, a graphing calculator smoothens the progress of learning where students build up higher mental thinking beyond their already acquired capabilities and improve their mathematical performance (Goos, Galbraith, Renshaw & Geiger, 2000). A sociocultural viewpoint has proven to be a constructive lens through which student learning and mathematics discussion could be viewed because it emphasises on socially and culturally shaped situations (Lubienski, 2002; Moschkovich, 2002; Boaler & Staples, 2008). Sociocultural theory is a perfect fit for this study because it investigates the role discourse play in the Mathematics classroom. Understanding developed through discourse help students to comprehend mathematical concepts and ideas (Driver et al., 1994; Mercer, Wegerif, & Dawes, 1999; Mercer, 2000; Mercer, Dawes, Wegerif & Sams, 2004). When students are given time to reflect and interact with their teacher and colleagues about their knowledge, individual students are encouraged to redefine, reorganise, elaborate, and build on their already acquired concepts and to develop scientific ways of thinking about a phenomena.

2.3 What is learning?

Education is the process of bringing desirable changes in the behavior of human beings. It can also be viewed as the process of imparting or obtaining knowledge and behavior through training (Gredler, 2001). The most significant purpose of educational process is to transmit knowledge to the next generation (Gredler, 2001). It is now widely established that the most vital factors in teaching competencies are the interaction with students, and the knowledge of the teacher. Teachers should possess the capability to understand a subject well to be able to communicate its meaning to a new generation of students. The objective is to institute a sound knowledge base on which students will be able to construct as they are exposed to different life occurrences. The main responsibility of teachers is to teach students the core knowledge built up over centuries of human experience for them to understand and retain this knowledge in order to build on it (Fredrick & Walberg, 1980).

In order to teach successfully, teachers must have adequate knowledge about students, in addition to knowledge about appropriate techniques of teaching. Modern research shows that if correct and appropriate methods and techniques are used, students of low ability levels can easily learn (Santrock, 2006). It is teacher's duty to see to it that the lessons are taught in such a manner that child-related objectives are met. In order to achieve this, teachers must appreciate the necessities of the program and be able to teach using appropriate skills and methods (Stalling, 1979).

Behaviorists define learning as a relatively permanent change in behaviour due to experience while cognitive psychology describes learning as a relatively permanent change in intellectual relationship (Ormrod, 1998). Both philosophies are similar so long

as they view learning as a permanent change and as a result of experience. But they vary because the first viewpoint describes learning as a change in behaviour and centers on environmental circumstances that bring about such changes. Cognitive perspective focuses on changes in invisible knowledge and reasoning rather than simply on visible behavior (Ormrod, 1998).

Ormrod (1998) views Piaget"s theory in the light that children construct their own body of knowledge from their experiences through the processes of assimilation and accommodation. Accordingly, their knowledge about the world goes on rising. The duty of teachers is to offer appropriate experiences to students so that they modify their existing composition of knowledge. Vygotsky (1978) claims that students should be given the opportunity to learn with colleagues and teachers in constructing knowledge and understanding.

There are two methods of teaching: the teacher centered instruction and students centered instruction. According to Santrock (2006), the behavioral theory of learning provides the conceptual understandings for teacher-centered instruction; the cognitive or the constructivist theories form the theoretical backdrop for learner centered instruction. Social constructive approach supports discourse and cooperative learning (Santrock, 2006). The focus of teaching in schools of many countries, including Ghana, is based on teacher centered instruction. However, student-centered instruction has recently gained popularity. Both instructional approaches have their own advocates and critics.

Advocates of teacher centered-instruction (objectivism) deem it the best for teaching basic skills and clearly prepared knowledge such as in English, Mathematics and Science when a teacher directly and explicitly teaches grammar rules, mathematics computations

and science facts respectively (Santrock, 2006). The critics of teacher-centered approaches, who are mostly the advocates of learner centered instruction, are of the view that it often leads to passive learning, over structured and stiff classroom with few chances for collaboration among learners (Santrock, 2006). Objectivism is a view that knowledge can be found outside the bodies of those that search for it. Knowledge is located in books and is independent of the student. Students are to view objects, events and phenomena with an objective mind, which is understood to be separated from cognitive processes such as imagination, intuitions, feelings, values and beliefs. Teacher-centered learning is a method of teaching where the teacher is the main supply of knowledge. Generally, teacher-centered classrooms, teaching is done primarily through lecture methods. The teacher is accountable for the transmission of specific, accurate, and generally scripted information to students who are mandated to take notes and apply them to suitable problems that reflect that lecture. There is virtually no student-to-student interaction and the little teacher to student interaction requires a low level of reasoning responses. Katsuko (1995) views that the purpose of curriculum encourages teacher-centered learning to convey facts, skills and values through mastering knowledge. Katsuko (1995) stresses that the curriculum centers on learning the right interpretation and understanding, and recognising the essential ideas and author‟s aim. Teacher decides all teaching methods and students are just the recipient of knowledge. In teacher-centered instruction, teachers do most of the work in the classroom for the students. Students‟ duty is to receive information and repeat it during assessment.

There is little or no application element of teacher-centered learning and students are not supported to explore their own reasoning. The main objective of this method is to pass on

values, attitudes and ideas from teachers to students. It is required that students master what is in books and in teachers‟ teaching notes (Katsuko, 1995). This approach is completely ability based and students are assessed by their ability to reproduce the required information.

Just as direct instruction represents teacher centered instruction (objectivism), student-centered instruction is equated with indirect instruction (constructivism). Emphasising the importance of student-centered instruction or constructivism Elliot et al, (2000) observe that as a result of dynamic nature of learning, achievement of facts and knowledge by means of direct instruction is not sufficient. As a result, students need to be adaptive and imaginative in order to adjust to the varying situation.

Teachers who use indirect instruction use approaches that give confidence to students to solve problems enthusiastically. Students search for information and build their own knowledge rather than inertly receive it through direct instruction. This method is based greatly on conceptual understanding, problems solving and mathematical discussion. This process positions the student at the center of the mathematics curricula. Through the direction of teachers, students build up conjectures and test them. Students work cooperatively with one another and form a group in the classroom as a community of learners. With shared respect for each other‟s learning, they go through inquiries and discovery lessons teachers design to help understand the main mathematical topics. However, this method of teaching mathematics is very new and very different for most teachers in Ghana.

Manouchehri and Enderson (1999) studied students in a mathematics classroom and observed that the classroom situation was fashioned in such a way that learning was tilted

towards students‟ own desires for building relationships, discovering patterns, making conjectures, forming arguments to support their conjectures, and sharing those arguments with their colleagues. Manouchehri and Enderson (1999) affirm that this method needs altering students‟ views of the position of teachers, teachers‟ expectations, and their own position as students within a classroom. This type of situation is very diverse from a teacher-centered classroom because the catalyst of knowledge is not coming from a textbook or a teacher, but is coming from the students‟ themselves and is being constructed from prior knowledge and investigations.

The creation of this type of environment is very difficult and does not occur suddenly. Manouchehri and Enderson (1999) are of the view that, teachers must concentrate on expectations in class and encourage students to solve individually challenging problems, explain personal solutions to their colleagues, pay attention to and try to make sense of each other‟s explanation, try to arrive at an agreement about an answer, and settle contradictory interpretations and solutions. To be able to attain an atmosphere that promotes these social norms, a lot of preparation and planning should be taken into account. The teacher needs to be ready to direct, guide and assist students in their discussion, because students‟ dialogue often leads to a different path that is commendable of exploring.

To be able to help students in their discovery, teachers should offer conceptual frameworks that guide and direct students thinking towards useful discussion. Teachers ask questions to guide the discovery procedure, raise disagreement, search for deep responses, support student to use examples from their own understanding, ask for classification, draw comparables to aid understanding, and pass the duty of learning to

students themselves. Teachers should also support students to relate ideas to their previous learning experience. Furthermore, they should offer hints to draw student attention to unsuitable answers (Manouchehri & Enderson, 1999).

Constructivism is a philosophical method that was founded on the basis that by reflecting on ones‟ own experience, one can build his/her own understanding of the world. A constructivist believes that students learn through the use of prior knowledge, or individual experience and independent realism to construct knowledge. Harlow, Cummings and Aberasturi (2006) assert that constructivism is learning of new knowledge through prior knowledge and what the students already know. Harlow, Cummings and Aberasturi (2006) declare that in constructivism an independent reality lives outside the mental world of the individual and that mental concept and technique are developed through the interaction of the constructive powers of the mind and the independence of the outside world. Constructivist learning approach states that people will take their understanding of some physical processes and generate their own meaning of it through prior knowledge and individual experiences. Dialogue is also used to promote critical and innovative thinking and to ascertain generalisations. Piaget and Vygotsky are the two most known cognitive psychologists who support this approach to teaching (Elliot et al, 2000).

Indirect instruction or student-centered learning, according to Elliot et al, (2000), has unique place in classrooms because it helps in learning concepts, draw conclusions and form generalisations as a replacement for simple memorisation. Based on the above literature, one can deduce that classroom discourse is a key element of student-centered

instruction that explains why the theoretical frame work for this study is based on constructivist learning theory.

2.4 Classroom Discourse

Mathematics plays a very important role in determining how individuals deal with the diverse spheres of private, social, and civil life. However, many students resist mathematics and become disaffected as they repeatedly confront obstacles to mathematics engagement (Anthony & Walshaw, 2008). In order to overcome this pattern of belief, it is important to understand how effective mathematics teaching is. A lot of people have looked to research for evidence about what kinds of pedagogical practices add to desirable student outcomes (Doig, McCrae, & Rowe, 2003; Ingvarson, Beavis, Bishop, Peck, & Ellsworth, 2004; Hiebert & Grouws, 2007; Anthony & Walshaw, 2008). They have argued for a more comprehensive, richer, and coherent knowledge base to update policy and practice. Teaching student ways of discussing mathematically is very significant and demands competent work on the part of the teacher (Walshaw & Anthony, 2008). Students should be taught to communicate sound mathematical clarifications and to justify their solutions. By promoting the use of oral, written and concrete demonstration, effective teachers replicate the process of explaining, justifying and guiding students into mathematical discussions and also use precise approaches, such as telling students how they are required to communicate (Hunter, 2005). While students‟ mind shifts from routine rules to making sense of mathematics, they become less anxious with finding answers and more with reasoning that leads to answers (Fravillig, Murphy, & Fuson, 1999).

Discursive classrooms place students as active members in a community of learners. The conviction is that students‟ active involvement will lead to the growth of specific student characteristics and competencies that are supposed to make a positive difference in students‟ life chances and their upcoming civil participation (Goos, 2004; Walshaw & Anthony, 2008). As students are occupied in mathematics classroom dialogue, they have important prospect to go through tricks involving mathematical dialogue and argumentation (Cobb, Wood and Yackel, 1992; Forman & Ansell, 2001; Goos, 2004; Sekiguchi, 2006; Walshaw and Anthony, 2008). They advocate that effective classroom discourse affords students opportunities not only to contribute their ideas in a mathematical community but also to examine and evaluate the thinking of their colleagues. Wood (2006) established that, those interaction models that demanded greater participation from the members were associated with higher levels of spoken mathematical thinking by learners. Presently, there has been significant attention within research literature to building inquiry-based learning situations in which learners not only communicates their own ideas but also use mathematical reasoning to confront those of their colleagues and the teacher.

The incursion of research concerning mathematical discussion has shown that mathematics education researchers have turn out to be aware of the importance of mathematical dialogue for successful student learning (Lampert, 1990; Williams and Baxter, 1996; Sfard, 2001; Nathan and Knuth, 2003; Blanton et al., 2005). Discussion has become a central point of teaching and learning of mathematics for the reason that it is through meaningful discussions about mathematics that students make meaning (NCTM, 2000). Blanton et al, (2005) also envisage the importance of mathematical dialogue by

stating that dialogue informs not only our understanding of learners‟ thinking about mathematics, but also teachers‟ thinking about teaching mathematics and again recognised that the mathematics classroom should reflect an intended attempt to learn about a concept or procedure that has become challenging. NCTM (2000) also acknowledge the role of discourse by stating that the nature of classroom discussion is a major influence on what students learn about mathematics. Cobb et al, (1992) observe mathematical dialogue as an opportunity that results in collective mathematical knowledge. Williams and Baxter (1996) emphasise the significance of discussion in the improvement of students and teachers‟ mathematical content knowledge. However, it is not clear whether Mathematics teachers in Ghana do practice discourse in their classrooms.

Studies on discourse have depicted purposeful discourse as constructive for the reason that students construct learning from what others think or believe (Nathan & Knuth, 2003). Similarly, Cobb et al, (1997) posit that the joint construction of knowledge by students during classroom discussion results in a collective reflection. Lampert (1990) on the other hand expresses that mathematical discourse allows joint knowledge construction to take place among students rather than independently between the teacher and student. Useful mathematical dialogue is seen as being learner focused. Williams and Baxter (1996) disclose that dialogue is a focus on the learner or on groups of learners, as the seat of knowledge construction, with the teacher seen as facilitating the construction of such knowledge. Williams and Baxter (1996) claim that while students take a key and dominant role in mathematical discourse, with teachers remaining active members. Studies have shown that mathematical dialogue encourages student learning (Lampert,

1990; Cobb et al., 1997; Sfard, 2001; Nathan and Knuth, 2003; Blanton et al., 2005). However, Cobb et al, (1997) cautioned that discourse can boost students‟ mathematical understanding, but it cannot determine it.

Through student centered instruction in which students have discussion with each other about mathematics, students have the possibility to come to a conceptual understanding of mathematical ideas (Simon, 1995; Williams and Baxter, 1996; Cobb et al., 1997; Nathan and Knuth, 2003). Burton (2004) reveals that understanding of mathematics through discourse was not limited to student learners alone. He realised that adult mathematicians recognised the value of collaboration in constructing mathematical knowledge. The mathematicians realised the rewards to their mathematical discussions such as the boost of quantity and quality of ideas and the support from the experience of others (Burton, 2004).

Cobb et al, (1997) acknowledge that facilitating purposeful and efficient mathematical dialogue entails that teachers have an understanding themselves of what classroom dialogue should involve. Hufferd-Ackles, Fuson, and Sherin (2004) give four main characteristics of effective mathematical dialogue: questioning, explaining mathematical thinking, source of mathematical ideas, and responsibility for learning.

Time and again, what a teacher thinks he is doing might be quite different from what he actually intended doing (Blanton et al. 2005; Nathan and Knuth, 2003). In Nathan and Knuth (2003) by examining a mathematics teacher, the teacher was able to develop student interaction and discussion in his classroom. However, records showed that in one year, student-to-student dialogue only occurred few times. Nathan and Knuth (2003) further stress that understanding classroom dialogue demands that teachers practice

discourse with their students. Teachers need to experience classroom discourse situations as students in order to engage in dialogue about the mathematics involved (Blanton et al, 2005). Ball (1993) agrees that the improvement of discourse proficiencies requires teachers to have enough knowledge about mathematics. Moreover, their maturity of how to use this knowledge in classroom conditions is required.

However, Alexander (2006) discovers discussion that fosters students‟ capability to reason is often missing in many classrooms. He is of the view that interaction is the basis of all learning and that the value of student learning is strongly linked to the value of classroom interaction. Alexander (2006) further affirms that both student commitment and teacher involvement is required to sustain the development of students‟ ability to think and to obtain knowledge, and that the major means by which students keenly connect and teachers fruitfully intervene is through talk. In addition, Alexander (2006) upholds that educators should scrutinise the interactions and exchanges of classroom dialogue in order to understand more about the association between talking, thinking and learning. Teachers‟ role has been depicted as that of facilitators, by listening carefully to their students, carefully asking questions and posing problems and carefully managing whole class discussion, students will be able to build up mathematical skills and understanding (Stigler & Hiebert, 1999). Barnes (1992) asserts that students need to play an extremely active role in classroom discussions if they are to have true ownership of meaning. Whole class dialogue offers models for students to demonstrate how to discuss mathematics. Students hardly ever come across mathematical discourse outside of their mathematics lessons. Time and again their teachers are their main model of mathematical language, although some of their colleagues may provide examples of these too. In the

mathematics classroom, students are not only learning facts, relationships and theorems but also suitable ways of discussing mathematics and what it means to act mathematically. Dialogue in mathematics classrooms can make learners think open and help them to clarify their own thoughts. This enables learners to open up their mind to questioning, clarification, justification and extension and enables the combined negotiation of meaning (Bauersfeld & Cobb, 1995). This can also encourage students in making connections between their daily experiences articulated in everyday language with mathematics and the language of mathematics. Whole class dialogue also supports teachers in evaluating their students understanding, their mathematical knowledge and misconceptions (Resnick, 1988).

In some classrooms there is little chance for students to talk aloud to each other, mainly during whole class discourse, as it is often seen as disturbing or as disruption to the other students (Pimm, 1987). It is also likely that many students do not wish to have their voice heard by the teacher or some of their colleagues because of the fright of being criticised on what they say (Mercer, 2000). It is the duty of teachers to promote more student discourse in the classroom. Wood, Williams and McNeal (2006) observe difference in students‟ ways of seeing and thinking, and these were as a result of specific differences recognised in the classrooms pertaining to when and how to contribute to mathematical dialogue and what to do as students. These outcomes were consistent with the results reported by researchers such as Dekker and Elshout-Mohr (2004) and Ding, Li, Piccolo and Kulm (2007), who agree that participation responsibilities put limits around the opportunities for students to contribute their ideas and to engage in mathematical practices. Whilst they make a distinction through classroom discussions, teachers move

students‟ cognitive interest toward making sense of their mathematical experiences, instead of restricting their focus to procedural rules.

Students build up mathematical disposition through the nature of interaction and discourse formed in the classroom and the process of assigning meaning to one another‟s effort to make sense of the world. Students‟ ability to learn about different ways to think about ideas, to reflect, and to clarify and modify thinking is essential to improve upon their learning. Carpenter, Franke and Levi (2003) observe that the nature of mathematics presume that students cannot learn mathematics with understanding devoid of engaging in discourse. On the other hand, more talk in the classrooms does not automatically improve student understanding. Healthier understanding is reliant on particular pedagogical methods, firmly focused on creating a discourse culture that brings forth clarification and generates consensus within the classroom environment.

Diversity of circumstances may occur in which the results are not fully realised. For instance, some amounts of studies have reported that some students succeed more than others in whole class discussions. Baxter, Woodward and Olson (2001) establish that highly eloquent students tend to control classroom discussions. Students with low ability levels usually remain inactive, and when they participate in class discussion, their contributions are relatively weaker, and their ideas sometimes incoherent. Nonetheless, instructional practices that create chances for students to clarify their thinking and to participate fully in discussion have been reported in some research (Steinberg, Empson & Carpenter, 2004). Steinberg, Empson and Carpenter (2004) observe that classroom dialogue was central to a continued change in students‟ conceptual understanding. However, many discursive approaches engaged with this purpose may not be successful.

Students may not share teacher‟s understanding of the rationale of the dialogue and frequently may not see what mathematical problems are embedded in the task and these are often a result of the systems of interaction within the classroom. Teachers have to make decisions about whether to permit a classroom dialogue to go on and develop when it does not conform to suitable mathematical view, allowing students to arrive at their own conclusions. The latter alternative reinforces the function of the teacher as expert or specialist (Mason, 2000). According to Williams and Baxter (1996), discourse takes place when students focus on teacher‟s wish for participation, rather than understanding the topic under discussion. Williams and Baxter (1996) observe that for some students dialogue became an end in itself and for others it become an additional extraneous condition. The dialogue oriented atmosphere teachers seek to build become part of the worthless practice of classroom situation, rather than a device for learning (Williams & Baxter, 1996). In such a classroom students seem not to have enthusiasm for listening keenly, making sense of, and building each other‟s ideas. If dialogue lacks genuine reason in students‟ minds, then it is not astonishing that discourse becomes part of education rather than part of learning mathematics (Williams & Baxter, 1996).

Stein (2007) believes that mathematics should be delivered in a way that supports students to use mathematical dialogue to make conjectures, talk, question, and agree or disagree about problems in order to determine significant mathematical concepts. According to Truxaw and DeFranco (2007) taking part in a mathematical community through dialogue is a vital pace for learning mathematics and for conceptual understanding. They observe that mathematical discourse is essential for ideas to become objects of reflection, refinement, discussion, and amendment. Discourse is an important

part of mathematics and formal mathematical language is a vital component of this discourse (Davis, 2008). Noting the significance of discourse in the mathematical development, Gay (2008) calls for the necessity for students to be familiar with the meaning of mathematics vocabulary, either written or spoken, in order to better understand and communicate mathematically.

During the learning of mathematics, it is essential for learners to use the right mathematical language, learn how to interpret mathematical terminology into verbal problems and how to translate verbal problems into mathematical terminology that they can work with (Askey, 1999). Students will then be occupied constructively in mathematical dialogue whilst solving problems by proposing, formulating, conjecturing, and justifying mathematical ideas and by assessing the mathematical ideas of their colleagues. Furthermore, according to Kotsopoulos (2007), students experience hindrances when they borrow language from their daily lives to use in their mathematics world, such that their failure to minimise this hindrance could potentially weaken their capability to learn. As a result of this, Adler (2005) suggests that it is imperative for teachers to build learning opportunities that supports students to use mathematical language themselves, so as to better grab the fundamental mathematical meaning of concepts. To attain these benefits, teachers must construct environments that support teamwork among students. Similarly, they must stay mindful of their use of language because they directly add to students‟ understanding or misunderstanding of ideas (Gay, 2008).

The NCTM (2000) observe that teachers whose classrooms lean towards mathematics classroom dialogue will anticipate students to make conjectures, explain, and justify their

different methods of solution, fight for the correctness of their methods, and try to understand the approaches posed by their colleagues and teachers. In classrooms like this, prominence on right answers shifts to the background while mathematical thinking moves to the foreground. Furthermore, classroom dialogue now counts as much more than just foreground situation for individual students‟ learning. That is a vital social process by which students achieve complex conceptual and discursive goals (Cazden, 2001).

By exploring discourse in the mathematics classroom, Cazden (2001) explains mathematical understanding as a resourceful and developing improvisational process, and this shared mathematical understanding can be experienced in classroom discussion. Discussion calls for teachers to be able to build communities whereby students engage in fruitful mathematical dialogue with their teachers as well as with their colleagues. Cobb et al, (2001) agree that mathematical understanding in classrooms materialises as teachers and students communicate and collaborate together with mathematical content. Discussion environment functions to bring together teachers and students as they engage in discussions about mathematics. As a result, what occurs collectively in the classrooms affects why and how students come to learn mathematics. Cazden (2001) views teachers‟ major attention to base on the institution of a shared classroom, making sure that conditions are met for the prospect of a mathematical community. This is not intended to shift the concerns of students understanding. The idea somewhat, is that students‟ mathematical understandings should be sustained.

Mathematics classroom dialogue, mainly the practice of students thinking aloud or explaining their thinking, is time and again a new experience for students who adopt

student-centered classrooms that emphasise discussions of mathematical thinking. Socialisation into this type of learning atmosphere often takes substantial time for such students as they adjust to revise classroom customs (Yackel & Cobb, 1996; Hufferd-Ackles, Fuson, & Sherin, 2004). Yackel and Cobb (1996) highlight the significance of establishing customs that are open to rich discussion. They differentiate between social and sociomathematical norms, the understanding that students are anticipate in explaining their answers and their ways of reasoning is a social norm, while the understanding of what is believed to be acceptable mathematical clarification is a sociomathematical norm. The culture in the classroom which has important consequences on the nature of discourse is not something that a teacher automatically creates alone, but is co-constructed and discussed by the teacher‟s interactions with their students in the classroom (Empson, 2003). Hence, teachers in mathematics dialogue communities must remain responsive to the distinctive abilities, interests, and social and emotional characteristics of students in the classroom.

2.5 How Teachers facilitate Mathematics discourse

There are amount of studies that offer good examples of how teachers facilitate more interactive mathematics classroom discussion (Kazemi & Franke, 2004; Hunter, 2008). This vital mass of studies have enabled a comprehensive analysis of those teacher practices that facilitate efficient mathematical discourse models both in group work activities and the general class discussions. The task of the teacher in discourse is positioned very highly in creating and sustaining an instructional situation that invites rich and useful forms of mathematics discourse. White (2003) advocates that successful interactive communication depends mainly on teacher‟s readiness to place all students at

the forefront of instruction. White (2003) observes that there are four key ideas that promote rich classroom discussion for all students. These are valuing students‟ ideas, investigating students‟ answers, integrating students‟ background knowledge, and encouraging student-to-student discussion. These ideas collectively advocate that an affective factor of care and desire to listen to and empower students is essential to teacher‟s capability to successfully support rich discourse for all students. Walshaw and Anthony (2008) highlight teacher‟s responsibility as establishing participation rules, in sustaining and encouraging mathematical reasoning, and in determining mathematical argumentation. In the same way, Stein, Engle, Smith, and Hughes (2008) offer five important practices that teachers can use to coordinate classroom discussions: anticipating, monitoring, selecting, sequencing, and making connections between student reactions. The NCTM (2000) describes the responsibility of a teacher engaged in facilitating focused mathematical discussion as one who can sieve and direct students‟ explorations of concepts. Consequently, Cobb et al, (1997) stress the significance of teacher‟s role in student discussion. Cobb et al, (1997) describe teachers as guide who facilitates the flow of topics through effective communication.

Students desire to learn in a discourse community in many settings (Boaler, 2008; Ingram, 2008). Teachers can make every student feel integrated by regarding and valuing the mathematics and the cultures that students bring to the classrooms. Ensuring that all students feel secure allows each student to get involved. However, it is imperative that the kind of relationships that are developed do not encourage students to become too reliant on their teachers. Efficient teachers support classroom relationships that permit students to think for themselves, to ask questions, and to take intellectual risks (Angier &

Povey, 1999). Teachers are the main important source for developing students,‚mathematical identities (Cobb & Hodge, 2002). They control the ways in which students‟ reason in the classroom (Walshaw, 2004). In instituting reasonable arrangements, efficient teachers pay attention to the different needs that result from different home settings, different languages, and different capacities and viewpoints. The affirmative thoughts that grows raises students‟ comfort level, enlarges their knowledge base, and gives them greater self-assurance in their ability to learn and make sense of mathematics. When students are confident in their own understandings, they will be more willing to think about new ideas offered by their teachers, to consider other students ideas and review the validity of other methods, and to persist in the face of mathematical dispute. A vital role of teachers is to offer students with working arrangements that are related to their needs. Every student needs some time to think and work gently by himself/herself, away from the diverse and sometimes conflicting views of other students (Sfard, Forman & Keiran, 2001). In the classroom, peers or associates in groups can give the context for sharing thoughts and for learning with and from others. Group arrangements are useful not only for facilitating engagement but also for exchanging, trying ideas and generating an advanced level of thinking (Ding, Li, Piccolo, & Kulm, 2007). During classroom discussion, students learn to make inferences and learn to employ mathematical argumentation and justification (O‟Conner & Michaels, 1996). When groups are varied in relation to academic attainment, insights are presented at varying levels within the group, and these insights have a propensity to enhance overall understandings, however teachers need to spell out expectations of partaking and ensure

that roles of members, such as listening, writing, answering, questioning, and critically reviewing, are understood and put into practice (Hunter, 2008).

Whole class dialogue can provide a medium for broader interpretations and a chance for students to explain their understanding. It can also support students in solving challenging tasks when a solution is not primarily available. As teachers focus on the proficient ways of recording, they encourage students to pay attention and value one another,,s solutions and evaluate different perspectives (Hunter, 2008). In all structures of classroom organisation it is the teacher,,s duty to pay attention, to observe how often students contribute, and to keep the dialogue focused. When class dialogue become an essential part of an overall plan for teaching and learning, students give their teachers information about what they know and what they are required to learn (Hunter, 2008).

Efficient teachers prepare mathematics learning experiences that permit students to build on their already acquired proficiencies, interest, and experiences. In preparation for learning, efficient teachers put students‟ existing knowledge and interests at the forefront of their instructional decision making (Carpenter, Fennema, & Franke, 1996). Conversant with on-going appraisal of students‟ competencies, including language, reading and listening skills, ability to deal with complexity, and mathematical reasoning, teachers regulate their teaching to meet the learning needs of all their students (Hunter, 2008).

With the prominence on structuring students‟ existing proficiencies, rather than remediating flaws and filling holes in students‟ knowledge, effective teachers are able to be both alert with their students and to their control (Carpenter, Fennema, & Franke, 1996). To help students to learn from their mistakes, teachers institute discussions with peers or the whole class that center students thought on the known difficulties. Asking

students to share a range of interpretation strategies enables learners to balance and re-evaluate their ideas.

Teachers who begin where students are at with their learning are also able to plan suitable levels of challenges for their students. With regards to low ability level students, teachers find ways to lessen the difficulty of tasks without falling back on repetition and busywork and without compromising the mathematical rigour of the activity (Houssart, 2002). In order to boost tasks challenge in all classrooms, efficient teachers put barriers in the way of solutions, take away some information, necessitate the use of particular representations, or request for generalisations (Sullivan, Mousley & Zevenbergen, 2006). When directing students into ways of mathematical argumentation, it is significant that the classroom learning community allows for disagreements that enable conflicts to be determined (Chapin & O'Connor, 2007). Teachers support should involve activities for students to work more efficiently together, to give reasons for their analysis and to present their ideas and opinions. As students‟ concentration shifts from routine rules to making sense of mathematics, students become less anxious to finding answers and more with thinking that leads to answers (Fravillig, Murphy & Fuson, 1999).

Davis (1997) claims that teacher listening is a vital skill in the facilitation of efficient classroom discourse. Davis (1997) asserts the significance of listening in discussion-oriented classrooms emphasising that attentiveness to how mathematics teachers listen may be a valuable route to pursue as they endeavour to understand and accordingly, help teachers better understand their performance. According to Davis, efficient teacher listening enables successful teacher questioning and the facilitation of student discussion of mathematical concepts. Listening allows teachers to determine when discourse is

effective and when teacher guidance is necessary. Students and teachers both need to listen to each other‟s ideas and to use debate to establish common understandings. Listening carefully to student ideas helps teachers to decide when to step in and out of the conversation, when to push for understanding, when to determine competing student claims, and when to address misunderstandings or uncertainty (Lobato, Clarke & Ellis, 2005). Since students are encouraged to talk more in interactive classrooms, listening cautiously to student contributions is therefore an essential feature of mathematics discourse communities (Jacobs et al, 2006). Ball (1993) refers to this as teachers‟ ability to listen to students and value their thinking, even in cases where students emerge to be applying reasoning that is inaccurate.

One ground that listening carefully to students‟ contributions is so significant in mathematics discussion is because teachers are often called upon to arbitrate students‟ contributions. That is, the teacher automatically assumes a large portion of the responsibility in supporting listening with conception of individual speakers‟ utterances.

Another way to encourage classroom discussion is to use high-level mathematical tasks. (Stein et al, 2000) define a mathematical task as a set of problems that deal with a related mathematical idea or thought. The type of mathematics tasks selected by teachers is a critical component to facilitating productive dialogue. First, mathematics teaching is typically planned and arranged around instructional tasks. More specially, delivery of content in mathematics classrooms consists of working on tasks, activities, or problems. Second, the tasks with which students take on are a vital feature in what students learn about mathematics and how they learn it (Stein, Remillard & Smith, 2007). The

connection between good tasks and good dialogue is interesting. If we would like students to have interesting dialogue, we need to give them worthwhile task to discuss. Supporting useful dialogue can be made simpler if teachers work with mathematical tasks that allow for various strategies, connect core mathematical ideas, and are of significance to the students (Franke, Kazemi & Battey, 2007). The types of instructional stuff that teachers select to use directly affect the education students obtain. Teachers should select tasks that are challenging and involve more critical thinking; however that task must be within students‟ mathematical knowledge. These types of tasks are important in improving classroom dialogue because they touch on a range of different concepts and motivate students to connect ideas, talk among each other mathematically. It is also useful for teachers to select tasks that are of importance to students in hopes that students can add to the discussion.

Efficient teachers use a range of assessment practices to make students thinking noticeable and sustain students learning. Mathematics teachers make use of extensive variety of formal and informal assessments to monitor learning development to diagnose and to determine what can be done to advance learning. Within the daily activities of the classroom, teachers gather information about how students learn, what they appear to know and are able to do, and what they are attracted to. This information helps teachers decide whether particular activities are thriving and informs decisions about what they should be doing to meet the learning needs of the class (William, 2007). Efficient teachers collect information about students by observing students as they take part in individual or group work and by talking with them. They observe their students

understanding, observe the strategies that they prefer, and take note of the language they use. The timely assessment helps them make decisions regarding what questions to ask, when to interfere in student activity and how to answer questions.

Again, the degree to which students can profit from discourse depends highly on the value of questions that teachers ask. Teachers require asking more open ended questions that enables students to think decisively and abstractly. To keep away from too much teacher talk in the classroom, teachers should anticipate student answers and plan good open ended questions prior to a lesson (Cirillo, 2013). Good questions are questions that compel a student to answer with more than one word, and entail a deeper level of mathematical thinking. These questions open the door for healthy dialogue and allow students an opportunity to present their own approach to the task in question, unless those tasks are not too difficult for students‟ current mathematical level (Cirillo, 2013). Classroom interactions in the form of cautious questioning provide a powerful way to review students‟ current knowledge and ways of reasoning (Steinberg, Empson & Carpenter, 2004). For example, questions that have a multiplicity of solutions, or that can be solved in other way, can help teachers understand students‟ mathematical thinking and reasoning. Probing questions and questioning patterns is a significant feature when looking closely at the classroom discourse (Herbel-Eisenmann & Cirillo, 2009). This examination has been revealed to give adequate support to teachers in facilitating productive dialogue that center on mathematical meaning and associations and make connections between mathematical ideas and relationships (Smith & Stein, 2011). A well-formulated question can be enough for a discussion (Dillon, 1983). However, many studies have revealed that while teachers ask a lot of questions, these questions often call

for specific accurate answers, resulting in an inferior cognitive thought (Gall, 1984; Perrot, 2002).

Some questions open up discussion, while others are more closed (Ainley, 1987). Teachers should ask well-formulated questions because in answering these types of questions, students need to provide more than just one word answers since the answers are complex and need a deeper level of thinking to give entire answers. More open questions are frequently better for opening conversation and maximizing the probability of individuals to contribute to the dialogue (Smith, 1986). It can be helpful to prepare not only tasks but also good questions ahead of the lesson (Smith & Stein, 2011), and to think about what questions we can ask to stay away from too much story telling.

Teachers can use the method of revoicing, repeating, rephrasing, or intensifying on student talk (Forman & Ansell, 2001). Teachers use revoicing in many ways which includes; stressing on ideas that have come directly from students, to help the improvement of students understandings contained in those ideas, to discuss meaning with their students, and to put in new ideas, or move dialogue in another direction. A number of researchers have studied teachers‟ efforts to make individual student contributions available to all students in the class, which is mainly executed through the act of revoicing (Forman & Ansell, 2001; Empson, 2003), where a teacher rebroadcasts students‟ input back to students. Revoicing is vital for several reasons. First, it permits a teacher to capture the general idea of student contributions but also expresses students‟ views clearer and logical steps. Because students typically put in great effort to communicate their thinking by using highly fluent terms during exploratory talk,

revoicing is often needed to provide clarity for all students. Second, it allows teachers to situate themselves as facilitators, rather than the single validating power of student contributions, allowing individual students to uphold ownership of new ideas while setting a situation that enables the group to echo students‟ contributions (O‟Connor & Michaels, 1996). Forman and Ansell (2001) discover that students are more concerned in providing clarifications of their reasoning in classrooms where revoicing is strategically put into practice by teachers. However, in a different study, the application of revoicing appear to often disrupt the flow of dialogue (Hufferd-Ackles et al, 2004), suggesting that the nature of revoicing as a useful instructional strategy is multifaceted.

Furthermore, incorporating high-quality proof writing abilities into the curriculum would also be helpful in promoting excellent classroom dialogue because proofs involve discussion, defending and clearing up ideas. However, one would need to guide against the traditional proof idea and move towards a more helpful technique of teaching proofs. The idea of proofs is a shared construct and is thus very much related to classroom dialogue. Proofs are significant part of mathematics because students learn to identify reasoning and proof as essential aspects of mathematics, make and explore mathematical conjectures, develop and assess mathematical arguments and proofs, and choose and use various types of reasoning and techniques (NCTM, 2000). Proofs involve argumentation and validation that the teacher can develop through interactive reasoning. Interactive reasoning is distinguished by clarification, elaboration, justification, and critique of students‟ own reasoning. Blanton and Knuth (2005) claim that interactive prompts are a significant part of discourse because they provide scaffolding tool to construct practices

of argumentation needed in the development of a proof. Thus, when teachers give interactive prompt, they are potentially varying students‟ cognitive stance from passive to active, from accepting to questioning, and these interactive prompts scaffold the progression of the composition of argumentation.

Another significant feature of mathematics classroom discussion is scaffolding. Teachers should lead students through the discovery process allowing them to put up and expand on their own ideas (Walshaw & Anthony, 2008). Scaffolding is intended to develop advanced order of thinking among students. Walshaw and Anthony (2008) found some advantages of scaffolding such as allowing students to see mathematics as produced by group of people, supporting students‟ learning by involving them in the construction and validation of ideas, and helping students become aware of more conceptually complex forms of mathematical activity.

However, students with lower socioeconomic conditions and or students with language difficulties may be passive during classroom dialogue and may not take part in activities where the teacher endeavors to use the scaffolding approach (NCTM, 2000). A study showed that in a particular classroom, students with lower socioeconomic conditions were unwilling to contribute, stating that the ideas contributed to the dialogue confused their efforts to produce right answers. Their difficulty in differentiating between mathematically suitable solutions and bizarre solutions affected their decisions to give up trying (Walshaw & Anthony, 2008). Indeed, scaffolding may be difficult in a classroom with these types of students, and this type of approach is often more directed towards higher ability level students. However the results of scaffolded teaching have been shown

to really profit the lower ability level students by improving their sense of action (NCTM, 2000).

Expanding on wrong student answers can generate good discussion. When students give wrong answer, as an alternative of telling the students they are wrong and move on, teachers can grab the opportunity and have the class investigate why the answer is incorrect or why the selected process does not work. By allowing only correct solutions and approaches to surface in dialogue, teachers have to take steps to lessen the stigma attached to being wrong, thus explain to students that errors are part of the learning process (Staples & Colonis, 2007). Some researchers have established that exploring wrong solutions can serve as a catalyst for discussion. This can provide a spotlight to the conversation and engage students in outlining why a suggestion does or does not make sense (Bochicchio et al, 2009). This move has numerous advantages, including addressing common misconceptions, refining student thinking, prompting metacognition, and involving students in developing theories (Bochicchio et al, 2009). Staples and Colonis (2007) establish that, in shared discussions; it is uncommon for something to explicitly be recognised as wrong. Rather, students‟ thoughts are treated as "works in progress," and the center of attention of teachers‟ guidance was to help students and the class broadens the idea that had been offered and continues to develop collaboratively a feasible solution. Decisively, choosing and sequencing the presentation of student ideas can be a successful way to organise a dialogue of both wrong and right student solutions.

2.6 The Role Mathematics Discourse Plays in Student Learning

Student discussion will be more established in student centered instruction than traditional instruction since students will be working jointly and discussing problems with everyone. The importance of students‟ discussion is more prominent in their personal and academic development. It is believed that discourse plays a vital role in motivating students to learn.

De Fina (2011) agrees that students‟ progress through discourse because it improves cognitive growth and social improvement. Furthermore, Yackel, Cobb and Wood (1991) stress that the discussion extracted from the classroom situation encourage and support students to work together to construct knowledge. Similarly, Rowe and Bicknell (2004) agree that discourse helps lift the level of cognitive talk among students that would not have been achieved without group interaction. Dialogue allows students to expand their mathematical thinking and scrutinising skills by working together with one another to talk about healthy mathematical problems.

According to Middleton and Jansen (2011) discussion motivates students to learn by suggesting that teachers should make efforts to involve students in class by persuading them that contributions will help progress the classroom knowledge. If teachers are able to do this more students will feel comfortable and courageous enough to contribute to classroom discussions (Middleton & Jansen, 2011). By actively taking part in a mathematics classroom discussion can have a positive impact on student motivation. Motivation therefore, can lead to the building of knowledge, developing students

understanding and also developing relationships with mathematics and with classroom community members (Middleton & Jansen, 2011).

For students to participate in lively discussions, teachers have the significant task of creating an important, worthwhile, and wealthy problem. A wealthy mathematical problem is a challenging problem that compels students to put into effect profound mathematical thinking. The problem should be challenging, yet attainable. The intention of wealthy tasks is to give confidence to all students to critically examine mathematics, keenly participate, and efficiently engage in solving problems. Even though generating wealthy problems may be hard and time consuming, one of teacher‟s primary tasks is to choose and develop worthwhile tasks; tasks that are wealthy with mathematical viewpoint and prospects (Borko et al, 2000; Hsu, Kysh & Resek, 2007). Presenting students with wealthy problems will challenge them to make sense of the problems, while also encouraging them to persist in solving them. Teachers ought to offer fruitful reinforcement to students and make sure that students also obtain positive support from peers (Hsu, Kysh & Resek, 2007). This encouraging classroom situation will give confidence to students to persist in finding solutions, and develop their general problem-solving skills. During solving wealthy problems, student discussion can be improved and play a crucial function in facilitating learning in the mathematics classroom.

Again, the tone in which different instances of discussion take place can produce a classroom culture. Classroom culture is a supportive condition good to optimising students‟ mathematical knowledge attainment. Student-to-student discussion can help create a smooth social network and sustain system, which can direct to a comfortable student friendly classroom culture. The teacher plays a vital role in organising and

maintaining a productive environment helpful of student learning. The teacher can ask students to validate their thoughts to group members, or to clarify answers to a completely different group of students. The communication of the teacher is helpful in managing these groups of discussion and creating a complete classroom culture. An encouraging classroom culture is vital to establish in order to maintain student learning and development. Lave and Wenger (1991) declared that student learning is rooted within the task and context where it usually takes place.

According to Lave and Wenger (1991), knowledge is presented in a genuine situation such as social interaction and cooperation; particularly community of practice. Furthermore a community of practice is a set of people with general welfare, sharing experiences and information with everyone to learn and grow individually and professionally (Lave & Wenger, 1991). Student and the community of practice are interrelated. Students grow as a result of taking part in the community, and the community grows as a result of students‟ contribution. This permutation relates to a mathematics classroom where student learning can flourish participating with fellow colleagues, and at the same time the whole group. To build and sustain a positive classroom atmosphere, it is essential for students to feel relaxed in the classroom working together with peers. Teachers play important roles in instituting and sustaining a constructive classroom atmosphere. Chapman (2004) claims that mathematics teachers constantly engage students in group work and student-to-student interaction. Working frequently in shared groups, students become more keenly engaged, work together with peers, and develop their collective and interactive abilities. The results showed that students appreciate and respect each other than ever before, which guide the

establishment of a supportive classroom culture favorable for learning mathematics. To encourage academic success, building a helpful classroom culture supportive of student learning is an important asset. Learning mathematics is greatly more than just rote memorisation, appreciating concepts, and growing knowledge. It is a preparation for learners to interact in future communities of practice wherever they want to learn, debate, and usually participate in dialogue (Chapman, 2004).

The culmination of the helpful impacts of dialogue and the encouraging classroom culture is the aim of increasing self-efficacy. Self-efficacy plays an essential function in students in order to shine in mathematics, emphasising that students with high self-efficacy usually achieve more academic success than those with low self-efficacy (Bouffard-Bouchard, Parent and Larivee, 1991; Multon et al., 1991; Pajares and Graham, 1999). One of the methods to motivate students to be successful in mathematics is through applying a variety of ways to improve their self- efficacy. Bandura (1997) defines self-efficacy as the principle in one‟s abilities put in order to perform the courses of action necessary to manage prospective circumstances. This perceived self-reliance influences a diversity of factors, including effort put into learning, determination in academics, and resiliency to impediments.

Bourdieu (1992) posits that one cannot talk about self-efficacy without mentioning social capital. While self-efficacy concerns with one‟s confidence in his or her capability to complete a given task, social capital deals with the value of creating friendly relationships as students confidence increases. Bourdieu (1992) defines social capital as the amount of the resources that ensue to an individual or a group as a result of possessing a strong network of more or less institutionalised associations of shared acquaintance and respect.

Putnam (1995) describes social capital as an aspect of social association such as networks, norms, and social trust that smoothes the progress of coordination and teamwork for a common benefit. Yosso (2005) explains social capital as network of people and society resources. These peers and other social acquaintances can present both active and exciting support to navigate through society‟s establishments. Dialogue inside classroom culture develops social capital and gives students the basis to gain interpersonal and mathematics skills essential to operate in a more broad community of practice (Yosso, 2005).

In the mathematics classroom, social capital entails students‟ confidence in their capability, as well as, the networks of people sustaining each other, interacting by asking questions, learning new methods, and developing knowledge (Putnam, 1995). Student dialogue in the mathematics classroom is vital and necessary for working with colleagues and increasing mathematical development, and in the end boosting social capital. Students with high-level of social capital have positive advantages over peers with lower-levels. For instance, students with high social capital have many colleagues they can work together with for help and support; mainly people in their community of practice (Putnam, 1995). With the help from colleagues, students can achieve more success in mathematics, and increase their self-efficacy. While students increase their self-efficacy, they achieve more confidence in doing mathematics and feel more relaxed in learning (Bourdieu, 1992). The NCTM (2000) powerfully encourages implementing student discourse in the classroom to take advantage of students learning. The NCTM (2000) positions those students who have prospect, encouragement, and support for speaking, writing, reading, and listening in mathematics classes obtain dual advantages; they

discuss to learn mathematics and they learn to discuss mathematically. The classroom culture, how students and teachers interact, the sort of learning practices students have, and the problems that students are asked to work with all greatly affect the chances that students have to learn mathematics in any particular classroom (Hiebert et al, 1997). Students learn more through social interaction (Vygotsky, 1978; Lave & Wenger, 1991). A Vygotskian point of view, as expressed by Gibbons (2006), proposes that language use is the origin of learning. More particularly, this view of language calls for inspection of teaching and learning to treat interactions between teacher and student as critical. These interactions not only form students‟ interaction, but they help to build understanding (Gibbons, 2006). Dialogue can occur in small groups or in a whole class set up. When observing a classroom as a community of learners, it must be considered that interacting is not voluntary, but rather it is necessary because discourse is indispensable for building understanding (Hiebert et al, 1997).

Dialogue can sustain teachers in understanding and evaluating student thinking, this is because some classroom interaction models support deeper mathematical thinking than others (Herbel-Eisenmann & Breyfogle, 2005), and competent questioning of student thoughts can offer teachers with important knowledge about students‟ developing mathematical thoughts (Martino & Maher, 1999). NCTM (2000) posits that efficient mathematics teaching involves understanding what students know and require to learn and then challenging and sustaining them to learn it well. Discourse is a plan that can uphold teachers in understanding what students previously know and in determining what they still have to learn (Gibbons, 2006). In this sense, listening to students‟ ideas in dialogue can provide a form of formative assessment that helps teachers formulate

decisions about teaching (NCTM, 2000). To take full advantage of the instructional value of dialogue using formative assessment, teachers must move away from the right or wrong analysis of problems and focus on how students are thinking about the problem (Gibbons, 2006). By concentrating only on mistake, teachers ought to make efforts to make out important student insights on which further development can be based (NCTM, 2000). Emphasising on problems that focus on thinking, sense-making and providing students with prospects to talk about mathematics serves to give teachers with ongoing assessment information. Teachers have to guide students in the direction of understanding and support their improvement as they work to talk mathematically.

A key element of formative assessment is response. As students regularly take part in dialogue in which meanings are constructed and shared, they are presented with responses that sustain them to progress their learning (Lee, 2006). In particular, response allows students to weigh against how their reasoning correlates with that of other students in the class as well as the conventional mathematical thoughts. It also permits students" chance to reconsider and modify their reasoning from the initial stage to a more polished final version (Chappin, 2007). A rich dialogue learning atmosphere gives students authority over their individual learning. Dialogue can move the Mathematical authority to community while teachers shape the dialogue by facilitating it through discussion, there is genuine possibility to move the mathematical authority from teacher to community dialogue (Webel, 2010). For this change to be recognised students have to be aware of and willing to take on positions that vary from their roles in the traditional classroom environment. More particularly, for dialogue to be useful, students ought to share the responsibility for constructing a community of learners in which they contribute (Hiebert

et al, 1997). Two significant features of students‟ role in discourse classroom communities are sharing and listening. First, students ought to take duty for sharing the outcome of their explorations and for explaining and justifying their approach. Second, students ought to understand that learning involves acquiring ideas from others, taking advantage of others‟ ideas, and listening to the outcome of their colleagues‟ investigations (Hiebert et al, 1997). To turn out to be full participants in a community of students doing mathematics, students must be prepared to share with and keenly listen to one another.

According to Otten et al, (2011) when students keenly listen to others, mathematical reasoning can be made more open and more available. Due to this, more students can take part in the dialogue by articulating mathematical views and developing collective meanings. This kind of community knowledge-building can help students compare and contrast their individual mathematical reasoning to that of their colleagues, change their own reasoning, and come to new understandings (Kosko, 2012). The teacher plays a vital role in helping students understand what counts as a suitable clarification and justification in mathematics classroom (Yackel & Cobb, 1996), so that students‟ abilities to listen to each other are not hindered by student discourse that is unclear or vague.

It should be emphasised that discussing mathematics in schools can lead to increased student learning. Chapin, O‟Connor and Anderson (2003) offer convincing evidence to suggest that changing to a discussion-based teaching format completely impacts student learning. Chapin, O‟Connor and Anderson (2003) put an immense deal of prominence on student interaction. They posit that students continued participation in academically fruitful interaction is vital to their learning. Emphasising the importance of Mathematics

classroom discourse, Elliot et al, (2000) observe that as a result of dynamic nature of learning, attainment of knowledge by means of discourse instruction is very pleasing. Teachers who use discourse approach give confidence to students to solve problems enthusiastically. Students search for information and build their own knowledge rather than receiving it from their teacher. Discourse positions the student at the center of the mathematics curricula (Elliot et al, 2000). Through the direction of teachers, students build up conjectures and test them. Students work cooperatively with one another and form a group in the classroom as a community of learners (Manouchehri & Enderson, 1999). With shared respect for each other‟s learning, they go through inquiries and discover lessons teachers design to help understand the main mathematical topics. Manouchehri and Enderson (1999) observe teachers concentrate on expectations in classrooms and encourage students to solve individually challenging problems, explain personal solutions to their colleagues, pay attention to and try to make sense of each other‟s explanation, try to arrive at an agreement about an answer, and settle contradictory interpretations and solutions. The teacher needs to be ready to direct, guide and assist students in their discussion, because students‟ dialogue often leads to a different path that is commendable of exploring.

2.7 Challenges that Teachers Encounter when Engaging Students in Discourse

Although classroom discourse appears to have positive effects on students‟ conceptual understanding of mathematics, there are also challenges associated with this method.

The difficulty teachers experience when they teach mathematics in ways they did not encounter as students (Anderson & Piazza 1996). Most teachers did not experience discourse during their training as teachers as a result of this they find it difficult engaging

their students in discourse. They do not feel comfortable when trying to facilitate discourse in the classroom (Bruce, 2005).

Lack of content knowledge teachers‟ encounter discourages many mathematics teachers to adopt discourse strategies in teaching (Bibby, 2000). Teachers should be aware of what students learn based on what they know. The application of teachers‟ professional knowledge and understanding of pupils, curriculum, instructional activities, and classroom organisational plans to support mathematics classroom discourse must intensify.

The institution of dialogue in the classroom which requires facilitation abilities and keen attention to classroom dynamics is missing. These are: modelling of discourse so that students understand the norms of interaction in the mathematics classroom (Cobb & Bauersfield, 1995), encouraging learners to give reason for their solutions and building on one another‟s ideas (Hufferd-Ackles, Fuson & Gamoran-Sherin, 2004), and finally stepping aside as students take increasing responsibility for sustaining and enriching discourse is missing in most Ghanaian classroom.

Time is also an additional setback. As a result of the demand on the syllabi, the period required for the facilitation of discourse has been identified by teachers as a setback to implementing mathematics classroom discourse (Black, 2004). Teachers believe that engaging students in discourse in the mathematics classroom is time consuming and as a result would not help them to complete their syllabi. That explains why the traditional method of teaching mathematics is very common in Ghanaian classroom.

Wilgus (2002) observe that discourse is not significant at the third grade level for any scholarly attainment. Huggins and Maiste (1999) also note that students of this age needed more manipulative and tangible interventions than to engage in discourse. Younger students need more time to process concepts and engage them in discourse at that level is difficult. Mulyran (1995) agrees that students with low ability level are less actively involved than students with high ability level. Teachers who engage students in classroom discourse need to be aware of the student‟s patterns of working and take steps to promote more active involvement by all students (Mulyran, 1995).

Since students may attend Senior High Schools with the assumption that it is acceptable to criticise fellow students for doing something wrong, teachers must establish norms for discourse. Students must be encouraged to question one another‟s ideas, yet teachers must demand that students respect one another as human. In the classroom community teachers seek to build, criticizing someone ideas is acceptable but criticizing the person is not (Wilgus, 2002).

In some instances, as students comfort and confidence grows it may lead to disturbances in the classroom. The teacher must ensure that discourse in the classroom does not get lost and that progress is made along the path not only toward a real mathematical discourse community but also toward the increased mathematical proficiency of all students (Black, 2004).

Many tasks used during mathematics instruction do not lead themselves to rich discourse. Teachers should realise the limitation of such tasks and select and use tasks that give greater opportunity for the exploration and discussion of important mathematical ideas

(Black, 2004). In order for tasks to have the desired impact for engaging and challenging students, teachers need to implement them in a manner that ensures that students understand the task and are able to make progress towards its solution (Black, 2004).

Summary

In summary, it is important to understand the key practices of discourse in order to use it effectively. Although, there have been many studies that describe the role of discourse and the teacher‟s role in the classroom, the studies that investigate classroom, students and teachers practices are rare. Moreover, many of the existing studies only observed the classroom interactions without interviewing teachers and students to understand the purpose of teachers and students actions. The study not only investigates teachers‟ practices inside the classroom but also the role discourse plays in the teaching and learning of mathematics. From the literature it could be observed that Mathematics discourse facilitates the teaching of Mathematics, it put the task for learning directly on students to bear and it helps students to explain their own Mathematical thought. It was also evident in the literature that teachers could facilitate discourse through listening to students effectively, using open-ended questions and repeating or stressing on students ideas.

CHAPTER THREE

METHODOLOGY

3.1 Overview

This chapter discusses the method and procedure that were used to obtain and analyse data for the research work. This was done under the following sub-topics:

- Research design
- Population and Sample
- Sampling Techniques
- Instrumentation
- Method of data collection
- Data analysis procedure

3.2 Research Design

This study utilises a mixed- method design to investigate the research questions. The research design links the research questions to the strategy that was used to carry out the research (Punch, 1998). A mixed-method design is the process and procedure for collecting, analyzing and gathering both quantitative and qualitative data in a study, based on priority and series of information (Creswell & Plano Clark, 2006). Teddlie and Tashakkori (2003) define a mixed-method design as a methodology that integrates multiple methods in all phases of the research from problem identification to research questions, data collection, data analysis, and conclusion. According to Tashakkori and Teddlie (2003) mixed- method design develop from the idea of triangulating information from diverse data sources. Mixed-method design draws strength from both qualitative

and quantitative approaches to data collection as a way to counteract the limitations of any one method (Creswell, 2009). This design was used because the qualitative and quantitative techniques balance each other to deal with the weakness in using only one method. By collecting diverse types of data, a better understanding of the research problem is attained. Through triangulations of data sources, researchers can establish a consensus across qualitative and quantitative data methods, or integrate the data to reinforce findings. In other words implementing a mixed-method design provides the researcher with more opportunities to use triangulation to ascertain the validity and reliability of the study.

3.3 Population and Sample

The target population for this study was all Mathematics teachers and form three Senior High School students in the Subin sub-Metro of the Kumasi Metro in the Ashanti Region of Ghana. The Subin sub-Metro has five governments‟ assisted Senior High schools and a private school. The Subin sub-Metro was selected for this study because of the proximity to the researcher; it has diverse students‟ population with students from all the ten regions of Ghana; most of the teachers in these schools are very experienced and as a result they might have used all kinds of methods to teach and also it is made up of all manner of schools, such as boys, girls and mixed schools. In all, five schools were involved in the study with students‟ population of 8,687 and the population of the form three students being 2,439. The population of the mathematics teachers in the Senior High Schools was 210.

A sample of 110 Mathematics teachers (80 males and 30 females) was selected from the target population. Out of the 110 teachers 5 were chosen for an interview. Again, 120

form three students (70 males and 50 females) were also selected from all the form three students in the senior high schools in the Subin-sub Metro of the Kumasi Metro. Out of these, 5 students were also selected for an interview.

3.4 Sampling Techniques

The researcher sought permission from all the Heads of the Senior High Schools in the area of study. When approval was given, the researcher separately met all Mathematics teachers and form three students in each of the schools and discussed his intentions with regard to the research. Those who agreed to participate were purposively selected for the study. In purposive sampling, the researcher handpicks the cases to be included in the sample on the basis of judgement of their typicality and uniqueness, or particularly knowledgeable about the issues under study. Thus, in purposive sampling the researcher purposely chooses subjects whose opinions are thought to be relevant to the research topic (Amedahe & Gyimah, 2003). In this research the emphasis is on describing a situation (discourse) and the sample for the study was selected through purposive sampling since the researcher wanted to ensure that the sample is suited to the intent of the study (Fraenkel & Wallen, 1996). Because this study focuses on interactions, teachers with at least five years teaching experience were selected to provide credible information to aid the study. Again, teachers who had some expertise as far as Mathematics discourse was concerned were selected hence the use of purposeful sampling. Senior High School form three students were more appropriate since they provided rich and reliable information because they have been learning mathematics for the past two years and also they might have been taught using all manner of methods and exhibited appropriate level of expertise as far as Mathematics discourse was concerned. Five teachers and 5 students

were randomly selected from the 110 teachers and the 120 students respectively, and interviewed.

3.5 Instruments

This study employed closed-ended and open-ended questionnaire to collect data. The first sets of data were collected through a structured closed-ended questionnaire. It contained eleventh-item Likert scale questions using a three point scale (Agree, No view and Disagree). A Likert scale is a psychometric response scale primarily used in questionnaires to obtain participant‟s preferences or degree of agreement with a statement or set of statements (Jamieson, 2004). Respondents are asked to indicate their level of agreement with a given statement. The questionnaire was made up of two different sets of 11 closed-ended items; one for teachers and one for students. The closed-ended items collected quantitative data that basically addressed the level of understanding of Mathematics discourse by both teachers and students. The closed-ended questionnaire (consisted of a list of predetermined answers from which participants selected from) was distributed to both teachers and students.

The open-ended questionnaire captured the viewpoints and thoughts of the students and the teachers. The open-ended questionnaire was designed based on issues relevant to mathematics classroom discourse. The open-ended questionnaire consisted of three key questions; each set for the teachers and the students. The open-ended interview guide was issued out to each of the 5 selected teachers and 5 students. The interview guide was used to collect qualitative data. By interviewing students and teachers, the researcher collected rich and detailed data on their opinions of learning mathematics through discourse.

Interviews for both the teachers‟ and the students‟ were completed within one week. In addition, the participants were informed of confidentiality of their responses.

Interviewing selected participants is a significant method in qualitative research. Bogdan and Biklen (1992) define interview as a focused discussion, usually between two people but at times involving more, that is aimed at one in order to get information from the other. Fetterman (1989) recognises interview as the most significant data collection method in qualitative studies. Interviewing cautiously and asking pertinent questions tend to find out what is on someone‟s mind, what he thinks or how he feels about something (Fraenkel & Wallen, 1996). Patton (1990) claims that people are interviewed to find out from them about those things that cannot easily be observed. The matter is not whether observational data is more desirable, valid, or meaningful than self-report data. The fact is that issues regarding feelings, thoughts, and intentions cannot easily be determined. Interview technique has both advantages and disadvantages. Through interviewing it is likely to obtain full and detailed answers from the interviewees (Tutty, Rothery & Grinnell, 1996). In addition, interviewers do not only observe non-verbal behavior and assess the validity of participants‟ answers but also they direct the order of question. Also, interviewers can regulate the environment where the interview will be made in the efficient manner (Bailey, 1982). Again, the interviewer can clarify vague questions and ask participants to expand answers mostly important or helpful. On the other hand, interviews could be too long to be conducted; in addition the presence of a researcher may influence participants‟ responses (Fraenkel & Wallen, 1996).

3.6 Data Collection Procedure

Recruitment of participants began after obtaining approval from the authorities of the Mathematics Department of the University of Education, Winneba. After approval was granted, letters were sent to the Headmasters/Headmistresses of the selected schools seeking their approval as well. When approval was granted, the participants in each school were contacted to initially explain and discuss the purpose of the study and to agree on a day and time that was agreeable to all of them. After responding to the necessary protocols, the questionnaire was administered to the 110 teachers and 120 students. The participants agreed to complete the questionnaire within one week. Two follow-up visits were made to each school to collect the completed questionnaires.

3.7 Data Analysis Procedure

Data analysis took two different approaches. In the first instance, data from the closed-ended questionnaire were analysed statistically. Simple descriptive statistics such as percentage distribution provided the basic information needed to answer the questions. The results of the questionnaire were organised by totaling the number of participants that chose each response. Percentages were computed for each response based on the total number of participants that took part. The data were then analysed by comparing the percentage each response obtained and then statements were used to describe the findings.

The interviews were transcribed and analysed. After the transcriptions were completed, the responses of all interviewees were listed. The similarities of the responses were checked. Accordingly, interviewees‟ with similar or same responses were identified and

grouped for each question in order to analyse them as part of the coding system. Each code was carefully examined and it was investigated if there emerged categories under each code. So these categories produced the themes. This meant that the researcher captured reoccurring patterns that emerged by searching for meaningful pieces of data that addressed the research questions. Finally, descriptive interpretations of the themes which were obtained from the interviews were written.

CHAPTER FOUR

ANALYSIS OF RESULTS AND DISCUSSION

4.1 Overview

The purpose of this study was to build more opportunities for students to interact with each other, the teacher and the class as a whole. In this chapter, demographic data of participants as well as findings from the study are presented and discussed in relation to the four research questions. Discussions on these research questions were based on quantitative and qualitative analysis of data collected from closed-ended and open-ended questionnaires respectively. The discussions focused on the findings related to the research questions. In this study, teachers‟ efforts to facilitate whole-class discussion in the mathematics classrooms were examined. Specifically, the following research questions were investigated:

1. What level of understanding of Mathematics discourse do Mathematics teachers exhibit in their teaching?
2. What factors motivate Mathematics teachers to facilitate Mathematics discourse in the Senior High School mathematics classrooms?
3. What level of understanding of Mathematics discourse do students‟ exhibit and what role does it play in students Mathematics learning?
4. What challenges do Mathematics teachers encounter when engaging students in Mathematics discourse?

This chapter is divided into five main sections; section one addresses the demographic data of the participants, section two addresses research question one and its discussion,

section three addresses research question two and its discussion, section four addresses research question three and its discussion and section five addresses research question four and its discussion.

4.2 Demographic Information about the Teachers

Information about the demographic background of teachers who were sampled for the purpose of this study covered the following characteristics; gender, age, and teaching experience. Since this study was about Mathematics discourse, teachers who were very experienced and have taught for at least five years were included. Again, teachers who had some expertise in discourse practices were purposefully sampled. Table 1 shows statistics of teachers‟ gender. 80 teachers representing 72.7% were males and 30 teachers representing 27.3% were females.

Table 4.1: Gender of Teachers

Gender	Frequency	Percent
Male	80	72.7
Female	30	27.3
Total	**110**	**100**

Table 2 shows the ages of teachers who took part in the study. Out of the 80 male teachers, 13 teachers were between the ages of 31 and 35; 25 between the ages of 36 and 40; 27 between the ages of 41 and 45 and 15 teachers between the ages of 46 and 50.

Again out of the 30 female teachers, 10 were between the ages of 31 and 35; 8 between 36 and 40; 9 between the ages of 41 and 45 and 3 were between the ages of 46 and 50.

Table 4.2 Shows the Ages of Teachers who took part in the Study.

Sex / Age	31 – 35	36 – 40	41 – 45	46 – 50	Total
Males	13	25	27	15	80
Females	10	8	9	3	30

Table 3 shows the experience of teachers sampled. The average teaching experience of teachers between the ages of 31 and 35 was 7 years, those between the ages of 36 and 40 was 11 years, 41 and 45 was 16 years and those between the ages of 46 and 50 was 20 years.

Table 4.3: Teaching Experience of Teachers

Ages (in years)	Experience (in years)
31 – 35	7
36 – 40	11
41 – 45	16
46 – 50	20

4.3 Demographic Information about the Students

Information about the demographic background of the students who were sampled for this study covered the following characteristics; gender and age. Since this study was about discourse, students who had studied Core Mathematics at the Senior High School for at least two years and had experienced different teaching methods and also exhibited some level of expertise in discourse were selected. Statistics gathered in Table 4 on gender of students showed 70 students representing 58.3% were males and 50 students representing 41.7% were females.

Table 4.4: Gender of Students

Gender	Frequency	Percent
Male	70	58.3
Female	50	41.7
Total	**120**	**100**

Table 5 shows the ages of the students. Out of the 70 male students 51 of them were 18 years old, 11 were 19 years old and 8 were 20 years old.

Out of the 50 female students, 37 were 18 years old, 8 were 19 years old and 5 were 20 years old.

Table 4.5: Ages of students who took part in the study.

Sex / Age (years)	18	19	20	Total
Males	51	11	8	70
Females	37	8	5	50

4.4 RESEARCH QUESTION 1: *What level of understanding of discourse do Mathematics teachers' exhibit in their teaching?*

This research question was designed to evaluate the level of understanding of Mathematics discourse by the teachers.

Table 4.6: Factors that affect Mathematics teachers discourse, *(N=110)*

Items	Variables	Agree		No view		Disagree	
		No.	%	No.	%	No.	%
1	Like to engage my students in Mathematics discourse	102	92.7%	0	0%	8	7.3%
2	Listening carefully to my students help them to express their thoughts	99	90%	4	3.6%	7	6.4%
3	Discourse does not help students to understand concepts better	3	2.7%	1	0.9%	106	96.4%
4	Students become aware that the ability to learn maths is a shared responsibility	100	90.9%	4	3.6%	6	5.5%
5	Questioning students help them to come out with their ideas	97	88.2%	5	4.5%	8	7.3%
6	Discourse does not involve students in the teaching and learning process	2	1.8%	1	0.9%	107	97.3%
7	Discourse improves students cognitive development	107	97.3%	0	0%	3	2.7%
8	Discourse motivates students to learn better	101	91.8%	2	1.8%	7	6.4%
9	Discourse does not give students confidence	3	2.7%	1	0.9%	106	96.4%
10	Discourse is better than traditional teaching	106	96.4%	2	1.8%	2	1.8%
11	Discourse does not enhance learning and socialization	5	4.5%	1	0.9%	104	94.6%

Table 4.6 shows that out of the 110 teachers who participated in the study 102 teachers representing 92.7% agreed that they liked to engage their students in Mathematics discourse while 8 teachers representing 7.3% disagreed.

Ninety-nine teachers representing 90% agreed that listening carefully to their students helped them to express their thought, 4 teachers representing 3.6% expressed no view and 7 teachers representing 6.4% disagreed. Out of the 110 teachers, 3 teachers representing

2.7% agreed that it did not help students to understand concepts better, 1 teacher representing 0.9% had no view and 106 teachers representing 96.4% disagreed.

Out of the 110 teachers, 100 teachers representing 90.9% agreed that students became aware that the ability to learn mathematics is a shared responsibility, 4 teachers representing 3.6% expressed no view and 6 teachers representing 5.5% disagreed. Nine seven teachers representing 88.2% agreed that questioning students helped them to come out with their ideas, 5 teachers representing 4.5% expressed no view and 8 teachers representing 7.3% disagreed. 2 teachers representing 1.8% agreed that it did not involve students in the teaching and learning process, 1 teacher representing 0.9% expressed no view and 107 teachers representing 97.3% disagreed.

One hundred and seven teachers representing 97.3% agreed that discourse improved students" cognitive development and 3 teachers representing 2.7% disagreed. Out of the 110 teachers, 101 of them representing 91.8% agreed that discourse motivated students to learn better, 2 teachers representing 1.8% expressed no view and 7 teachers representing 6.4% disagreed. Three teachers representing 2.7% agreed that it did not give students confidence, 1 teacher representing 0.9% expressed no view and 106 teachers representing 96.4% disagreed. Out of the 110 teachers, 106 teachers representing 96.4% agreed that discourse is better than traditional teaching, 2 teachers representing 1.8% had no view and another 2 teachers representing 1.8% disagreed. 5 teachers representing 4.5% agreed that it did not enhance learning and socialisation, 1 teacher representing 0.9% expressed no view and 104 teachers representing 94.6% disagreed.

4.5 Discussion of Findings

Research question one was designed to find out the level of understanding of discourse by teachers. It is evident in the results that the level of understanding of discourse by teachers was high. From the analysis above, it could be observed that teachers believed that discourse play a major role in the teaching/learning of mathematics. In particular, from table 4.6 above, it could be seen that the percentage of teachers who responded positively to each of the items on the questionnaire was very high which is very strong indication that teachers believed that mathematics classroom discourse is very significant in the teaching/learning of mathematics. Teachers believe that in the discourse classroom, learning occurs when students act and interact with each other, creating new knowledge together and learning from each other (Chapman, 2004). This suggests that in discourse classroom, the teacher facilitates and direct students in what to do and promotes participation and genuine interaction to encourage learning (Middleton & Jansen 2011). Teachers are not the source of knowledge in the classroom, but co-authors of knowledge with students by guiding students‟ attention towards the intended goal. In the discourse classroom teachers and students work together to bring forth a world of understanding and this common goal cannot be achieved if the teacher does not understand discourse (Chapman, 2004). The results are consistent with earlier findings by Hufferd-Ackles, et al, (2004) that teachers who are conversant with discourse engage their students in discussion in the mathematics classroom. This gives students the chance to explain their own mathematical thoughts, and make considerable contributions that can be questioned and built upon by other students. Walshaw and Anthony (2008) declare that teachers who understand Mathematics discourse are able to increase student communication of useful

mathematical reasoning which helps students to comprehend mathematics concepts. The inference is that students are occupied in learning communities in which all partakers have opportunities to take part in productive mathematical discourse (Manoucheri & St. John, 2006).

4.6 RESEARCH QUESTION 2: *What factors motivate Mathematics teachers to facilitate Mathematics discourse in the Senior High School mathematics classrooms?*

This research question was designed to identify factors that motivate teachers to facilitate discourse in the classroom.

The following question was posed to teachers: „How do you discuss mathematics with your students."

Responses are representative of all the teachers and students, with all names as pseudonyms.

Mr. Anokye: I pose questions that will move students from working individually to engage in discussions and helpful interaction. I also ask questions that are likely to cause students to think positively.

Mr. Boating: I ask students questions that expose and induce their Mathematical reasoning about important ideas.

Mrs. Owusu: I engage students in series of questions that will move them away from rote learning to developing conceptual understanding. I also ask questions that shift students" attention from the teacher as the only source of all mathematics ideas.

Mr. Piiga: I ask questions that enable students to explain their points well. I also ask questions that involve students in problem-solving skills. Again, I ask questions that

cause students to give simple and concise answers which will interest other students to join the discussion.

Mr. Adabor: Students are asked questions that enable them to connect new lesson to prior lesson. Also teachers ask questions that enable them to draw on the knowledge and the level of understanding of the students.

From the responses of the teachers it could be observed that teachers believed that questioning students is very important in the teaching and learning of Mathematics. It is clear from the responses of teachers that questioning is significant in the process of facilitating Mathematics discourse.

The following question was further posed to teachers: „what factors help you to facilitate discourse in the Mathematics classroom"?

Mrs. Owusu: I listen to my students which helps me to ask effective questions which in effect facilitate fruitful classroom discourse. Listening also enables the teacher to find out when discussion is effective or otherwise.

Mr. Boateng: Teachers can use questioning to facilitate discourse by asking student's questions that will cause them to think.

Mr. Piiga: Through discourse teachers can lead the students to discover things for themselves instead of telling them the correct answer.

Mr. Anokye: When students give wrong answers, the teacher can use that as an avenue to ask the class to investigate why the answer is wrong.

Mr. Adabor: Stressing on students points of view during discourse can be used to facilitate discourse in the classroom because as you do that students get the true meaning of what their friends say for better understanding.

From the teachers responses it could be observed that teachers could facilitate discourse through listening to their students effectively, using open-ended questions, repeating or stressing on students ideas, scaffolding and expanding on wrong answers.

4.7 Discussion of Findings

Teachers believe that discourse could be seen as a facilitator for the teaching and learning of mathematics. It could be observed in the teachers‟ responses that student engagement in meaningful mathematical discourse will have positive effect on their mathematical understanding (Lobato, Clarke & Ellis, 2005). As teachers incorporate discourse in their teaching, they need to have an idea for what meaningful discussion is and also be equipped on how to get the discussion going for students to enjoy. The main role of the teacher is that of decision maker or a facilitator. Teachers should make a decision on what to practice in depth, at what time and how to add mathematical information to learners‟ thoughts, what time to shed light on an issue, when to replicate, when to guide, when to let students struggle with difficulty, and how to support each student to take part. These decisions are central to effective discourse and remain crucial to the teaching of mathematics (Jacobs et al, 2006). Teachers need to understand the importance of communication in teaching and learning, be sensitive to the ways in which discourse is carried out in the classroom and appreciate students‟ dialogic practices (Jacobs et al, 2006). It is evident in the teachers responses that questioning is a very good ingredient in

the process of facilitating discourse. This finding is consistent with views of some prominent researchers (Smith, 1986; Steinberg, Empson, & Carpenter, 2004; Herbel-Eisenmann & Cirillo, 2009 and Cirillo, 2013). In order to keep teachers away from too much talk in the classroom, teachers should anticipate student answers and plan good open-ended questions prior to a lesson. Questions open the door for wealthy dialogue and allow students opportunity to present their own approach to the task in question, unless those tasks are not too difficult for the students‟ current mathematical level (Cirillo, 2013). Classroom interactions in the form of questioning provide a powerful way to review students‟ current knowledge and ways of reasoning and that probing students‟ questions is a significant feature when looking closely at classroom discourse (Steinberg, Empson & Carpenter, 2004). Open-ended questions are frequently better for opening conversation and maximising the probability of students to contribute to the dialogue. The result of this study confirms the effectiveness of questioning as a way of helping students build a strong mathematical understanding. Questioning helps teachers to facilitate many of the finest methods in teaching that formerly seemed disengaged and hard to understand. These conceptions are consistent with the view of (Smith, 1986).

The study also revealed that listening as an activity for facilitating discourse. This confirms assertion that teacher listening is a vital skill in the facilitation of efficient classroom discourse (Davis, 1997). Teachers‟ responses indicated that by listening carefully to students enable them to ask effective questions which facilitate fruitful classroom discourse and also are able to find out when discussion is effective and when teacher assistance is needed. Lobato, Clarke and Ellis (2005) affirm that listening to student ideas help teachers to decide when to step in and out of a conversation, when to

push for understanding, when to determine competing student claims, and when to address misunderstandings or uncertainties. Jacobs et al, (2006) stress that since students are encouraged to talk more in interactive classrooms, listening cautiously to student contributions is therefore an essential feature of mathematics classroom discourse.

Teachers conceived revoicing (repeating) as an important factor for facilitating discussion in the classroom. They viewed repeating what students say or stressing students‟ ideas in order to discuss a point with students or to add new points to what students say facilitate discourse in the classroom. This is consistent with the study conducted by Forman and Ansell (2001) and Empson (2003), which they claimed that teachers used revoicing to make individual student contributions available to all students in the class. Revoicing also allows teachers to act as facilitators, rather than the single validating power of student contributions, allowing individual students to uphold ownership of new ideas while setting a situation that enables students to echo each other‟s contributions (O‟Connor & Michaels, 1996). Students were more willing to provide clarifications of their reasoning in classrooms where revoicing was strategically put into practice by teachers. As a matter of urgency, teachers could use revoicing to capture student contributions and also re-express students‟ views in terms that are clearer and logical (Forman & Ansell, 2001).

Another significant feature of mathematics classroom discourse that teachers revealed was scaffolding. Scaffolding can be used by the teacher to facilitate discourse where teachers lead students through the learning process and allowing them to expand on their own thoughts instead of pointing out the correct answer to them. Scaffolding allows students to see mathematics as produced by group of people, supporting each other in the

learning process and involving them in the construction and validation of ideas, and helping them become aware of more conceptually complex forms of mathematical activity (Walshaw & Anthony, 2008). However, NCTM (2000) has revealed that scaffolding actually benefits lower ability level students by improving their sense of action. Through scaffolding, students learn processes on their own. Scaffolding can therefore be seen as a range of instructional methods used by teachers to move students towards stronger understanding and greater freedom in the learning procedure.

The study also revealed that by expanding on wrong student answers teachers could facilitate effective classroom discourse. It was clear from the teachers‟ responses that when students give wrong answers, teachers can cease that opportunity and ask the class to investigate why the answer is wrong. This is in support of Staples and Colonis (2007) assertion that rather, by allowing only correct solutions and approaches to surface in dialogue, teachers have to take steps to lessen the stigma attached to being wrong. Thus, teachers should explain to students that errors are part of the learning process. Exploring wrong solutions can serve as a catalyst for discussion. This can provide a spotlight to the conversation and engage students in outlining out why a suggestion does or does not make sense (Bochicchio et al, 2009).

4.8 RESEARCH QUESTION 3: *What level of understanding of Mathematics discourse do students' exhibit and what role does it play in students' Mathematics learning?*

This research question was to examine the level of understanding of Mathematics discourse by students and the role discourse play in their learning.

Table 4.7: Factors that affect Students discourse, *(N=120)*

Items	Variables	Agree		No view		Disagree	
		No.	**%**	**No**	**%**	**No.**	**%**
1	Discourse enhance learning and socialization	107	89.2%	4	3.3%	9	7.5%
2	Discourse helps to commit students to other members	94	78.3%	8	6.7%	18	15%
3	Teacher acts as facilitator	99	82.5%	7	5.8%	14	11.7%
4	Discourse does not improve cognitive development	13	10.8%	1	0.8%	106	88.4%
5	Classroom is well structured	99	82.5%	4	3.3%	17	14.2%
6	Discourse does not motivate me to learn	16	13.3%	2	1.7%	102	85%
7	Like discourse in the maths classroom	101	84.1%	2	1.7%	17	14.2%
8	Discourse helps to understand concepts better	104	86.7%	4	3.3%	12	10%
9	Discourse does not help to establish friendly relationship with classmates	18	15%	2	1.7%	100	83.3%
10	Discourse is better than individual work	110	91.7%	0	0%	10	8.3%
11	Discourse gives confidence to students	106	88.4%	1	0.8%	13	10.8%

Table 4.7 shows that out of the 120 students who participated in the study, 107 students representing 89.2% agreed that they experienced enhance learning and socialization when discourse was used, 4 representing 3.3% had no view and 9 students representing 7.5% disagreed. Ninety four students representing 78.3% agreed that they are committed to other members whenever discourse is used in the teaching and learning process, 8 students representing 6.7% expressed no view and 18 students representing 15% disagreed. Ninety nine students representing 82.5% agreed that teacher acted as facilitator, 7 students representing 5.8% had no view and 14 students representing 11.7% disagreed. Out of the 120 students, 13 of them representing 10.8% agreed that discourse did not improve cognitive development, 1 student representing 0.8% had no view and

106 students representing 88.4% disagreed. Ninety nine students representing 82.5% agreed that classroom is well structured, 4 students representing 3.3% had no view and 17 students representing 14.2% disagreed. Sixteen students representing 13.3% agreed that mathematics discourse did not motivate them to learn, 2 students representing 1.7% had no view and 102 students representing 85% disagreed. Out of the 120 students, 101 representing 84.1% agreed that they liked discourse in the Mathematics classroom, 2 students representing 1.7% had no view and 17 students representing 14.2% disagreed. One hundred and four students representing 86.7% agreed that discourse helped to understand concepts better, 4 students representing 3.3% had no view and 12 students representing 10% disagreed. Out of the 120 students, 18 of them representing 15% agreed that discourse did not help to establish friendly relationship with classmates, 2 students representing 1.7% expressed no view and 100 students representing 83.3% disagreed. One hundred and ten students representing 91.7% agreed that discourse is better than individual work and 10 students representing 8.3% disagreed. One hundred and six students representing 88.4% agreed that discourse gave confidence to students, 1 student representing 0.8% had no view and 13 students representing 10.8% disagreed.

4.9 Discussion of Findings

From the analysis above, it is evident that students understand that discourse is of great importance to their success in mathematics. Specifically, from table 4.7, it could be observed that majority of the students confessed that discourse is an effective approach to their learning. Those students who responded positively to each of the statement in the questionnaire was very high as compared to those who disagreed and those who remained undecided, which is very strong signal that students believed that understanding of

mathematics classroom discourse play a very significant role in the learning of mathematics. Discourse place students as active members in a community of learners. The conviction is that students‟ understanding of discourse will lead to the growth of specific students‟ competencies that are supposed to make a positive difference in their learning (Goos, 2004; Walshaw & Anthony, 2008). As students are occupied in mathematics classroom discourse, they have important prospect to go through tricks involving mathematical discourse and argumentation (Cobb, Wood and Yackel, 1992; Forman & Ansell, 2001; Goos, 2004; Sekiguchi, 2006; Walshaw and Anthony, 2008). They advocate that effective classroom discourse affords students opportunities not only to contribute their ideas in a mathematical community but also to examine and evaluate the thinking of their colleagues. The study has confirmed the earlier findings by Nathan and Knuth (2003) that understanding mathematics discourse is significant for successful student learning and that discourse has become a central point of teaching and learning of mathematics for the reason that it is through meaningful discussions about mathematics that students make meaning. The findings are consistent with Blanton et al, (2005) who envisage the importance of mathematics discourse by stating that discourse informs not only our understanding of learners‟ thinking about mathematics, but also teachers‟ thinking about teaching mathematics and again recognised that the mathematics classroom should reflect an intended attempt to learn about a concept or procedure that has become challenging. NCTM (2000) acknowledges that, the understanding of discourse is important by stating that the nature of classroom discussion is a major influence on what students learn about mathematics. Cobb et al, (1992) observe mathematical dialogue as an opportunity that results in collective construction of

mathematical knowledge emphasising the significance of discussion in the improvement of students and teachers‟ mathematical content knowledge. This study has depicted understanding of discourse as constructive for the reason that students construct learning from what others think or believe (Simon, 1995; Nathan & Knuth, 2003). Similarly, Cobb et al, (1997) posit that understanding of discourse leads to joint construction of knowledge by students during classroom discussion which results in a collective reflection. Lampert (1990) on the other hand expresses that understanding mathematical discourse allows joint knowledge construction to take place among students rather than independently between the teacher and student.

During the interview, the following question was posed to students: „Why do you like Mathematics discourse‟?

Ernest: If students are involved in discourse, it means that many of them will bring out their ideas during the discussion which help us to acquire information from different students thereby helping us to respond to questions adequately.

Robert: If you are taught through discourse you get information from different sources which help you to understand mathematics well, so that anywhere you go you will be able to solve problems that you face whether in the school or in the house.

Owusuaa: When you are engaged in discourse you get ideas from different students which help you to explain and justify your solutions when you are asked to do so.

John: If you are involve in discourse you get ideas from different students which help you so that you will not be sitting there while the other students are talking, you actually get involved and engaged in what is happening in the classroom.

From the students‟ responses, it could be observed that discourse help students to obtain more information from colleagues thereby assisting them to understand Mathematics concepts.

The following question was further posed to students: "What benefit do you obtain when you engage in Mathematics discourse?"

John: Discourse facilitates learning because it improves students‟ mathematical reasoning and encourages students to work together. Taking part in discourse also helps lift the level of reasoning among students.

Owusuaa: Discourse motivates me to learn well because when you see every student taking part in the discussion, it gives you some kind of hope and strength to participate. It makes you feel comfortable and removes fear from you. As a result of this, it makes you understand the lesson very well. Again, discourse helps to improve your thinking abilities because through discourse you get ideas from so many students which aid you to develop your own thereby facilitating learning.

Ernest: Discourse helps you to be confident in yourself and as a result you make sure to take part in every discussion that occurs in the classroom, this makes learning easy for us. Also, because everybody becomes confident in himself it creates competition in the class which leads to healthy discussion.

Robert: Discourse helps to set up friendly association with classmates which facilitate learning. This is because as we argue and justify our ideas it creates understanding between us and as a result we become friends. Again, discussion help students to realise that mathematics is part of everyday life so we are not afraid of the subject and therefore we develop interest in it.

Hannah: Discussion develops students‟ mathematical thinking because it supports students to work as a group to construct their own knowledge.

It is clear from the students‟ responses that discourse plays several roles in students Mathematics learning. These include: discourse improves students‟ mathematical reasoning; it motivates students; it makes students confident and also it helps to establish friendly relationship among students.

Discussion of Findings

It is evident in the students responses that discourse could be seen as a catalyst that facilitates mathematics learning. Discourse helps students to express their mathematical thoughts accurately, share their mathematical idea sensibly and clearly to their colleagues and the teachers (Blanton et al, 2005). Moreover, discussion that gets the students to be involved in the mathematics classroom, develop ideas, and question each other fruitfully has a constructive impact on mathematics understanding (NCTM, 2000).

From the students‟ responses, it was revealed that Mathematics discourse plays several roles in facilitating students learning. One of such roles is that Mathematics discourse improves students‟ mathematical reasoning. This is consistent with the study by De Fina (2011) that revealed that students progress through Mathematics discourse because it

improves cognitive growth and social improvement. Yackel, Cobb and Wood (1991) stress that discussion extracted from the classroom situation encourage and support students to work together to construct knowledge. Students‟ interaction helped lift the level of cognitive talk among students that would not have been achieved without group interaction (Rowe & Bicknell, 2004).

Students conceived that Mathematics discourse motivates them to learn better. This confirms Middleton and Jansen (2011)‟s assertion that discussion motivates students to learn by suggesting that teachers should make efforts to engage their students in class by persuading them that contributions will help progress the students‟ knowledge. If teachers are able to do this, more students will feel comfortable and courageous enough to contribute to classroom discussions.

The study revealed that Mathematics discourse makes students confident. It is evident in the students‟ response that discussion helps to build strong confidence in students. This view is consistent with the claim that self-efficacy (confidence) plays an essential function in students in order to be successful in mathematics, emphasising that students with high self-efficacy usually achieve more academic success than those with low self-efficacy. Teachers are therefore required to boost the confidence level of their students during discourse (Bouffard-Bouchard, Parent and Larivee, 1991; Multon et al., 1991; Pajares and Graham, 1999).

Students conceived that Mathematics discourse can also be said to increase social capital, in other words Mathematics discourse enables students to establish friendly relationship among them. Through Mathematics discourse students get to know each other better and create friendly atmosphere in the classroom. This supports Putnam (1995) description of

social capital as an aspect of social association such as networks, norms, and social trust that smoothes the progress of coordination and teamwork for a common benefit. As students argue and justify their ideas it creates understanding between them and as a result it builds cordial relationship among them.

4.10 RESEARCH QUESTION 4: *What challenges do Mathematics teachers encounter when engaging students in Mathematics discourse?*

This research question was designed to investigate the challenges teachers encounter when engaging students in discourse.

During the interview teachers were asked the following question: "Why do you feel reluctant in engaging your students in Mathematics discourse?" The common theme that was identified from teachers" responses was that, „They face problems when engaging students in Mathematics discourse". Below are the representative teacher responses.

Mrs. Owusu: Engaging students in discourse wastes time because it does not help me to finish my syllabus.

Mr. Piiga: In my training as a teacher I was never involved in discourse so at times I find it difficult to practice it in the classroom. Again, it is also time consuming.

Mr. Boateng: Some teachers find it difficult to engage their students in discourse because they do not have the required facts about the topic to carry out discourse in the classroom. Also, students sometimes make noise when you engage them in discourse.

Mr. Anokye: If discourse is not planned well, always the good students dominate all discussions in the classroom while the other students do not take part.

Mr. Adabor: It is difficult to involve timid students in discourse because they always feel shy to talk in the classroom.

Learning to communicate mathematically is at the heart of deepening understanding in mathematics for teachers and students, but teachers find it difficult to engage students in meaningful mathematical discussions. It could be observed from the teachers‟ responses that there are challenges associated with discourse, these includes: discourse is time consuming; some teachers never experienced discourse during their training as teachers; difficulty to involve timid students in discourse; some teachers do not have the requisite content knowledge to carry out discourse in the classroom and if discourse is not planned well, always the brilliant students dominate all discussions in the classroom.

4.11 Discussion of Findings

Teachers made mention of challenges they encounter when engaging students in their responses. It was clear in the teachers‟ responses that engaging students in Mathematics discourse is time consuming and as such it does not help them to complete their syllabus. This is consistent with Black (2004)‟s assertion that the time required for the facilitation of Mathematics discourse has been identified by teachers as a setback to implementing mathematics classroom discourse. That is why it is not surprising that the traditional method of teaching mathematics is very common in most Ghanaian classroom.

Teachers also conceived that some of them never experienced Mathematics discourse during their training as teachers and as a result they find it difficult engaging their students. This confirms Anderson and Piazza (1996)‟s statement that the major problem with Mathematics discourse comes from teachers trying to teach mathematics in ways

they did not encounter as students. Teachers do not feel comfortable when trying to facilitate Mathematics discourse in the classroom (Bruce, 2005).

Another challenge teachers talked about during the interview was the fact that some teachers do not have the requisite content knowledge to carry out discourse in the classroom. Difficulty of some Mathematics teachers to thoroughly master the concepts in Mathematics content makes teachers reluctant to adopt Mathematics discourse strategies in teaching. It is therefore important for teachers to apply their own professional knowledge and understanding of pupils, curriculum, instructional activities, and classroom organisational plans to support mathematics classroom discourse (Bibby, 2000).

Teachers also lamented that it is difficult to involve timid students in Mathematics discourse because they always feel shy to talk in the classroom. However, Manouchehri and St. John (2006) made it clear that by encouraging students to express what they mean and repeat what their colleagues have said, teachers can make it easier for timid students to contribute during classroom discussion. This is based on the principle that openly referencing and building on the ideas of others, is a characteristic of academic and proficient discussions (Choppin, 2007).

Teachers made it clear during the interview that if Mathematics discourse is not planned well, the brilliant students will always dominate all discussions in the classroom, whiles the rest of the students will be left behind. This is in consistent with Mulyran (1995)'s claim that low ability level students are less actively involved in discourse than high ability level students. Teachers who use mathematics classroom discourse need to be

aware of every student's patterns of working and take steps to promote more active involvement by all students and especially low ability level students (Mulyran, 1995).

CHAPTER FIVE

SUMMARY, CONCLUSION AND RECOMMENDATIONS

5.1 Overview of the Study

This chapter provides the conclusion of the whole research study. It includes a summary of the findings and highlights its educational implications. It further outlines some recommendations and suggestions for further research studies.

The study investigated how mathematics classroom discourse is facilitated by teachers, the role Mathematics discourse play in students‟ mathematics learning and the challenges teachers encounter when engaging students in Mathematics discourse in Ghana. Mixed method design was used as the research design for the study; data collected for the study was both quantitative and qualitative. Quantitative data was used to investigate the level of understanding of Mathematics discourse by both teachers and students. Qualitative data on the other hand was used to investigate the views and thoughts of both teachers and students on Mathematics discourse. The target populations for this study were mathematics teachers and Form three students in the Senior High Schools in the Subin sub-Metro of the Kumasi Metropolis in the Ashanti Region of Ghana. Samples used for the purpose of the study were made up of 110 teachers and 120 students. The study was guided by research questions stated in the summary of key findings of the study below. Instruments that were used in the collection of data were basically, questionnaire (open ended and closed-ended). Analyses of data were based on both descriptive statistics and thematic analysis of interviews results.

5.2 Summary of key findings

5.2.1 Research question one: *What level of understanding of Mathematics discourse do Mathematics teachers exhibit in their teaching?*

Based on this research question, the underlisted findings emerged.

Teachers understood that:

- Mathematics discourse facilitates the teaching of Mathematics.
- Mathematics discourse puts the task for learning directly on students to bear.
- It helps students to explain their own Mathematical thought.
- Mathematics discourse helps students to understand concepts very well.

This research has shown that if teachers are to develop their beliefs, knowledge and practice in relation to effective classroom discourse it will help them to engage their students effectively in the classroom. Teachers should note that they need to gain a clear understanding of Mathematics discourse and its significance in the classroom, be aware of what substantive Mathematics discourse is, what discourse looks like in the context of whole-class discussions and how productive discourse significantly improves students" interactions and opportunities for learning. They need to know how to create a classroom culture that is supportive of substantive talk and how to use teacher questioning and discourse moves to generate and manage communication in the classroom.

Teachers need to be aware of how to match their communicative approach to the instructional focus of the lesson and the phase of inquiry so that they progress the discourse from simply engaging students and exploring their ideas to supporting them to develop clear explanations and reasons for their findings.

5.2.2 Research question two: *What factors motivate Mathematics teachers to facilitate Mathematics discourse in the Senior High School mathematics classrooms?*

Based on this research question, it was observed that teachers could facilitate discourse by.

- Listening to students effectively.
- Using open-ended questions.
- Repeating or stressing on students ideas.
- Scaffolding.
- Expanding on wrong answers.

Discourse requires that teachers devote time to talking with and listening to their students so that they can shape their teaching in a way that is responsive to students‟ needs. Such an outcome suggests that teachers‟ efforts would be well rewarded if they concentrated their focus away from just getting things done to an area where taking time to conduct planned and purposeful discussions. This is seen as a legitimate and essential element of effective classroom discourse.

It was observed that if teachers facilitate Mathematics discourse very well, they can surely lift up the worth of student learning. In addition, teachers play a central role in sustaining classroom interactions and directing classroom discussions by asking appropriate questions for students to carry out Mathematics discourse. Involving students in problem solving, searching appropriate situations, and giving students‟ time to discover, build, converse, argue, conjecture, and investigate, teachers arouse deeper student insight and understanding of mathematics.

5.2.3 Research question three: *What level of understanding of Mathematics discourse do students' exhibit and what role does discourse play in students' Mathematics learning?*

With reference to this research question, the following findings were observed:

- Mathematics discourse facilitates learning process.
- Mathematics discourse exposes students reasoning in a manner that give teachers chance to respond with appropriate answers.
- Learning is a mutual duty between teachers and learners and also between students and their colleagues.
- Learners become aware of the significance of reasoning for themselves.
- Mathematics discourse helps students in the following ways:

  i. Discourse improves students" mathematical reasoning.

  ii. It motivates students.

  iii. It makes students confident.

  iv. It helps to establish friendly relationship among students.

It was observed that comprehensive classroom discourse is fundamental to students" mathematics learning. Facilitating courteous interactions in the classroom contributes to the enhancement of student learning. It is therefore worth every teacher"s efforts to try to improve the amount of student discourse in the mathematics classroom. No matter the style of teaching or the type of mathematics classroom that exists, it is believe that every student could benefit from improved student discourse. The results of this study support the notion that it is important for every teacher to try to incorporate as much student

discourse into the classroom as possible. It should be noted that, it is not just getting students to talk more, but rather the organisation of the Mathematics discourse must be purposeful and it must be academically productive in that it supports the development of students‟ reasoning and students‟ abilities to express their thoughts clearly. Teachers must be aware that meaningful talk goes on in the classroom, so that students will understand mathematics concept being discussed.

Engaging students in conversation in the Mathematics classroom is a significant method for the teaching and learning of Mathematics and also for theoretical understanding. Communication in Mathematics classroom is central for ideas to become matters of reflection, refinement and amendment. That is, the vehicle that supports understanding of mathematical concepts is the capability to communicate mathematically in the classroom.

5.2.4 Research question four: *What challenges do Mathematics teachers encounter when engaging students in Mathematics discourse?*

With reference to this research question, the following findings were observed.

1. Problem with teachers trying to teach mathematics in ways they did not experience as students.
2. Difficulty for some Mathematics teachers with their own level of mathematics content knowledge.
3. Absence of negotiation of Mathematics discourse in the classroom which requires facilitation skills and keen attention.
4. Time required for the facilitation of Mathematics discourse has been identified by teachers as a setback to implementing mathematics classroom discourse.

5. Low ability level students are less actively involved than high ability level students.

Identifying and describing the mathematical challenges that teachers face in relation to using Mathematics discourse in the classroom represents an important step for improving mathematics instruction. Providing strategies, tools, and resources that support classroom organisation and behavior management will help teachers experience fewer barriers when using discourse practices in their instruction. By explicitly teaching students self-regulatory and social skills, teachers may be better able to facilitate mathematical discourse and promote challenging problem solving activities in the classroom.

In addition to ensuring that teachers develop the essential content knowledge necessary for teaching and training, professional development programs should provide ample opportunities for teachers to improve their day-to-day classroom practices and social interactions with children.

5.3 Educational Implications

Current belief in mathematics education is that students need to be active learners instead of being passive participants of mathematical concepts. It could be observed from this study that a number of studies in the mathematics education community have recommended that the teaching of mathematics should be done through discourse.

Classroom work is made inspiring when dialogue involves the courteous exchange of ideas, when teachers make sure that this exchange involves all students, and when the ideas being discussed are proportionate to mathematical principles and curricular objectives. Teachers should make sure that mathematics classroom discourse involves a

continued push for validation and explanation, as well as to know when to mediate and when to step out.

Teachers should be sensitive in providing opportunities for students to discover mathematics through a variety of discursive situations that contribute to the development of social and cognitive engagement. The most successful settings offer a balance between opportunities for students to gain from their peers involvement in dialogue. The tasks that teachers plan, and the kinds of mathematical discourse that take place around those tasks, are significant to learning.

Excellent teaching at all stages ensures that mathematical discourse is not just time filler but is focused instead on the answer of an actual mathematical problem. The most prolific discourse is that which allows students to access vital mathematical concepts and relationships, to explore mathematical structure, and to use methods properly. When teachers use classroom discourse for these purposes over continued periods of time, they give students opportunities for success, they present a fitting level of challenge, they increase students‟ sense of control, and they improve students‟ mathematical outlook.

The efficient use of classroom discourse makes students‟ mathematical reasoning noticeable and open for reflection. In a situation where thoughts are shared, students own ideas develop into assets for their own learning. In addition, their justifications motivate, challenge, and extend other students‟ reasoning.

Teachers need to know what discourse really is, what it looks like in the context of whole-class discussions and how productive discourse significantly improves students‟ interactions and opportunities for learning. They need to know how to create a classroom

culture that is supportive of substantive talk and how to use teacher questioning and discourse moves to generate and manage substantive discussion.

Teachers need to know how to match their communicative approach to the instructional focus of the lesson and the phase of inquiry so that they progress the discourse from simply engaging the students and exploring their ideas to supporting them, to develop clear explanations and reasons for their findings.

5.4 Conclusion

In conclusion, the quality of student learning is linked with the quality of classroom discourse. Teachers should attach more significance to Mathematics discourse during classroom contact. Teachers should act more often as mentors but not just mere transmitters of knowledge; they should support students to create their own learning patterns and to search for alternative solutions. Moreover, spoken tasks should be given greater importance than it is in the usual proportion of verbal and written tasks. If teachers can develop the quality of classroom discourse, they can definitely lift the quality of student learning.

Teachers who put into practice classroom discourse must unavoidably focus on building community, making sure that students within the community are given chances to talk about, sustain, and care for each other‟s learning. This study has provided an organised and convincing evidence base on quality discourse in mathematics classrooms and explains the kind of instructive approaches that lead to improved involvement and pleasing outcomes for students from varied social groups.

The study has expanded the understanding of mathematics discourse practices in many ways. It has been observed that inclusive classroom corporations are basic to effective teaching. Facilitating discourse in the classroom add to the improvement of students‟ aspirations, attitudes, and achievements. Teachers who set up circumstances that is favorable for classroom discourse come to appreciate their students better. Through students‟ focused participation in discourse, through listening politely to other students‟ ideas, through arguing and defending their own point of views, and through receiving and providing a critique of ideas, students improve their own knowledge and build up their mathematical identities.

The findings of this study emphasise that decisions that teachers‟ make, relative to Mathematics discourse, considerably controls learning. Also, emphasised in this study is the fact that discursive situations that are wealthy in cognitive skills for all students sustain the growth of creative reasoning. Teachers who are able to provide such situations concurrently increase students‟ sense of control and build up important student mathematical outlook. It could be seen that classroom task is made more interesting when discourse involves building together mathematical concepts through courteous exchange of ideas. Although Mathematics classroom discourse appears to have positive effects on students‟ conceptual understanding of mathematics, however, there are also challenges associated with it. Teachers must therefore be vigilant in coordinating Mathematics discourse. As teachers work to build up comprehensive corporation for the exchange of ideas, they should make sure that the ideas they put forward are balanced with mathematical rules and curricular objectives.

5.5 Recommendations

From the findings of this study, the following recommendations are made:

Mathematics teachers should encourage and stimulate students‟ to actively participate in the teaching and learning process.

Mathematics teachers should be proactive in promoting a classroom atmosphere free from intimidation and fear to motivate many students to be actively involved in the teaching and learning process.

Mathematics teachers should be confident to introduce teaching and learning strategies that will get their students more involved in their lessons.

Teachers should learn to act as mathematical artists so that they can inculcate the joy of mathematics into students.

Teachers should consider the effect of their own actions on Mathematics discourse so that they could increase the possibility that learning through discourse will take place as they imagined.

Students must be given more opportunity to think for themselves during discourse.

Teachers should make sure that lesson delivery becomes a shared responsibility between the teacher and the students.

Discourse should be carried out in the classroom in such a way that it acts as the vehicle that supports understanding of mathematical concepts and enables students to communicate mathematically.

Educators and policy-makers, who are in charge for developing teachers, should try to bring innovations in the training of teachers in order to help handle the complex nature of teaching.

5.6 Suggestions for further studies

The study examined Senior High Schools Mathematics classroom discourse without an examination of the classroom conditions. The classroom condition is therefore worth studying to make our understanding of discourse complete.

The study covered only five Senior High schools in the Kumasi Metro because of proximity, and time constrains. The research design could be modified so that more schools could be used to give a wider view on discourse.

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APENDICES

Appendix A

Individual Students Questionnaire

Directions for Students

This questionnaire contains statements about discourse practices which could take place in the mathematics classroom. You will be asked how you agree or disagree to each of the statements. There are no 'right' or 'wrong' answers. Your responses will be treated as confidential and will only be used for the purposes of this research. Be sure to give a response for all statements. If you change your mind about any response, just cross it out and tick another.

Please give your opinion about all statements by ticking the box against your response.

Note that each statement is about Mathematics classroom discourse.

Section A: Demographic Data

Name of student:

Class:

Date:

Age:

Sex: Male [ ] Female [ ]

Section B: Closed – ended questionnaire

Items	Variables	Agree	No view	Disagree
1	Discourse enhance learning and socialization			
2	Discourse helps students to be committed to other members			
3	Teacher acts as facilitator			
4	Discourse does not improve cognitive development			
5	Classroom is well structured			
6	Discourse does not motivate me to learn			
7	Like discourse in the maths classroom			
8	Discourse helps to understand concepts better			
9	Discourse does not help to establish friendly relationship with classmates			
10	Discourse is better than individual work			
11	Discourse gives confidence to students			

Section C: Open – ended questionnaire

Use two or three sentences to answer these questions.

1. Why do you like mathematics discourse?

2. What makes you keenly participate in mathematics classroom discourse?

3. What benefit do you obtain when you are engaged in mathematics discourse?

Appendix B

Teachers Questionnaire

This questionnaire contains statements about discourse practices which could take place in the mathematics classroom. You will be asked how you agree or disagree to each of the statements. There are no 'right' or 'wrong' answers. Your responses will be treated as confidential and will only be used for the purposes of this research. Be sure to give a response for all statements. If you change your mind about any response, just cross it out and tick another.

Please give your opinion about all statements by ticking the box against your response.

Note that each statement is about Mathematics classroom discourse.

Section A: Demographic Data

Name of teacher:

Date:

Number of years of teaching:

Sex: Male [ ] **Female** [ ]

Age: *Tick the range you fall within.* (31 – 35), (36 – 40), (41 – 45), (46 – 50)

Section B: Closed – ended questionnaire

Items	Variables	Agree	No view	Disagree
1	Like to engage my students in discourse			
2	Listening carefully to my students help them to express their thoughts			
3	Discourse does not help students to understand concepts better			
4	Students become aware that the ability to learn maths is a shared responsibility			
5	Questioning students help them to come out with their ideas			
6	Discourse does not involve students in the teaching and learning process			
7	Discourse improves students cognitive development			
8	Discourse motivates students to learn better			
9	Discourse does not give students confidence			
10	Discourse is better than traditional teaching			
11	Discourse does not enhance learning and socialization			

Section C: Open – ended questionnaire

Use two or three sentences to answer these questions.

1. How do you discuss mathematics with your students?

2. What factors help you to facilitate discourse in the mathematics classroom?

3. Why do you feel reluctant in engaging your students in mathematics discourse?