AN INVESTIGATION INTO THE FACTORS IMPACTING ON THE SELECTION AND ADOPTION OF CONSTRUCTIVIST TEACHING METHODS BY MATHEMATICS TEACHERS IN SELECTED GAUTENG URBAN SCHOOLS

by

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DECLARATION

Student Number: 4804 175 0

I declare that **AN INVESTIGATION INTO THE FACTORS IMPACTING ON THE SELECTION AND ADOPTION OF CONSTRUCTIVIST TEACHING METHODS BY MATHEMATICS TEACHERS IN SELECTED GAUTENG URBAN SCHOOLS** is my own work and that all the sources that I have used or quoted have been indicated and acknowledged by means of complete references.

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Signature

MR I. MOYO May 2014

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KEY TERMS

Constructivism

Problem Solving

Problem Centred Learning

Problem Based Learning

Teaching

Learning

Teaching Methods

ABSTRACT

Constructivist teaching strategies are undeniably accepted as effective in achieving the desired educational goals of constructing knowledge through active and creative inquiry. Inasmuch as teachers would love to adopt these strategies in their teaching, mathematics teachers find themselves in a situation where they are forced not to use them. This study investigated the factors that impacted on the selection and adoption of constructivist teaching strategies in selected Gauteng's urban schools. Four (4) public schools and sixteen (16) mathematics teachers participated in the study. The parallel mixed methods design was employed in the study to produce both quantitative and qualitative data. The data were therefore analysed both quantitatively and qualitatively. It was found that the participating mathematics teachers had an understanding of constructivist theories of teaching and that they perceived their classroom environments to be constructivist in character. The study also found that the adoption of constructivist teaching strategies was hindered by teachers' lack of skills and competencies to handle a curriculum that they felt was handed down to them without their full involvement at all the stages of its development. Learners' family backgrounds were also identified as a major social factor that impacted negatively against selection of constructivist strategies. Based on these findings, recommendations were made on how constructivist views can be realised in the teaching of mathematics in South African schools.

LIST OF ABBREVIATIONS

CAPS – Curriculum Assessment Policy Statement

CASS – Continued Assessment

CCK – Common Content Knowledge

DBE – Department of Basic Education

DoE – Department of Education

GDE – Gauteng Department of Education

FET – Further Education and Training

KCS – Knowledge of Content and Students

KCT – Knowledge of Content and Teaching

MEC – Member of Executive Council

MKT – Mathematical Knowledge for Teaching

NBT – National Benchmark Test

NCS – National Curriculum Statement

OBE – Outcomes Based Education

PCK – Pedagogical Content Knowledge

PK – Pedagogical Knowledge

SCK – Specialised Content Knowledge

SSIP – Secondary Schools Intervention Programme

TIMSS – Trends in International Mathematics and Science Study

ZPD – Zone of Proximal Development

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CHAPTER 1: INTRODUCTION AND CONTEXTUALISATION OF THE STUDY

1.1 BACKGROUND TO THE STUDY

South Africa faces some challenges in the area of improving its education system following many years of apartheid. There is adequate evidence that the Gauteng Provincial Government is doing the best it can to try and bring the standard of education in the province to international and acceptable standards. The Gauteng Member of Executive Council (MEC) for Education, Barbara Creecy, is quoted as suggesting that the Gauteng Department of Education (GDE) "is making strides in improving education" in the province (Khumalo, 2012). Some of the areas of improvement the MEC alludes to are the areas of teacher support and learner performance. Up to 6496 teachers in Gauteng were supplied with lesson plans and training to help them handle primary school education, and 6765 Further Education and Training (FET) educators were trained in science and mathematics in 2010/2011 (Khumalo, 2012). Furthermore, the Secondary Schools Intervention Programme (SSIP) by Government is considered as one contributing factor to the 81.1% pass rate by learners in the province in 2011 (Khumalo, 2012).

At national level, the Presidential spokesperson, Mac Maharaj, suggests, however, that the teaching of Mathematics and Science still needs a lot of attention, and he argues that the passes obtained by learners are not of university standard (SAnews, 2012). This suggests that school systems are not effective in addressing issues of learner competence and performance that matches university requirements.

There is evidence of on-going concern about South African education both domestically and internationally. Recently, President Jacob Zuma was invited to be part of the United Nation's Education First Initiative which focuses on quality and relevant education in the world (SAnews, 2012). This suggests that the South African education system needs to catch up with international standards as well as match up with global trends. In 1995, 2002 and 2011 South Africa participated in the Trends in International Mathematics and Science Study (TIMSS) (Reddy, van der Berg, van Rensburg & Taylor, 2012). In all cases, Grade 8 and Grade 9 learners from South Africa achieved low averages in mathematics and science achievement tests. In 2011, out of 42 countries that participated in the TIMSS, South Africa achieved a score of 356 and this placed the country two places from the bottom (Reddy et al., 2012). Dennis and Murray (2012) found out in their study that first year students who

registered at the University of the Free State (UFS) in 2009 had difficulties in mathematics and this made it impossible for them to cope with first year university mathematics without some kind of intervention program. This finding was consistent with the findings of the 2009 National Benchmark Test (NBT) which showed that 92% of high school graduates who applied for university entry in 2010 were not competent enough to cope with university mathematics expectations without support (Dennis & Murray, 2012).

Academic performance is affected by several factors. Reddy et al. (2012), suggest that some of these factors that affect academic performance are social and include the prevailing school climate, teacher qualifications, classroom resources, learners' home environment and learner attitudes. For example, reports of violence, abuse and misconduct that have been reported in some South African schools (Prinsloo, 2005) potentially have a negative impact on academic performance. According to Reddy et al. (2012), the perceived safety of schools by learners affects academic performance. This suggests that mathematics learning can also be explained in the light of the climate that exists in schools and in society at large.

Reddy et al. (2012), report that 60% of the learners who participated in the TIMSS in 2011 were taught by teachers who had not yet completed their degree studies. This is a strong factor in determining quality learning.

Scarcity of resources at schools is among the reasons cited by Reddy et al. (2012), as to why learners' achievement is low in mathematics and science. Reddy et al. (2012), state that 87% of the schools that participated in TIMSS 2011 reported that they were not adequately resourced.

The issue of language can also be cited as a possible cause for poor achievement (Reddy et al., 2012). For most learners, the English language used in tests is not the same language used at home. This is likely to pose problems for learners of mathematics.

Farooq and Shah (2008), in their study found that learners' success in mathematics depended on their attitudes towards the subject. Learners themselves may lack self-confidence in handling mathematics and such an attitude is likely to affect their achievement in mathematics.

There are many theories of learning that have been proposed and developed by educationists and psychologists, and all of them aim at finding the best approach to the teaching and learning of school subjects, mathematics included. The constructivist teaching and learning

theory is one of the many theories that seek to address the question of learner performance. The current study seeks to investigate the factors that impact on teacher selection and adoption of constructivist teaching methods in mathematics in selected Gauteng schools in South Africa. The study will confirm whether some of, or all of, the factors highlighted above have any impact on the selection of constructivist strategies by mathematics teachers in Gauteng, as well as establish whether there are other factors that need to be taken note of. Research has shown that constructivist teaching models are superior to traditional teaching models in terms of the quality of learning outcomes they are capable of achieving, and that educators generally agree that active learning methods are more beneficial than traditional teaching methods (Mpofana 1997, Anyanwu 2008, Alemu 2010, Woolfolk 2010). The constructivist strategies of teaching cited by these researchers emphasise active learning, an approach to teaching that places the learner, instead of the teacher or the curriculum, as the centre of the learning process (Woolfolk 2010, Alemu 2010). According to Brooks and Brooks (1993), the teacher's role in constructivist teaching and learning strategies is that of a mediator rather than the transmitter. The following characteristics are suggested as descriptors of a constructivist learning environment:

- Learner autonomy is encouraged. Learners must be afforded the opportunity to generate new ideas.
- Raw data and Interactive materials are used. Learners are afforded the opportunity to interact with the real world and to extract knowledge from their own points of views.
- Learners drive the lesson. It should be possible for the direction of the lesson to be altered by learners' responses and reactions.
- Learners' conceptual understanding must be considered ahead of the teacher's understanding. The teacher must not be in a hurry to provide his or her own ideas before considering the learners' understanding.
- Encourage interaction. Learners must work collaboratively and share ideas with the teacher and amongst themselves.
- Encourage student inquiry. The teacher must pose questions that provoke inquiry.
- Encourage discussion. Learners must be encouraged to think hypothetically and critically by providing them with situations that allow diverse thinking.

- Encourage formation of patterns. Learners must be given the opportunity to work out relationships between or among the variables being studied. (Brooks & Brooks, 1993:2)

Constructivist models, therefore, emphasise learner-centred strategies of teaching which empower learners to acquire knowledge by creating it themselves.

However, findings of a study by Waghorn and Stevens (1996) show that there is a mismatch between theory and practice because despite the fact that teachers embrace the principles of constructivist theories, they do not always succeed in employing them in practice. Some factors that lead to the abandonment of a preferred teaching strategy are cited by Waghorn and Stevens (1996:76) as the "direct contradiction between their (teachers') ideas and those of their supervising teacher and conflict with the wider school timetable". Another reason given by Waghorn and Stevens (1996:79) for failure to adopt a preferred method of teaching is the "lack of communication between educational research and teacher decision making". In other words, teachers have a challenge when it comes to putting into practice methods that are theoretically accepted as beneficial. An understanding of those factors that cause teachers to fail to employ constructivist models will help mathematics educators and other stake holders in mathematics education to find ways of dealing with such challenges.

Classroom practice is considered in the current study as an important variable in determining solutions that mathematics education seeks to find. Achievement in mathematics is, hypothetically, influenced by classroom practices. The current study, therefore, seeks to understand the factors that impact on the mathematics teachers of the selected schools in the creation and adoption of constructivist teaching models in their quest to adapt to international standards of classroom practice. Finding answers to this question will inform stake holders on the challenges faced by mathematics teachers in South Africa when adopting a constructivist approach in their teaching and learning.

1.2 PROBLEM STATEMENT

The foregoing discussion shows that teaching of mathematics is not a simple skill because many intertwined variables like learners, methods, content and teachers' competencies come into the picture. South Africa's constitution seeks to pursue national goals that are in line with democracy, and the Bill of Rights is perceived as the cornerstone of democracy (Constitution of the Republic of South Africa, 1996). The many years of apartheid destroyed people's lives

and humanity, and the undertaking by the current government to address colonial imbalances of the past is reflected in the country's education policy documents. The National Curriculum Statement (NCS) (DoE, 2007) and the Curriculum Assessment Policy Statement (CAPS) (DBE 2011a, 2011b), which is an amendment of the NCS, were therefore designed along the perceived principles of constructivism. A successful implementation of these statements will hopefully produce adequately trained citizens who will fit easily into the new South Africa. The National Curriculum Statement (DoE, 2003 & DoE, 2007) and subsequently, CAPS (DBE, 2011a, 2011b) were developed to address several issues that the Constitution of South Africa seeks to address, namely, to address past injustices, to build a democratic society, to improve the quality of life and to bring South Africa to fit into the global family (DoE, 2003, DBE, 2011a, DBE 2011b). It is also envisaged that the product of this education system will be a citizen who fits well into the global family. The National Curriculum Statement goes further to state that Outcomes Based Education (OBE) forms the foundation for the South African Curriculum (DoE, 2003). The critical outcomes of this curriculum include problem solving skills, decision making skills, analysis skills, evaluation skills, communication skills and responsibility (DoE, 2003 & DBE 2011a, 2011b).

According to Ramparsad (2001), curriculum designers and developers during 1996 considered the teacher to be a crucial factor in, not only implementation of the curriculum, but also in the development of the curriculum. The Department of Education involved teachers by soliciting for their ideas in the development of Curriculum 2005 (Ramparsad, 2001). Carl (2005) argues that teacher involvement in curriculum development will ensure that teaching is effective and learners are afforded the chance to optimise their potential. A research by Carl (2005), on the voice of the teacher in curriculum development shows that teachers are willing and actually want to be given the chance to contribute towards national curriculum debates and design. In most cases, the teacher is expected to implement a curriculum that he or she was not given a chance to develop, which is why most curriculum programmes end up failing.

The above arguments motivated the current study to seek answers to why constructivist teaching strategies may not be used in the teaching and learning of mathematics in schools despite the fact that everyone, from politician to curriculum designer to curriculum implementer, holds the same view that Outcomes Based Education, with its embedded

constructivist elements and features, is the answer to South Africa's social, political and economic problems.

1.3 RESEARCH QUESTIONS

This study, therefore sought to answer the following main problem:

What factors impact on the selection and adoption of constructivist teaching methods by mathematics teachers in Urban South African schools?

The study sought to find answers to the following sub-questions:

1. What are teachers' perceptions of constructivist mathematics classroom environments?
2. What factors impact on teachers' creation and adoption of constructivist classroom environments?

1.4 AIMS OF THE STUDY

The main aim of this study is to identify the factors that impact on mathematics teachers' selection and use of constructivist teaching strategies in their teaching. The researcher's view is that knowledge of these factors will help education practitioners in finding ways of effectively dealing with mathematics learning difficulties. In addition, if the dilemma faced by mathematics teachers in employing constructivist strategies is known, then there is hope that effective mathematics teaching can be realised because curriculum planners and developers, and other stakeholders in the education of children, will factor in these variables in their planning.

The researcher also hopes that the identification and discussion of these impacting factors will shed some light on why mathematics teachers feel inadequate when they fail to accomplish what they are convinced should be accomplished. As stated earlier, Carl (2005) found that teachers were willing to participate in curriculum development. Other studies highlighted earlier also show that teachers agree, in general, that constructivist teaching is effective and must replace traditional strategies of instruction (Iheanachor 2011, Arredondo, 2011).

This study, therefore, has the following auxiliary objectives to achieve:

1. To determine the extent to which mathematics teachers feel that they employ constructivist strategies in their instruction.

2. To determine the extent to which constructivist classroom environments are influenced by the teacher.
3. To determine the extent to which constructivist classroom environments are influenced by the learners that teachers teach.
4. To determine the extent to which constructivist classroom environments are influenced by the social and school climate.

1.5 SIGNIFICANCE OF THE STUDY

Booyse (2010) studied how constructivist strategies can be employed so that they result in effective teaching, learning and assessment. The study showed that teaching strategies are enhanced by the knowledge of the theoretical frameworks on which to base such planning. Booyse (2010) then proposes a theoretical structure within which learners can be given an opportunity to feel involved in their learning just as much as their teachers are. In this particular study, the researcher focuses on the possible factors that either prevent teachers from using constructivist methods or motivate them to choose and use them.

Iheanachor (2011) explored the relationship that exists between the teachers' knowledge of the mathematics subject matter and their effectiveness in teaching the subject. The study concluded that there was a significant relationship between these variables. In the context of constructivist learning strategies, the current study adopts the general conclusion that constructivist strategies yield the best results in terms of learners creating knowledge that they can later transfer into new and unfamiliar situations. The current study then focuses on the challenges or hurdles that are likely to affect the teachers' choice of these constructivist strategies. The findings of the current study will then help fill in the gap that exists between theory and choice, and implementation, of the constructivist teaching strategies. The findings will answer questions that relate to why constructivist strategies may still not be used in mathematics teaching despite the perceived benefits they have for the learner and the effective teaching of mathematics.

Wolhuter (2011:280), states that the quality of matric passes from 2003 to 2008 dropped from 73.3% to 62.5%. The Presidential spokesperson, Mac Maharaj is quoted in SAnews of October 2012 as saying that the matric pass rate from 2010 to 2011 increased from 67.8% to 70.2%. Apartheid is usually blamed for poor performance, whilst strategic government intervention programmes that are targeted on learners and teachers are hailed for the achievements (Khumalo, 2012). Wolhuter (2011:280) states that one of the challenges faced

by the South African education system is that the adopted Outcomes Based Education (OBE) requires certain contextual conditions which do not exist in South Africa to be met if the system is to succeed. Some of these conditions include adequate school resources, learner background, language proficiency and the learning and teaching culture. The current study hopes to find answers to the same problems but from the point of view of the learning and the teaching of mathematics in some urban schools.

The findings of the current study will also help curriculum planners, designers and implementers to consider practical ways of empowering mathematics teachers as curriculum implementers. Carl (2009), states that teachers have a crucial role to play in curriculum development and for that reason must be empowered to participate in curriculum design processes.

Constructivist principles have a lot in common with problem solving models, problem based learning and problem centred learning. These key terms are defined in the following sections.

1.6 DEFINITION OF KEY TERMS

1.6.1 CONSTRUCTIVISM

Piaget's Cognitive model and Vygotsky's Social Cognitive model describe constructivism as an activity where learners construct their knowledge and meaning using their previous knowledge as well as their environment (Woolfolk, 2010). The teacher plays the role of facilitator and gives the learner the opportunity to actively create knowledge.

1.6.2 PROBLEM SOLVING

Uprichard, Phillips and Soriano (1984) agree with Woolfolk (2010:279) who states that problem-solving is "formulating new answers, going beyond the simple application of previously learned rules to achieve goals." Uprichard et al. (1984) state that when a learner is confronted with a mathematical problem, he or she begins to journey from his or her initial state towards the "goal state" through paths that he or she must create. The existing problem does not immediately have a solution and so the learner must have conceptual skills to remove all the obstacles that lie between the problem and the solution.

1.6.3 PROBLEM-BASED LEARNING

Problem based learning refers to "methods that provide students with realistic problems that don't necessarily have "right" answers." (Woolfolk, 2010:318). This approach requires that learners be faced with real life mathematics problems to process. The problems do not need

to have a particular right answer per se, but they must motivate learners to develop skills to solve non-routine problems which do not have a well-defined procedure to follow.

1.6.4 PROBLEM-CENTRED LEARNING

Problem centred learning is related to problem based learning in the sense that it is a learning approach where, at the start of the lesson, learners are given selected problems to solve. Learners work collaboratively in small groups in which they are able to discuss and explain to each other, the mathematical constructs they may reach (Wheatley, 2012). This implies that problems are utilised as sources of knowledge acquisition.

1.6.5 LEARNING

Woolfolk (2010:198) defines learning as "a process through which experience causes permanent change in knowledge or behaviour". Learning, in other words, must result in change as people interact with their environment.

According to behavioural psychologists, like Skinner, this change or outcome can be in the form of behaviour (Woolfolk, 2010). The behavioural view to learning is that learning takes place as a result of external environmental events which act as stimuli to make the learner behave in a certain way.

On the other hand, learning according to cognitive theorists, is a process of active and internal construction of knowledge which is a result of an extension of what learners already know (Woolfolk, 2010). In other words, learning is an internal activity through which learners gain knowledge and experience.

Piaget, Vygotsky and Glasersfeld are some of the well-known constructivists who believe that learning is an active construction of knowledge by learners. Piaget argues that children's cognitive abilities improve as they develop (Woolfolk, 2010).This implies that children can learn anything as long as it is at their cognitive level of development. Vygotsky further argues that learning takes place in an environment of social interaction in which learners actively participate in constructing meaning and knowledge as they collaborate with their teachers and peers (Woolfolk, 2010). Through scaffolding, teachers can help their learners to acquire problem solving abilities.

1.6.6 TEACHING AND TEACHING METHODS

From the discussion of learning in the fore-going section, this study will consider teaching to be the process of planning for and presentation of the learning activities that learners need to

learn. Teaching methods are approaches that teachers employ to deliver mathematics lessons. Constructivists use teaching methods such as group work, problem solving and problem-centred because they actively involve the learner. On the other hand, traditional and teacher-centred methods like the lecture method assume that learners are empty vessels who need the teacher to tell them knowledge.

1.7 RESEARCH DESIGN

The current study seeks to determine the factors that impact on teachers' selection of constructivist strategies. This requires mathematics teachers to indicate the extent to which their classroom climate can be judged to be constructivist. A questionnaire in which teachers indicate on a Likert scale from "strongly agree to strongly disagree" is used to collect this set of data. This data, which is quantitative, is analysed quantitatively. However, since this data does not fully answer the research question, an in-depth understanding of beliefs held by the teachers is obtained by including open-ended questions at the end of the same questionnaire. The open-ended questions are qualitative in nature and are analysed qualitatively using inductive analysis.

The current study, therefore, adopts a Parallel Mixed Methods Design. According to Creswell (in press) cited by Johnson, Onwuegbuzie and Turner (2007), mixed methods research designs are research designs where the researcher collects both quantitative and qualitative data in the same study. Johnson et al. 2007, citing Denzin (1978), points out that the use of mixed methods research designs provides data triangulation because it eliminates the bias that may exist in a single data source. The open ended questions that the participants are requested to respond to are designed in such a way as to create data triangulation in the study.

Creswell and Plano Clark (2007), Tashakkori and Teddlie (2003) and Tashakkori and Teddlie (2009) all cited by Hall (2012), state that the mixed methods research design can be used when a research study yields both quantitative and qualitative data. The current study thus adopts the parallel mixed methods design to the extent that it gathers both quantitative and qualitative data. The quantitative data and the qualitative data are collected at the same time but analysed separately. The results from the two analyses are then merged in order to determine any comparisons emerging from the two data sources. Denzin (1978) cited by Johnson et al. 2007, provide three possible outcomes of mixed methods designs as convergence, inconsistency and contradiction. The current study mixes the results of the quantitative and qualitative data by comparing and discussing these results, and then drawing

conclusions about the factors that impact on the teachers' selection of constructivist strategies.

The quantitative data gathered by the current study through the Likert scale addresses the following sections:

- the level of awareness teachers have of constructivist theoretical frameworks
- the extent to which teachers perceive their mathematics classroom environments to be constructivist in character

The qualitative section of the questionnaire involves open ended questions addressing the following categories:

- the extent to which constructivist classroom environments are influenced by the teacher
- the extent to which constructivist classroom environments are influenced by the learners that teachers teach
- the extent to which constructivist classroom environments are influenced by the social and school climate in which teachers teach
- the extent to which constructivist classroom environments are influenced by the school curriculum

A more detailed description of the mixed research designs used in this study is given in Chapter 3.

1.8 DIVISION INTO CHAPTERS

The report of this study is divided into the following major chapters:

Chapter 1: Introduction and Background to the Study: In this chapter, the background of the study, the problem statement and the research sub-questions were given. This was intended to put the study into context as well as clarify the major problem to be studied. The aim and significance of the study were also discussed in order to show how the research problem and the research sub-problems link. The research design is briefly explained in this chapter as well.

Chapter 2: Theoretical Frameworks and Related Literature Review: In Chapter 2, the theoretical frameworks and related literature review are presented including the concepts of teaching and learning. The chapter discusses several teaching and learning perspectives

including critical constructivism which is Platonic, social constructivism, radical constructivism, the situated perspective and the modelling perspective. Teaching approaches including the problem solving and problem-centred are also briefly discussed in this chapter since they have a bearing on the aims of the study.

Chapter 3: Research Design and Methodology: Chapter 3 discusses in detail the research design and methodology adopted for the study. A mixed methods design was selected because the researcher wanted a quantitative and qualitative survey to gather both quantitative and qualitative data from teachers using a questionnaire. The qualitative questionnaire is administered to teachers to gather data about their beliefs, perceptions and attitudes. This chapter also discusses the data analysis methods used.

Chapter 4: Findings and Analysis of Results: The findings and analysis of results are recorded and summarised in this chapter.

Chapter 5: Discussion, Implications, recommendations and conclusion: In this chapter, the researcher discusses the implication and the recommendations of the study.

1.9 CONCULSION

This chapter described the contextual background of the study, the problem statement and sub-problems of the study, the aims and significance of the study and the research design followed in the study. Some key terms or concepts used in the study were also defined.

CHAPTER 2: REVIEW OF LITERATURE AND THEORETICAL FRAMEWORKS

2.1 INTRODUCTION

Some of the factors that influence mathematics teaching are the nature of learners that are taught, the content and concepts that are to be taught and learnt, the teaching methodologies, the curriculum outcomes and teachers' beliefs and how they influence choice of teaching methods (Woolfolk 2010, Anthony 1996). In addition, mathematics teaching calls for a careful consideration of several other variables including the learning resources and the learning environment. The current study adopted the same view held by other authors that constructivist models are effective learning approaches, and also employed related literature and theoretical frameworks as bases for determining the factors that impacted on the selection of constructivist strategies by mathematics teachers in the selected Gauteng schools. The study investigated to what extent the factors mentioned in the related literature study impacted on the selection and adoption of constructivist learning and teaching strategies by mathematics teachers in the selected Gauteng urban schools, but also investigated whether there could possibly be other emerging factors as well.

Educationists and researchers generally agree that constructivist learning models are the answer to effective teaching and learning (Plourde & Alawiye, 2003; Arredondo, 2011; Soanes, 2007; Nkhoboti, 2002). The South African National Curriculum Statement (NCS) (2003) is based on the principle that mathematics enables creative and logical thinking and so emphasises that problem solving ability must be the goal of mathematics education (DoE 2003, NCS 10 – 12).

In this chapter, literature related to this study is reviewed. The review includes the concepts of teaching and learning, as well as how teachers select teaching methods. The teacher's subject matter knowledge is also discussed as one possible factor that influences the teaching and learning of mathematics. Piaget's cognitive learning theories and Vygotsky's social constructivist learning perspectives are presented together with the situated and the modelling perspectives. Finally, the problem solving and the problem centred teaching approaches are presented as some of the approaches that constructivist teachers can employ in their mathematics classrooms.

2.2 TEACHING, LEARNING, TEACHERS AND LEARNERS

Learners and teachers are crucial variables in the teaching and learning of mathematics. All models of teaching, namely, the behaviourist model, the structuralist model, the integrated environmentalist model, the problem- solving model, the problem-centred model and the constructivist model place great importance on the learner and the teacher (Woolfolk, 2010). Indeed, without the learner, there cannot be any teaching of mathematics. These several teaching theories embed different principles that can be followed by teachers in the teaching of mathematics.

For example, Platonic Absolutists who hold a view that mathematics is universal and exists independently of learners' minds (Taylor, Fraser & White, 1994) are likely to adopt teaching strategies that are teacher-centred because this view of mathematics assumes that there is some knowledge that learners do not have and the teacher is there to transmit such mathematics knowledge to them. The role of the teacher who is influenced by this theory becomes that of an expert according to Taylor et al. (1994).

Constructivists on the other hand, see the role of the teacher as that of a facilitator in a learner-centred environment where learners construct their own meaning and knowledge (Plourde & Alawiye, 2003; Tuncel, 2009; Anthony, 1996). It is generally agreed, in education, that learners possess the ability to construct their own meaning and knowledge (Anthony, 1996). This new knowledge is constructed using existing or current knowledge that the learners possess. A study by Nkhoboti (2002) shows that learners have a capacity to display behaviour that is in line with principles of constructivism. The implication of this finding is that mathematics educators have a responsibility to create conditions, in the classroom, which afford learners a chance to construct their own meaning. Parker (2009) studied the constructivist theory of teaching with particular focus on the effect it has on children at risk. Some of these children at risk are the weak leaners who run the risk of failing to attain competent levels in mathematics. The study showed that such learners benefited from constructivist teaching methods in the sense that they could construct their own meaning and knowledge of the situations that were presented before them.

Teachers and learners indeed, have roles to play in mathematics education, and an understanding of these roles should be viewed in the light of the benefits they have for the learner. Constructivism maintains that learners create permanent meaning and knowledge if they are allowed to learn mathematics in a constructivist environment.

In the current study, an investigation as to whether teachers are aware of constructivist perspectives and whether they adopt them in their teaching of mathematics was undertaken. It was important to do this because the study sought to determine factors that impacted on the selection and adoption of constructivist strategies by mathematics teachers, and the findings would provide an explanation as to why teachers find themselves adopting platonic approaches instead of constructivist approaches in their classrooms.

2.3 TEACHERS' SELECTION OF TEACHING METHODS

Teachers tend to select and use teaching methods that match their beliefs and knowledge about mathematics (Brewer, 1997; Lloyd, 2002; McGlynn, 2001). Some teachers may feel comfortable with a particular teaching strategy simply because they learned their school mathematics through that method. Khader (2012) suggests that a teacher who is authoritative and believes that he or she possesses all the mathematics knowledge that learners need to know will most likely prefer to employ the traditional teaching method which compels him or her to transmit that knowledge to the learners. Khader (2012:73) cites Pajares (1992) and Cantu (2001) and states that

> "*What teachers do in the classroom is said to be governed by what they believe, and these beliefs often serve to act as a filter through which instructional judgments and decisions are made*".

This statement further implies that a teacher who holds the belief that learners possess prior knowledge that can be used to construct new knowledge is likely to select instructional strategies that will allow learners to be actively involved in the learning situation.

A study by Brewer (1997) showed that mathematics teaching in Japan was far more effective compared to mathematics teaching in America seemingly because American educators still employed traditional teaching methods which emanated from their beliefs about mathematics. The belief that one must get the right answer using one right method or one correct set of rules when doing mathematics meant that mathematics educators exerted learners to boring routines which contributed to mathematics being labelled as difficult and meaningless by its learners.

Booyse (2010) argues that mathematics educators have the responsibility to develop learners into critical and creative beings who can handle real life problems with confidence. Booyse (2010) agrees with Anyanwu (2008) that teachers' knowledge of the theoretical frameworks on which to base instructional design will enhance effective planning and teaching. Teachers'

knowledge of Vygotsky's social-constructivist theory or Piaget's cognitive development theories, for example, will influence their planning and instruction in line with these theories. In a study by Arredondo (2011), different types of teachers displayed different types of preferences when it came to instructional design. Some teachers preferred traditional methods of teaching, so they used lots of paper assessments with their learners. Others preferred socio-constructivist principles, and so they involved their learners conceptually.

Plourde and Alawiye (2003)'s study showed a strong correlation between teacher knowledge of constructivism and their application of constructivist principles in the classroom. The study showed, in other words, that teachers are more likely to apply constructivist strategies if they are knowledgeable about constructivism. Rowe (2006) recognises the teacher as the most valuable resource in schools and emphasizes the need for teacher training institutions to equip them with pedagogical skills that effectively meet the needs of learners. Rowe believes that learner centred teaching methods are in line with constructivism and their adoption increases learner motivation and active learning.

The current study investigated the factors that impacted on the selection of constructivist teaching methods by mathematics teachers, and also sought to determine the rationale for adopting those teaching methods. In this study an investigation as to whether the teachers' beliefs and knowledge about mathematics and constructivist theoretical frameworks influenced their adoption of teaching methods was undertaken. This was necessary because the study needed to determine the extent to which teacher deficiencies and beliefs impacted on the selection of learner centred methods.

2.4 TEACHERS' SUBJECT MATTER KNOWLEDGE

The teaching of mathematics inevitably requires that teachers be knowledgeable about the content or subject matter to the extent that they can plan for its effective sequencing for purposes of promoting optimal understanding by the learners. The extent to which teaching is effective is measured by the degree to which learning concepts have been simplified to the level of the learner (Woolfolk, 2010). Constructivist teachers can achieve this objective by scaffolding the learning situation. Iheanachor (2011) found in his study of the relationship between mathematics subject matter knowledge and teacher effectiveness that there was a significantly positive relationship that existed between the two variables. Teachers' effectiveness, according to Iheanachor (2011) is influenced by knowledge of subject matter.

Related to the subject of constructivist teaching is the argument by Koehler and Mishra (2009) that the teacher's deep pedagogical knowledge (PK) helps the teacher to understand how students construct knowledge. According to Koehler and Mishra (2009), and Ball, Thames and Phelps (2008), there are categories of mathematics knowledge that teachers need to possess in order to be effective in their teaching. These include what Ball et al. (2008) term, Common Content Knowledge (CCK), Knowledge of Content and Students (KCS), Knowledge of Content and Teaching (KCT) and Specialised Content Knowledge (SCK). A teacher who has a grounded Common Content Knowledge (CCK) possesses the ability to handle the mathematical situations that he or she gives to his or her learners. This implies that if learners make errors in their work, the teacher can detect the source of that mistake. A teacher with a good Knowledge of Content and Students (KCS) is able to anticipate how his or her learners will respond to the mathematical situation he or she has presented because such a teacher understands both the content and the nature of learners taught. More importantly, a teacher with a sound Knowledge of Content and Teaching (KCT) is able to plan his or her lessons in a sequence of instructions which are designed in a way that will help the learners understand the work. This argument shows that teaching is complex in the sense that it involves several factors that interact and combine with each other to make teaching effective. Shulman (1986), cited by Ball et al. (2008) and, Koehler and Mishra (2009), refers to this conceptual framework as Pedagogical Content Knowledge (PCK), and argues that such knowledge guides teachers in their teaching. A study by Hill, Rowan and Ball (2005) showed that teachers' mathematical knowledge and student achievement are significantly related. Mathematical knowledge for teaching (MKT) is defined by Hill et al. (2005) as the knowledge that mathematics teachers use when teaching mathematics. This is an important factor in the teaching of mathematics because teachers who demonstrate competency in mathematical knowledge are necessarily able to explain mathematical concepts as well as evaluate students' statements.

It is generally agreed that South Africa has a critical shortage of adequately qualified mathematics educators. The majority of the few that are available are not adequately knowledgeable about the subject, which is one of the reasons why Government finds it necessary to introduce interventions such as providing teachers with prepared lesson plans to use in their classes (Khumalo, 2012). Such intervention by Government is an indication that they acknowledge that the majority of mathematics teachers in South Africa are not adequately prepared to handle mathematics teaching. The mathematics learning content in the

National Curriculum Statement (NCS) (DoE, 2007) is designed in such a way as to comply with the principles and practices that promote national development as stipulated in the South African constitution. Mathematics teachers who have scanty knowledge of the subject matter cannot be effective in producing the envisaged school leaver who is well equipped with skills that are necessary to take the country to the desired level of development.

2.5 MATHEMATICS TEACHING AND LEARNING PERSPECTIVES

Mathematics education is concerned, among other things, with the development of problem solving skills in Mathematics. Uprichard, Phillips and Soriano (1984) allude to the fact that learning mathematics must focus on problem solving skills and that many theoretical views to mathematical knowledge acquisition have been developed to try and explain the process of learning mathematics through problem solving processes. Notably, many views to learning have been proposed in mathematics education, and among them are Piaget's and Vygotsky's constructivist views.

2.5.1 CONSTRUCTIVISM

Constructivists hold the belief that knowledge is constructed by learners in their minds as they interact with their environment. Learners, according to this view, play an active role in the process of building mathematical knowledge (Woolfolk, 2010). Von Glasersfeld, cited by Anthony (1996:349) also concurs with this view and states that "learning is not a passive receiving of ready-made knowledge but a process of construction in which the students themselves have to be the primary actors." The teacher must therefore, present learners with situations that will allow the latter to select their own strategies for solving real life problems under minimum guidance and support from the teacher (Woolfolk, 2010). There are several views about constructivism and some of these are discussed in the next paragraphs.

2.5.1.1 CRITICAL CONSTRUCTIVIST THEORY

Critical constructivism is a theoretical stance that learners must be afforded the opportunity to acquire knowledge in a manner that allows them freedom to personally and critically create their own meaning and knowledge through personal and social cultural consciousness (Bentley, 2003). This implies that learners must be assisted, not merely to achieve high marks in tests, but to apply their self-created knowledge in their social and cultural contexts. The implication that this stance has on the role of the teacher is that teachers must not view themselves as experts who transmit knowledge to learners (Taylor et al., 1994). Instead, the teacher should accept knowledge that his or her learners develop as socially and culturally

valid (Bentley, 2003). This further calls for a learning environment where mathematics knowledge is not viewed as static and universally true as suggested by Platonists and Absolutists (Bentley, 2003; Taylor et al., 1994). If the knowledge developed by learners should be viewed as socially valid and culturally applicable, then the belief that mathematics has only one true outcome must be classified as myth and teachers and learners must begin to demystify that notion. Critical constructivist approaches, according to Taylor et al. (1994) involve creation of learning environments that allow negotiation within a social context. The mathematics curriculum is not supposed to be delivered to learners as a rigid universally true product. Learners of mathematics should be allowed a chance to be critical as they work towards shaping their world. This liberty will give them a sense of ownership of the knowledge they have developed.

2.5.1.2 SOCIAL CONSTRUCTIVIST THEORY

Vygotsky is associated with the social constructivist theory. Vygotsky argues that everything an individual has to learn must necessarily first have existed in the social context and setting of that individual (Woolfolk, 2010; Plourde & Alawiye, 2003). For this reason, learning takes place when the learner interacts with other people, adults or more knowledgeable peers, in his or her social and cultural setting. This automatically brings in the question of language as an important tool for acquiring knowledge within the social constructivist context.

Vygotsky's social constructivist theory takes into account two levels of development, the first of which is what he calls the "actual" level of development (Woolfolk, 2010; Tuncel, 2009). This is a level of development where a learner is capable of doing or displaying knowledge of something without the help of another person (Woolfolk, 2010; Tuncel, 2009). The second level of development is called the Zone of Proximal Development (ZPD), which is a level where a learner can potentially solve a problem with the assistance of another person, an adult or a more knowledgeable learner. A process of scaffolding is used to break down the learning process into the level that the learner can solve the problem, but simultaneously making sure that the learner is left to construct the meaning himself or herself (Tuncel, 2009; Woolfolk, 2010; Plourde & Alawiye, 2003).

The social constructivist theory has implications for teaching and learning. As mentioned earlier, the constructivist theory emphasises that learners must construct their own knowledge and meaning through social interaction with peer learners and adults or their teachers. Some

of the principles that are engendered by this theory are suggested by Woolfolk (2010), Tuncel (2009), and Plourde and Alawiye (2003) to include the following:

- Learners' prior knowledge is important. Mathematics teachers must, therefore, desist from treating learners as empty vessels, but should plan for lessons that allow learners to get actively involved in the creation of their mathematical knowledge and meaning.
- The teacher must adopt teaching strategies that are learner-centred and that support interaction or collaboration amongst learners.
- The teacher acts as a facilitator who guides learners through their learning without depriving them of their responsibility to construct their own meaning and knowledge. The teacher, therefore, brings into the lesson situations that promote interaction, flexibility, creativity and problem solving.

The NCS (DoE, 2007) alludes to the adoption and employment of the social constructivist theory when it advocates for the adoption of the Outcomes Based Education (OBE). Interaction amongst learners is viewed as a democratic process through which respect for self and for one another can be enforced. The NCS is also based on the principle that active and critical learning encourages acquisition and application of knowledge and skills in a way that is meaningful to the lives of the learners (DBE, 2011a, 2011b). As learners create their own understanding of mathematical knowledge in a critical and creative way, they develop several skills that are embedded in mathematics as a discipline. Some of these skills include reasoning, interpreting, organising, reflecting, analysing, communicating and evaluating to mention but a few, and learners who possess these skills are considered to be in a better position to be responsible, accountable and effective citizens (DBE, 2011a, 2011b).

2.5.1.3 RADICAL CONSTRUCTIVIST THEORY

Glasersfeld (1996) argues that learners use their sensory capacities to actively construct knowledge from their environment, and that knowing is a process which involves learners adapting to their new social environments by modifying what they already know about their world. According to Glasersfeld (1996), the process of cognition does not lead to what Piaget's theories of constructivist cognitive learning would term "truth" of the world that exists by itself , but instead, cognitive processes lead to a creation of the learner's own world as he or she experiences it (Glasersfeld, 1996). In brief, this view implies that mathematics learning by learners must not be approached from a point of view that says the learner knows nothing and the teacher must fill him or her up with truth. Learners must use their thinking

processes to create their own understanding and to experience the world around them as such. This requires learners to be active and reflective in their acquisition of mathematical knowledge, with the teacher acting as facilitator.

2.5.1.4 PIAGET'S COGNITIVE CONSTRUCTIVISM THEORETICAL FRAMEWORK

Piaget held the view that learners construct their own knowledge through cognition using the processes of assimilation, accommodation and equilibration (Woolfolk, 2010). Piaget identified four stages of development through which children grow, namely, the sensorimotor stage, the preoperational stage, the concrete stage and the formal operational stage. As children develop through these stages, their cognitive capacities develop as well and become more organised. Children aged 12 years and above are therefore able to reason abstractly and hypothetically (Woolfolk, 2010). In other words, Piaget argued that as children develop, their thinking also develops so that the more mature they become, the more organised their thinking becomes also. Children's prior knowledge or experiences play a crucial role in acquisition of new knowledge. This implies that teachers can help learners learn mathematics by selecting learning content that match their cognitive levels of development.

2.5.2 THE SITUATED PERSPECTIVE

The situated perspective and the constructivist perspective are related to a certain extent because they both can be interpreted as processes of enculturation since their proponents believe that everything that can be learnt must necessarily be present in the community that the learner exists. Woolfolk (2010:314) states that what people learn is "specific to the situation in which it is learned." The implication of this perspective in learning mathematics is that students must be active participators in order to acquire mathematical knowledge. Situated learning also implies that learning is contextual and learners must do mathematics that relates to their culture. This is the same view that constructivists like Vygotsky hold as discussed in section 2.5.1.2.

2.5.3 THE MODELLING PERSPECTIVE

The modelling perspective is an approach to learning that is associated with problem solving situations. According to Doerr and English (2003), the modelling perspective places emphasis on the creation of a system of relationships in problem solving which can be generalized and used in new situations. This implies that learning is not complete if it does not end up in the learner acquiring tools and processes that can be used later in new situations to solve mathematical problems. In the light of Vygotsky's view, teaching and learning

occurs in the context of developing cultural tools, such as language, to enhance mathematical understanding (Dekker & Elshout-Mohr, 1998). The problems that learners seek solutions to are embedded in the culture and environment that learners exist in. Through their interaction with peers and more knowledgeable adults, learners are able to develop problem solving abilities.

Vygotsky's notion of the Zone of Proximal Development (ZPD) suggests that appropriate interaction between the learner and the teacher can help in improving mathematical understanding. In their study, Dekker and Elshout (1998) found that the modelling process can be effective when learners work together in small groups to solve realistic problems that emanate from their context. The modelling perspective thus incorporates Vygotsky's ZPD in the sense that the process of creating a solution is a cognitive constructive activity that takes place in a realistic cultural context when learners interact with each other.

The modelling perspective requires that learners be in a position to see relationships in mathematical situations (Doerr & English, 2003). These relationships are constructed by the learners themselves when they are faced with mathematical situations that give them the opportunity to reason mathematically to invent models. Constructivists argue that knowledge is constructed when learners actively participate in mathematical reasoning (Woolfolk, 2010). This view is also in line with Piaget's view that universal knowledge is constructed in the mind of the learner through cognition (Woolfolk, 2010:312). The modelling perspective incorporates the constructivist views of Piaget in the sense that the construction of mathematical models requires the engagement of cognitive processes in the mind of the learner. These models involve relationships and rules that are consistent and reusable in similar and familiar situations.

The modelling perspective according to Doerr and English (2003) is a problem solving approach that incorporates reasoning within realistic contexts. This notion is in line with the views held by the Situated Perspective which states that what learners learn is specific to or situated in the context or culture in which it is learnt (Woolfolk, 2010). In order for learners to solve problems, there is, therefore, need for the problem solving situations to be taken from the learners' environment or culture, and these contexts must be interesting and motivating enough to promote understanding. The problems selected must necessarily be non-routine in nature, but offer opportunities for learners to mathematize the situation and form models and symbols that can be reused in familiar situations.

The modelling perspective is an effective approach to learning since the knowledge that learners construct in the process is applicable in other new and familiar situations. Challenges could arise, however, when selected problems do not match the cognitive level of the learners. Piaget's views suggest that learning tasks should be carefully selected so that they match the cognitive level of the learners, but this in practice can be a challenge for the teacher.

The modelling perspective will work effectively if the selected learning tasks are realistic and relate to the culture and context of the learner. The practicality of selecting realistic tasks by the teacher comes with its challenges as well. The learners may not be motivated enough to enjoy what the teacher considers as realistic and this makes the process of selecting interesting situations a big challenge for the teacher. Learners can be afforded the opportunity to select contexts they enjoy but such practice cannot be relied on completely.

The independent and self-regulated learning that learners are encouraged to undertake in the modelling perspective can fail if the teacher is not aware of the levels and nature of intervention that he should give. Oversimplification of the problem by the teacher in the process of scaffolding as suggested by Vygotsky's Zone of Proximal Development can undermine the whole idea of constructing knowledge by learners on their own. It is therefore important that mathematics teachers acquire a sound understanding of the modelling perspective in order to effectively apply its principles in problem solving situations.

Teachers who have an understanding of these learning perspectives can adjust and refine their classroom practices so that their learners' needs are adequately addressed. The current study gives participating teachers an opportunity to describe what goes on in their classrooms, and from these descriptions, the study hopes to reach a clear understanding of why teachers approach mathematics teaching the way they do.

2.6 MATHEMATICS TEACHING PERSPECTIVES

Learning through constructivist strategies involves interaction with one's environment as discussed in section 2.5. Problem solving skills and creativity are some of the intended learning outcomes of a constructivist lesson. This section focuses on problem solving stages, and shows that skills developed through problem solving are related to constructivism. Problem-centred learning is also discussed in the context of constructivist learning since it advocates for collaborative learning through group work.

2.6.1 PROBLEM SOLVING APPROACH TO THE TEACHING OF MATHEMATICS

Woolfolk (2010) and Uprichard, Phillips and Soriano (1984) present discussions of the problem-solving approach to learning. According to Woolfolk (2010:279), problem-solving is "formulating new answers, going beyond the simple application of previously learned rules to achieve goals." The implication of this definition is what Uprichard et al. (1984) allude to when they state that the learner, when confronted with a mathematical problem, starts a journey from his or her initial state towards the goal state through pathways that he or she must create. Necessarily, there is no immediate solution to the problem and the learner cannot even draw from his or her previous knowledge in order to reach the goal state immediately. The block that lies between the problem and its solution must be removed by the learner through conceptual processes.

Uprichard et al. (1984) describe several problem-solving models that were proposed by Polya (1957), Johnson (1955), Klausmeier and Goodwin (1966), Gagne (1983) and Lester (1977). Uprichard et al. (1984) describe Polya's model as a prescriptive model with five phases or stages that must be followed when solving problems. These stages involve posing a problem, understanding the problem, devising a plan, following the plan and looking back. Johnson's model on the other hand offers three phases which describe the behaviours that are evident during the process of problem-solving. The stages involve preparation, production and judgement (Uprichard et al., 1984). The other models by Klausmeier and Goodwin, Gagne and Lester also offer prescriptive stages that can be followed in problem solving (Uprichard et al., 1984).

All problem solving approaches are characterized by the existence of what the learner perceives as a problem. However, there is no direct way of getting the solution but there is a strong desire by the learner to find a solution. The motivation to arrive at a solution enables the learner to create possible pathways that must finally lead to the desired goal.

Polya prescribes five phases of problem solving namely (a) posing a problem, (b) understand a problem, (c) devise a plan, (d) follow the plan and (e) look back (Uprichard, Phillips & Soriano, 1984). Each of these phases offers both teachers and learners an opportunity to develop skills that promote mathematical thinking.

The nature of problems that are posed to learners in problem solving approaches relate to different situations that use mathematics. In these activities, learners are challenged to identify a problem and this is a skill that requires high quality mathematical thinking.

To try and understand the problem, learners must exploit previous knowledge, which is a mathematical process since the learner must see relationships in order to achieve that. A learner that has developed problem solving techniques is in a better position to solve various problems logically, inductively and deductively.

In the third phase learners devise a plan for solving the problem, and they carry out the plan in the next phase. This may require them to exercise skills such as estimation and pattern recognition as they find a solution to the problem. Finally, learners get a chance to examine their solutions. They can do this by sharing their ideas as expressed in their solutions. The skill of comparing outcomes and finding similarities and differences is a high quality skill in mathematics and problem solving approaches support them.

The teacher selects and presents mathematical situations to learners. Instead of identifying and explaining the steps or algorithms that are required to solve the problem, learners are only given guidance that will help them explore the problem for a solution. The teacher's guidance can be in form of a question. Learners then search for a solution through all possible paths that the learner is able to access (Murray, Olivier, & Human, 1998)

The teacher's role is to promote creative learning throughout the lesson. Learners must be allowed to offer their own solutions which result from their own thinking patterns. The teacher must encourage learners to make their own interpretations and judgments that help them obtain a reasonable solution. The learning environment itself must also support problem solving. Adequate time must be allocated to learners so that they complete their task, and appropriate material must be made available for learners to exploit when necessary.

2.6.2 PROBLEM CENTRED APPROACH TO THE TEACHING OF MATHEMATICS

Problem centred learning refers to "methods that provide students with realistic problems that don't necessarily have "right" answers." (Woolfolk, 2010:318). This approach requires that learners be faced with real life mathematics problems to process. The problems do not need to have a particular right answer per se, but they must motivate learners to develop skills in problem solving as they construct their own knowledge. Thus problem centred learning assumes that learners can construct their own knowledge (Cobb, Wood, Yackel, Nicholls, Wheatley, Trigatti & Perlwitz, 1991 cited by Murray et al., 1998).

The success of the problem solving and problem centred learning approaches, according to Woolfolk, (2010) and Murray et al. (1998) depend on the ability by the learner to perform a

number of conceptual skills that include interpreting mathematical situations, collecting useful data, identifying possible solutions and evaluating solutions. This kind of learning is characterized by flexibility and applicability in the sense that the knowledge obtained from this experience can be used in new situations.

Woolfolk (2010) and Murray et al. (1998) further infer that critical and creative thinking are the object of problem based learning. Learners are exposed to problems that offer them with opportunities that inculcate values of lifelong learning partly due to the fact that the types of problems that are tackled require open- mindedness in the sense that there is no one right answer to the problem. As a result, learners' exploration skills are sharpened during the problem solving exercise and this exploration helps them to see patterns and establish any existing relationships which might help them reach certain generalizations.

Problem centred learning also emphasizes working in groups. This promotes collaborative learning as learners investigate situations together. The results achieved through this approach are very original in the sense that learners themselves create them. This leaves learners at a level where they use mathematical skills to create mathematical responses to situations around them.

Problem centred learning requires the teacher to find and bring a problem to learners which does not necessarily have a particular right answer. The objective of such a problem is to help learners develop problem solving, creative and critical thinking skills. The teacher helps learners to understand the objectives of the activity, and he may need to organize learners into groups so that they share ideas. According to Murray et al. (1998), teachers communicate necessary information to the learners to the extent that learners understand the problem and can interpret it to each other. This implies that when learners become actively involved in constructing mathematics knowledge, there should be no interference from the teacher. The assistance that the teacher affords learners should be controlled in the sense that learners must be given the chance to find the solution independently through investigation. The skills developed from such activities can be applied in new situations in real life. The teacher, therefore, must assist learners to acquire lifelong learning skills like observation and analysis.

Problem solving and problem centred approaches promote reflective inquiry and ensure that learners' understanding is optimised. Teachers who understand these approaches can help learners to develop the ability to discuss, explain, interpret and justify their viewpoints without too much dependence on the teacher. The current study also undertakes to determine

the extent to which teachers in the selected schools in Gauteng create conditions for learners to acquire knowledge independently.

2.7 CONCLUSION

In this chapter, a description of the theoretical framework that undergirds the study was made. Several learning and teaching perspectives were discussed, among which are Piaget's, Vygotsky's and Glasersfeld's constructivist perspectives, the modeling perspective and the situated perspective. Some of the approaches to learning mathematics that were presented include the problem solving approach and the problem-centred approach. These perspectives and approaches are consistent in defining the roles that the teacher and the learner must assume in order for effective learning to take place. The problem of understanding factors that influence teachers' selection of teaching methods requires an understanding of these conceptual frameworks. The literature reviewed agrees on the view that the learning of mathematics can be enhanced by selecting teaching methods that allow learners to create mathematical meaning from their social and cognitive environment.

CHAPTER 3: RESEARCH DESIGN AND METHODOLOGY

3.1 INTRODUCTION

This chapter discusses the research design that the current study adopted. The population, as well as the research sample, the data collection instruments, data analysis methods and ethical issues are also discussed in this chapter. Finally, the validity and the reliability of the instruments are also addressed.

3.2 RESEARCH DESIGN

The current study sought to determine factors that impact on teachers' selection and adoption of constructivist teaching strategies. Some of these factors could take the form of attitudes and beliefs that teachers, learners and school communities had. The current study adopted the Parallel Mixed Methods Design where both quantitative and qualitative data were concurrently gathered but analysed separately before the results of the two analyses were then merged (Angell & Townsend, 2011). According to Johnson, Onwuegbuzie and Turner (2007), Angell and Townsend (2011) and Creswell J (in press) cited by Johnson et al. (2007), mixed methods research is a research design in which both qualitative and quantitative approaches of research are combined for the purpose of obtaining in-depth understanding of the research problem.

The mixed methods design was selected because the strengths of the quantitative data and the qualitative data can be combined to obtain a more insightful understanding of the research problem (Creswell & Plano Clark, 2007, cited by Galt, 2008). According to Galt (2008), the quantitative data in the mixed methods research may involve closed-ended questions which require deductive statistical analysis, while the qualitative data may involve broad general questions where views of the participants are sought by means of open-ended questions. The participants' views can be organised into themes which can then be interpreted inductively. The use of the mixed methods design, therefore, helped in the current study in the sense that the gathered quantitative data did not fully answer the research problem which sought to determine the factors that impacted on selection and adoption of teaching methodologies. Qualitative data necessarily needed to be collected so that it complemented the quantitative data source.

It was envisaged that the use of mixed methods in the current study would also help in achieving data triangulation. Denzin (1978:291) cited by Johnson et al. (2007), define

triangulation as “the combination of methodologies in the study of the same phenomenon”. Webb et al. (1966) cited by Johnson et al.(2007) argue that research results obtained through data triangulation can be accepted with a higher degree of confidence than when they are obtained through only one data source.

In the current study the parallel mixed methods design was appropriate because both quantitative and qualitative data types were required to help bring out the understanding of the research problem. The quantitative part of the questionnaire in the current study measured the extent to which teachers perceived their classroom climates to be constructivist. This, on its own did not, however, adequately shed some light on why there was such a phenomenon, hence the need for open-ended questions where participants gave their personal views on the subject matter. The mixed methods design therefore rendered itself to be efficient since both data types were gathered concurrently, analysed separately and the results merged to give appropriate interpretation to answer the research problem.

Validation of the findings was done by evaluating quantitative data and qualitative data individually and then merging the results of the two to give more insightful and complementary results as proposed by Caruth (2013). This validation process catered for any possible discrepant results that might have been obtained from the two data sources.

3.3 POPULATION AND SAMPLING

McMillan and Schumacher (2010:129) define population as the “total group to which results can be generalised”. The population of the current study was mathematics teachers in selected schools in urban Gauteng. Since it was not possible for the current study to collect data from every mathematics teacher in Gauteng’s schools, a sample of five schools was selected. One school in the sample did not return all the questionnaires that were sent to it, and this left only four schools participating. McMillan and Schumacher (2010:129) refer to a sample as a “group of individuals from whom data are collected”. The selection of the sample of the five schools was influenced by the convenient proximity of the schools to the researcher’s work place and place of residence. The five selected schools had in total, twenty eight (28) mathematics teachers teaching from Grade 8 to Grade 12. All the schools in the current study were public schools. The selected schools were located in Johannesburg East and Johannesburg North. Johannesburg has similar schools in all towns that make up the metropolitan. The five schools in the current study, therefore, had the capacity to be information rich on the topic of study.

The main aim of the current study was to investigate what factors impact on teachers' selection and use of constructivist teaching practices in urban schools in South Africa. The subjects of the study were practising mathematics educators in five Johannesburg high schools. These schools were selected conveniently because of their geographical location and proximity to the researcher's place of residence and employment. The study incorporated only public schools which were differently resourced despite the fact that they were all public institutions. Public schools are funded by government and school fees are subsidised. These schools have an average of 30 to 35 learners per class. The schools in the current study were directly controlled by government departments and enrolled learners who, in the majority, could not manage the high fees paid in private schools.

The purposive sampling techniques were used to select the participants of the study. Teddlie and Yu (2007) and, McMillan and Schumacher (2010), state that purposive sampling techniques or nonprobability sampling techniques may include selecting participants out of convenience in order to achieve the purposed objective. It was envisaged that an involvement of public schools in the study would help in obtaining comprehensive and insightful patterns to explain the factors that impact on teacher selection and use of teaching strategies in public schools. Data in the current study was collected from high school teachers who were offering mathematics from Grade 8 to Grade 12. An average minimum of five mathematics teachers from each school took part in the study. In total, 16 teachers participated in the study. The participants comprised teachers who had been practising mathematics educators for at least one year. These teachers potentially had rich information regarding the teaching of mathematics. It was envisaged that the teachers' number of years in the teaching service would potentially help to explain their beliefs and attitudes regarding preferences and limitations of adopting teaching strategies.

3.4 INSTRUMENTATION AND DATA COLLECTION TECHNIQUES

McMillan and Schumacher (2010) state that qualitative research approaches are appropriate for determining human perceptions or views of a situation. They further highlight that qualitative research is concerned with "understanding the social phenomenon from the participants' perspectives" (McMillan & Schumacher, 2010:12).In the current study factors that impact on teachers' selection of constructivist teaching strategies were extracted from mathematics teachers in a questionnaire survey through which they expressed their views about teaching, learning, learners, learning environment and learning methodologies. A

questionnaire survey was appropriate for this study because teachers' attitudes and beliefs about their learners, teaching methods and other related variables about mathematics learning and teaching can be solicited from a small number of participants and later generalised deductively or inductively over the whole population (McMillan & Schumacher, 2010).

Data was collected in the current study through a questionnaire. McMillan and Schumacher (2010), state that questionnaires have the advantage of being economical and can be used in such a way that the respondents remain anonymous. One disadvantage of using a questionnaire, according to McMillan and Schumacher (2010) is that some questions asked in the questionnaire may not be appropriate and their results may not be used after wasting all the time and the energy. The current study made every effort to include in the questionnaire, only questions and information that related to the aims of the study.

The questionnaire instrument had a total of four sections and twenty five questions. Section A of the questionnaire sought for demographic information about gender, grades taught, length of teaching experience, number of years after training and the type of school participants taught at. Questions 1 to 5 covered this section and participants needed to indicate their responses with a cross (X). Section B sought to determine the extent to which the participants were aware of constructivist theories on a 5 point Likert Scale from strongly agree (SA), agree (A), neutral (N), disagree (D) and strongly disagree (SD). There were 6 items in this section and participants needed to choose their responses by placing a cross (X) on the answer of their choice. Section C had 14 items which sought to determine the participants' perceptions of the extent to which their classrooms were constructivist in character. This also was done on a 5 point Likert Scale from strongly agree (SA) to strongly disagree (SD). Sections A to C provided data that was quantitative and required quantitative analysis. Section D, had four open ended questions which sought to determine teachers' views on how their selection of constructivist strategies was influenced by learners, school curriculum, school and social factors and other factors. Participants responded to these questions in the spaces provided in the questionnaire. The questions were designed to show what beliefs and attitudes the participants had regarding the use of or the failure to use constructivist teaching strategies in mathematics. These views were qualitative data and they were used in the current study together with the quantitative data obtained from the other sections to obtain in-depth understanding of the phenomenon being studied.

3.5 DATA ANALYSIS AND INTERPRETATION

The current study employed a survey in the form a questionnaire to collect data. The questionnaire was designed to generate both quantitative and qualitative data.

The set of Likert-type items in the current study was quantitative and was analysed using quantitative analysis. There are several ways of analysing Likert-type items, including the use of descriptive statistics like median, mode, frequencies, range, interquartile range, cross boxes and percentages to analyse items individually (Clason & Dormody, 1994). However, Clason and Dormody (1994) and Gliem and Gliem (2003), argue that analysing single items yields less reliable conclusions than when the multiple items are combined or summed. In the current study, the Likert Scale was obtained by grouping each Likert-type item with other related items in the same section to give an average score for that section. Clason and Dormody (1994), argue that this score is more reliable than the score obtained from a single item since multiple items are involved in the Likert scale. This allows the data to be analysed using descriptive statistics.

The last section of the survey in the current study comprised open-ended questions in which participants expressed their views, beliefs, conceptions and attitudes regarding factors that impacted on their selection of constructivist teaching strategies. This data was qualitative and demanded inductive qualitative analysis. McMillan and Schumacher (2010:367) state that the process of inductive analysis involves "coding, categorizing, and interpreting data to provide explanations of a single phenomenon of interest". Qualitative data in the current study was therefore, analysed by classifying teachers' responses into emerging categories that culminated in observable describable patterns. These patterns were then interpreted inductively to explain relationships.

3.6 VALIDITY OF THE STUDY

McMillan and Schumacher (2010:330) describe validity in qualitative research as the "degree to which the interpretations have mutual meaning between the participants and the researcher". Joppe (2000) cited by Golafshani (2003:599) state that validity in quantitative research "measures whether the research truly measures that which it was intended to measure or how truthful the results are". This, according to Golafshani (2003) and McMillan and Schumacher (2010), implies that the instruments used to collect data should be carefully scrutinised to determine their accuracy in measuring the construct in question. Furthermore, Yin (2011), explains that validity must be ensured in a study in order to make sure that the

conclusions of the study reflect the real world that was studied. Joseph Maxwell (2009) cited by Yin (2011), McMillan and Schumacher (2012), Lafaille and Wildeboer (1995) and Golafshani (2003) give suggestions on how validity can be ensured in research and the current study employed some of these strategies.

3.6.1 DATA TRIANGULATION

Denzin (1978:291) cited by Johnson et al. (2007), defines triangulation as "the combination of methodologies in the study of the same phenomenon". Four types of triangulation according to Johnson et al. (2007) are data triangulation, investigator triangulation, theory triangulation and methodological triangulation. According to Patton (2001) cited by Golafshani (2003), triangulation has the potential to validate research because it mixes research methods. The current study employed data triangulation, which is explained by Johnson et al. (2007) as the use of different data sources to enhance validity. In the current study, a mixture of quantitative and qualitative strategies was used. The questionnaire survey included Likert-type items that yielded quantitative data, as well as open-ended questions that yielded qualitative data. McMillan and Schumacher (2010) refer to this strategy as "multi-method strategies" and argue that it allows for data triangulation which helps to enhance validity.

3.6.2 ACCURACY AND CREDIBILITY

According to Thomson (2011) descriptive validity is the assurance that the data is accurate and credible. Credibility and accuracy is achieved when the researcher reflects participants' views (Thomson, 2011). Interpretive validity is another category of validity that McMillan and Schumacher (2010) and Thomson (2011) agree enhances justifiability of the study. Participants in the current study responded to closed-ended and open-ended statements and questions. According to McMillan and Schumacher (2010), validity can be threatened when respondents misinterpret closed-ended or open-ended statements. In the current study, participants expressed their views regarding the phenomenon under study. To enhance descriptive validity and interpretive validity, McMillan and Schumacher (2010) and Thomson (2011) suggest that the data collecting instruments can be given to peers for scrutiny. The instruments of the current study were pilot tested in order to get feedback on the wording of the statements. A colleague read through the items and suggested corrections which were adopted to improve the wording and the meaning of the statements.

3.6.3 TRANSFERABILITY

The external validity of a study is viewed by Walsh (2003) cited by Thomson (2011) as the ability to transfer, or to generalise, or to apply the results universally. Thomson (2011) suggests that a comprehensive description of the sites where data was gathered can help reduce the threat to external validity. In the current study, a comprehensive description of each of the four schools that participated in the study was given as an attempt to establish external validity. The questionnaires were administered in the month of September one week before schools closed. Teachers completed the questionnaire in their free time during the week. The results of the study can therefore, be applied to all schools of similar description with a certain degree of confidence.

3.7 RELIABILTY

Reliability measures the extent to which results can be replicated (McMillan & Schumacher, 2010). The implication of this description is that different studies focusing on the same phenomenon would make the same observations using the same methods. To enhance reliability in the current study, the questionnaires were administered at a time that was convenient to the participants. Respondents were allowed to complete the questionnaire before or after work hours when work pressure had subsided. McMillan and Schumacher (2010) suggest that participants must be given the same conditions under which to give their responses. All respondents in the current study were given the same option, to complete the questionnaire at their most convenient time, in order to eliminate fatigue and unreliable responses. The theoretical assumptions about the study were also explained to the participants so that they understood the nature of the study and gave their most honest responses.

3.8 ETHICAL CONSIDERATIONS

The following issues were taken into account before, during and after data collection:

3.8.1 PERMISSION TO CONDUCT RESEARCH

The Gauteng Department of Education was approached for permission to conduct research in institutions in Gauteng Johannesburg region. Permission was then given by the Johannesburg East and the Johannesburg North Districts to conduct research in their schools.

3.8.2 INFORMED CONSENT

Permission to carry out research in schools was sought from the Gauteng Department of Education, Johannesburg East and North Districts and the school management bodies. The participants' consent was also sought so that permission to involve them in the study was

granted prior to data collection. Adequate information was disclosed to the informants regarding the purpose of the study and the intended use of the results in order to achieve credibility. The participants were made aware of the fact that participation was voluntary. Participating teachers completed a consent form as an indication that they volunteered to be part of the study.

3.8.3 CONFIDENTIALITY AND ANONYMITY

Participants had the assurance that all information collected from them was going to be treated in confidence and in anonymity. They were also made aware of their rights to press charges should there be a violation of these ethics. To enhance anonymity, the respondents were requested not to include their names on the questionnaire.

3.9 CONCLUSION

This chapter dealt with the research design and methodology. The study took the form of a survey where a questionnaire and an interview were the major data collection instruments. Data analysis was deductive as well as inductive in nature. Participants' responses to open-ended questions were categorised into themes and these were used to determine the beliefs that the participants held about mathematics and mathematics teaching and learning.

CHAPTER 4: ANALYSIS AND PRESENTATION OF RESULTS

4.1 INTRODUCTION

This chapter presents an analysis of results obtained from the four sections of the questionnaire that participants responded to. The background information was summarised in a table showing the classes the teachers taught as well as the number of years the teachers had been teaching. Teachers' awareness of constructivist teaching strategies was summarised and presented in tabular form and the frequencies of the responses were noted and interpreted. Teachers were also requested to give an indication of the extent to which they considered their classroom practices to be constructivist in character. Their responses were summarised in tables and analysed by considering the frequencies of their responses to some statements. There were also open-ended questions that respondents responded to by expressing their views on certain aspects of the phenomenon under study. These responses are summarised in this chapter and analysed by observing patterns that emerge from the responses given.

4.2 SECTION A: BACKGROUND OF PARTICIPANTS

Participants were drawn from four public schools in Johannesburg East and Johannesburg North. Initially, five schools were approached and asked to participate in the current study with the hope that each school would be able to have four mathematics teachers who would be willing to participate. One school, however, did not return all the questionnaires that were sent to it. The following table shows the actual number of mathematics teachers in each school that was approached and the actual number of questionnaires received and returned by them. The schools are represented by their pseudonyms, HDP, NWK, FDL, MRD and GSD so as not to disclose their identity.

Table 1

Number of teachers approached and number questionnaires received and returned by them.

School	No. of teachers (No. of questionnaires received by them)	No. of questionnaires returned by them	% Returns
HDP	6	3	50%
NWK	4	3	75%
FDL	6	4	67%
MRD	6	0	0%
GSD	6	6	100%
TOTAL	28	16	57%

All the schools that participated were multi-racial public schools that collected school fees from learners. The schools were located in Sandton, Randburg and Midrand in Johannesburg East and Johannesburg North.

A total of 16 out of 28 mathematics teachers agreed to participate in the study. Of the 16 that participated, 4 of them had been teaching for less than 5 years, 3 of them for 5 to 10 years, and 9 of them for more than 10 years. There were five Grade 8 teachers, seven Grade 9 teachers, twelve Grade 10 teachers, eight Grade 11 teachers and seven Grade 12 teachers in the survey. Table 2 below shows a summary of the background information of the participating teachers.

Table 2

Background information of participating teachers

Participant ID	School	Gender	Grades Taught					Number of Years in Service		
			8	9	10	11	12	< 5	5-10.	> 10
1	HDP	F			X	X	X	X		
2	HDP	M			X	X	X		X	
3	HDP	M			X	X	X		X	
4	NWK	F			X	X			X	
5	NWK	F		X						X
6	NWK	M	X		X	X				X
7	FDL	F	X				X			X
8	FDL	M			X			X		
9	FDL	F		X	X					X
10	FDL	M		X	X			X		
11	GSD	F		X			X			X
12	GSD	F			X	X	X			X
13	GSD	F	X	X	X			X		
14	GSD	M	X	X	X					X
15	GSD	F			X	X	X			X
16	GSD	M	X	X		X				X

Gender			Number of years teaching		
Female	9		< 5	4	25%
Male	7		5-10.	3	18.75%
TOTAL	**16**		>10	9	56.25%
			Total	**16**	**100%**

4.3 QUANTITATIVE DATA FINDINGS

The current study sought to determine the factors that impacted on mathematics teachers' selection and adoption of constructivist teaching strategies. The questionnaire that the participants responded to sought to find answers to the following research questions:

1. What are teachers' perceptions of constructivist mathematics classroom environments?
2. What factors impact on teachers' creation and adoption of constructivist classroom environments?

The current study used a questionnaire to find answers to these questions. The questionnaire was divided into four sections, A, B, C and D. In Section A, the respondents were asked to give their backgrounds. This included the respondents' gender, years of teaching experience, classes taught and number of years since they qualified to teach mathematics. Section B was an exploration of the extent of the participants' awareness of constructivist teaching and learning models. Section C explored the extent to which the participants perceived their classroom environments to be constructivist in character. Finally, Section D explored factors that participants perceived as impacting on their selection and adoption of constructivist teaching strategies. Sections A, B and C yielded quantitative data that required quantitative analysis, while Section D sought for qualitative data that related to the participants' beliefs about factors that impacted on their selection and use of constructivist teaching styles. Each section was analysed separately and their findings were put together to determine the extent to which the research question and its sub-questions were answered.

4.3.1 SECTION B: TEACHERS' AWARENESS OF CONSTRUCTIVIST THEORIES

Section B of the questionnaire was aimed at determining the extent to which participants were aware of constructivist theories. This section consisted of six statements to which the respondents indicated their extent of agreement on a 5 point Likert scale from Strongly Agree (SA) to Strongly Disagree (SD). Table 3 shows the overall summary of the responses by all the 16 participants on the Likert scale. In this section participants responded to the Likert items by indicating their extent of agreement or disagreement from Strongly Agree (SA) to Strongly Disagree (SD). If they were neutral, the respondents selected Neutral (N). The scale was coded SA, A, N, D, SD and the following scores were used: SD = 5, A = 4, N = 3, D = 2 and SD = 1.

Table 3

Raw data of teacher awareness of constructivism

PARTICIPANT	*ITEM (STATEMENT)NUMBER*					
	1	**2**	**3**	**4**	**5**	**6**
1	4	2	4	3	2	4
2	3	4	4	3	4	5
3	5	5	1	3	1	4
4	5	5	5	3	4	3
5	4	4	5	2	2	5
6	5	5	3	2	2	5
7	4	5	5	5	3	4
8	4	4	2	3	1	2
9	4	5	4	4	2	1
10	5	4	3	4	1	3
11	5	4	4	3	4	4
12	5	4	1	5	1	2
13	3	4	4	3	2	4
14	4	4	2	4	2	2
15	5	3	3	3	2	2
16	4	4	2	3	2	3
MODE	**4 & 5**	**4**	**4**	**3**	**2**	**4**

Analysis of Data in Table 3

Statement 1: I have a clear understanding of Constructivist Theories of Learning

Table 3 shows that out of the sixteen (16) participants, fourteen (14), representing 87.5%, indicated that they had a clear understanding of constructivist teaching theories. Seven (7) of these fourteen participants indicated that they strongly agreed (SA) with the statement while seven (7) indicated that they agreed (A). Only two participants were neutral. The modal scores for this statement were 4 and 5, indicating that the selected teachers were confident that they possessed adequate knowledge of constructivist theories.

Statement 2: Constructivist teaching models allow learners to create their own mathematical knowledge

Fourteen (14) out of sixteen (16) respondents also indicated that they understood constructivist teaching and learning strategies as opportunities for learners to create their own knowledge. The modal score for this statement was 4, indicating that the majority of the participants agreed with the statement above.

Statement 3: Constructivist teaching models recognise the teacher as the source of mathematical information

Concerning the source of mathematical information, the respondents did not show much consistency with the views of constructivism. Eight (8) respondents agreed with the statement that the teacher was the source of mathematical information while five (5) disagreed, three (3) of them strongly. The findings show that from the selected teachers, 50% of them hold the belief that the teacher is a source of mathematical knowledge. This belief is not consistent with constructivist views which emphasises that the teacher must play the role of a facilitator, and not that of an informer. Teachers can be more knowledgeable about mathematics than the learners, but in constructivist approaches, learners must be allowed to create their own knowledge which might not be the same knowledge that the teacher has.

Statement 4: Constructivist theories recognise the learners' environment as the source of mathematical information

As seen from Table 3, six (6) of the respondents who agreed that teachers were the source of mathematical information did not agree that the learner's environment was the source of knowledge. Two (2) respondents who thought the teacher was the source of knowledge also thought that the learner's environment was the source of knowledge. Five (5) teachers, which represented 31%, agreed with the statement above. This confirms that the selected teachers

generally believed that the teacher, and not the learner, was the source of mathematical knowledge.

Statement 5: The learner's language and culture do not influence his/her acquisition of mathematical knowledge

The responses to the statement that language and culture do not influence mathematical knowledge acquisition show that the respondents agreed that language and culture were critical in learning. Twelve (12) of the sixteen (16) respondents disagreed with this statement, showing that 75% of the teachers in the survey believed that culture and language are important in mathematical knowledge acquisition. This stance is consistent with constructivist views which classify language and culture as tools that play a crucial role in knowledge acquisition.

Statement 6: Learners effectively acquire mathematical knowledge when they listen to the teacher's explanation carefully

Eight (8) teachers agreed with the above statement, three (3) were undecided and five (5) disagreed. The modal score was 4 showing that the majority of the respondents agreed that learners learn effectively when they listen carefully to the teacher's explanation. The teacher, as a facilitator, has to give instructions to his or her learners, and learners will benefit if they do pay attention. This, however, does not mean that other factors that contribute towards effective learning are undermined. The participants' responses regarding this statement are in line with constructivist views because listening is one of the important skills that learners must acquire in order for them to learn. After all, learners themselves need the skill to explain to each other, the different views they hold about the mathematical situation they could be working on.

Overall, the frequencies and the modes of the response scores as shown in this section indicate that the participants in the current study had a fair to good understanding of constructivist theories of teaching and learning. Out of the six statements that the participants responded to, 4 of them received responses that were consistent with constructivist theories. Statements 1, 2, 5 and 6 received scores that indicated that the teachers had a good understanding of these theories. Statements 3 and 4 were related to each other and teachers in the survey seemed to hold the view that the teacher is the source of information and not the learner or the learner's environment.

Teaching experience and teachers' awareness of constructivism

There were sixteen teachers who participated in the survey. Four of them (25%) had a teaching experience of five years or below, three of them (18.75%) had between five and ten years and nine of them (56.25%) more than ten years.

According to Vermunt and Endedijk (2011) cited by Feixas and Euler (2013), teachers' experiences influence them in adopting different teaching practices and developing various beliefs about teaching and learning. Feixas and Euler (2013) argue that the teaching and learning methods that teachers get exposed to in training institutions must closely resemble the teaching and learning methods that teachers are expected to employ in schools. The teachers' responses to the six statements from Section B were analysed by grouping the participants according to their years of teaching experience. This was done in order to determine whether there was any relationship between teaching experience and knowledge of constructivist theories. The results could also help shed some light on the depth of training the teachers in the different categories received. Table 4, Table 5 and Table 6 show the summary and analysis of the responses on "*Teacher's awareness of Constructivist Theories of Learning*" in terms of teachers' years of teaching experiences.

Table 4

Teachers with less than 5 years of teaching experience and their awareness of constructivist theories of learning

N = 4 [Participant ID # 1, 8, 10, 13]

Q#	***Statement***	***Results***
1	I have a clear understanding of constructivist teaching theories	3 out of 4 agree
2	Constructivist teaching models allow learners to create their own mathematical knowledge	3 out of 4 agree
3	Constructivist teaching models recognize the teacher as the source of mathematical information	2 out of 4 agree
4	Constructivist theories recognize the learner's environment as the source of mathematical information	1 out of 4 agree
5	The learner's language and culture do not influence his/her acquisition of mathematical knowledge	0 out of 4 agree
6	Learners effectively acquire mathematical knowledge when they listen to the teacher's' explanation carefully	2 out of 4 agree

There were 4 out of 16 participants who had mathematics teaching experience of below 5 years. Three out of the four participants, representing 75% of the teachers with teaching experience below five years, stated that they had a clear understanding of constructivist theories.

Seventy-five per cent (75%) of the participants in this category also expressed agreement with the statement that constructivist models allow learners to create their own knowledge. This result is in line with all constructivist models of teaching and learning which emphasise that learners must be allowed to make sense of the world around them and critically create their own knowledge.

Constructivists believe that the learner's environment plays a major role in knowledge acquisition. In the current survey, only 1 out of 4 teachers with below 5 years of teaching experience concurred with this belief. The learner's environment, according to constructivist theorists includes the real world and the context in which mathematical problems exist. This understanding helps teachers to select appropriate learning activities and methods in order to optimise learning. Teachers in this category therefore, may not always relate learning activities to the learners' real world. This result was rather unexpected because teachers in this category completed their professional training at a time when constructivism received huge recognition.

All the participants in this category, however, viewed language and culture as influential to acquisition of mathematical knowledge. This view is consistent with the constructivist view that learners must create knowledge in their social and cultural contexts (Bentley, 2003).

The results in general, show that the participants in the category of teachers with less than 5 years of teaching experience had some awareness of constructivist teaching theories. There were certain areas of inconsistency shown but, on the average, it can be concluded that a fair constructivist view was held by the teachers in this group.

Table 5

Teachers with 5 – 10 years of teaching experience and their awareness of constructivist theories of learning

N = 3 [Participant ID # 2, 3, 4]

Q#	***Statement***	***Results***
1	I have a clear understanding of constructivist teaching theories	2 out of 3 agree
2	Constructivist teaching models allow learners to create their own mathematical knowledge	3 out of 3 agree
3	Constructivist teaching models recognize the teacher as the source of mathematical information	2 out of 3 agree
4	Constructivist theories recognize the learner's environment as the source of mathematical information	0 out of 3 agree
5	The learner's language and culture do not influence his/her acquisition of mathematical knowledge	2 out of 3 agree
6	Learners effectively acquire mathematical knowledge when they listen to the teacher's' explanation carefully	2 out of 3 agree

In this category, three teachers had teaching experience ranging from five to ten years. Two out of three teachers in this category agreed that they had a clear understanding of constructivist theories. All teachers in this category agreed that learners construct their own knowledge.

However, out of the three teachers in this category, two of them thought language and culture did not influence learners' acquisition of mathematical knowledge. As stated by Woolfolk (2010), constructivists maintain that learning takes place when learners interact with other people in their cultural settings. The results from teachers in this group also showed that none of the three teachers believed that mathematics knowledge existed in the environment of the learner. This contradicts the claims by constructivist theorists that the learner's social context is a rich source of mathematical knowledge. The results therefore, show that teachers in this category did not have a complete awareness of constructivist theories. Interestingly, one of the teachers out of the potential 28 teachers that were targeted by this study told this researcher that the reason he did not want to participate in the study was because he did not know what constructivism was. Apparently, he had been teaching mathematics for the past 10 years.

As stated earlier, teachers in this category did not show adequate evidence that they understood constructivist theories. Lack of understanding of constructivist theories by mathematics teachers can impact negatively on the selection of constructivist strategies because teachers who believe that they are the source of knowledge are likely to tell learners what knowledge to memorise without creating conditions that allow critical and creative thinking. Also, as long as teachers fail to understand that the learner's environment is a rich source of mathematical knowledge, learning activities that do not match the real world of the learner will be planned, and this might lead to lack of motivation on the side of the learner.

Table 6

Teachers with more than 10 years of teaching experience and their awareness of constructivist theories of learning

N = 9 [Participant ID # 5, 6, 7, 9, 11, 12, 14, 15, 16]

Q#	***Statement***	***Results***
1	I have a clear understanding of constructivist teaching theories	9 out of 9 agree
2	Constructivist teaching models allow learners to create their own mathematical knowledge	8 out of 9 agree
3	Constructivist teaching models recognize the teacher as the source of mathematical information	4 out of 9 agree
4	Constructivist theories recognize the learner's environment as the source of mathematical information	4 out of 9 agree
5	The learner's language and culture do not influence his/her acquisition of mathematical knowledge	1 out of 9 agree
6	Learners effectively acquire mathematical knowledge when they listen to the teacher's' explanation carefully	4 out of 9 agree

There were 9 teachers in the survey who had more than 10 years of mathematics teaching experience. All of them indicated that they had a clear understanding of constructivist theories. Eight (8) out of the nine (9) teachers in this category agreed that teaching models that are associated with constructivism allow learners to create their own mathematical knowledge. Also, eight (8) out of nine (9) of these teachers indicated that language and culture play an important role in mathematical knowledge acquisition. Only 4 out of 9 of the teachers believed that the teacher was the source of mathematical information. These responses are positive indications that teachers in this category understood the role of the

teacher, the learner and the real world in which knowledge acquisition took place. Such understanding is likely to influence teaching and learning practices that are learner centred and allow learners to take responsibility for creating knowledge. The indication by teachers in this group that the teacher is not the source of mathematical information is in line with constructivist views that learners are not empty vessels but come into the learning environment with prior knowledge that can be developed through interaction with others. The teacher is just a facilitator of learning and not an informer.

There were four (4) teachers out of the nine (9) who agreed that learners effectively acquire mathematical knowledge when they listen to the teacher's explanation carefully. Four (4) out of nine (9) teachers disagreed with this statement, and only one (1) was neutral. Listening to the teacher per se will not necessarily result in knowledge acquisition. However, constructivists believe that learners must be actively involved, rather than passive, in order to acquire knowledge. Listening skills are, without a doubt, necessary for knowledge acquisition. In a constructivist classroom, learners share knowledge with others and this automatically makes listening important.

There was convincing evidence from the results that participants in this category were aware of constructivist views. The challenges of practising constructivist teaching styles by this group of teachers could therefore be attributed to other factors other than teachers' lack of knowledge and understanding of constructivist theories.

4.3.2 CONCLUSION

In Section B teachers responded to six statements that sought to determine the extent to which teachers understood constructivist theories. Overall, the responses by the teachers in the study showed that the teachers understood constructivism. This implies that teachers' failure to implement constructivist strategies in their teaching cannot be totally attributed to the teachers' lack of understanding of constructivist theories. Teachers who have an understanding of these theories have a strong base to plan their lessons around constructivist theoretical practices.

4.3.3 SECTION C: TEACHERS' PERCEPTIONS OF CONSTRUCTIVIST CLASSROOM CHARACTER

This section sought to explore the extent to which teachers perceived their classroom environments to be constructivist. Participants were asked to respond to 14 statements by indicating the extent of their agreement on a Likert scale from Strongly Agree (SA) to

Strongly Disagree (SD). The 14 statement were categorised into four groups for analysis purposes. These categories are

i. Category 1: Involvement of learners in planning learning and assessment activities
ii. Category 2: Accommodation of learners' views
iii. Category 3: Linking mathematics to the real world
iv. Category 4: Interaction amongst learners

Category 1 consisted of items 7, 8 and 9 and explored the extent to which teachers involve their learners in planning learning and assessment programmes. Category 2 consisted of items 10, 11, 12, 13 and 14 which explored the extent to which teachers accommodate leaners' views in their classrooms. Category 3 had items 15 and 16 and it explored the extent to which teachers incorporated the real world into their teaching. Category 4 had items 17, 18, 19 and 20 and it explored the degree to which learners were allowed to interact in class. The findings are presented in Tables 7, 8, 9 and 10 below.

4.3.3.1 CATEGORY 1: LEARNER INVOLVEMENT IN PLANNING LEARNING AND ASSESSMENT ACTIVITIES

There were three Likert items in the questionnaire which sought to investigate the extent to which teachers involved learners in planning learning and assessment activities. Carl (2009) emphasises the need for teachers to be empowered through involving them in planning the curriculum at all stages of curriculum development. If teacher involvement in curriculum planning motivates teachers, then learner involvement in planning learning and assessment activities must be a motivating factor to learners. Table 7 shows the extent to which teachers in the current study involved their learners in learning and assessment activities.

Table 7

The extent to which teachers involve learners in planning learning and assessment programmes

[Likert Items 7, 8 and 9] NR = No Response or Neutral

Item No.	***Statement***	***Results***		
		Yes	*NR*	*No*
7	I always involve my learners in deciding which topics they will learn	2 12.5%	0 0%	14 87.5%
8	I always plan the assessment programme with my learners	3 18.75%	0 0%	13 81.25%
9	I always consult my learners for their views on learning activities	7 43.75%	2 12.5%	7 43.75%

Two (2) out of 16 teachers indicated that they always involved learners in deciding which topics to teach. Three (3) teachers out of 16 indicated that they planned their assessment activities with their learners and seven (7) out of 16 teachers indicated that they consulted their learners for their views on learning activities. The two (2) teachers who involved their learners in deciding topics to be learnt also indicated that they planned their assessment with them. Seven (7) out of 16 teachers indicated that they considered learners' views on learning activities. The statistics indicate that involvement of learners in the planning stages of learning was not a priority among the respondents.

4.3.3.2 CATEGORY 2: ACCOMMODATION OF LEARNERS' VIEWS

Constructivist strategies place importance on the learners' views. In problem based and problem centred approaches, learners work in groups and share their views as they reflect on the problem at hand. The teacher as a facilitator is expected to allow learners to share their ideas which may be different from those of the teacher. Table 8 shows the extent to which teachers in the current study created conditions that allowed their learners to share their views. Likert items 10, 11, 12, 13 and 14 addressed this aspect.

Table 8

The extent to which teachers accommodate learners' views

[Likert items 10, 11, 12, 13 and 14]

NR = No Response or Neutral

Item No.	***Statement***	***Results***		
		Yes	*NR*	*No*
10	I always allow my learners to question my views in mathematics	13 81.25%	3 18.75%	0 0%
11	I don't allow my lessons to be derailed by my learners	9 56.25%	3 18.75%	4 25%
12	I allow my learners to use their own methods in solving problems	13 81.25%	2 12.5%	1 6.25%
13	I am fine when my learners don't use the method I spent the whole lesson explaining to them	11 68.75%	2 12.5%	3 18,75%
14	I insist that my learners use the formulae that I give them to arrive at the correct answers	5 31.25%	0 0%	11 68.75%

The results indicate that the participants allowed learners to express themselves in the process of learning mathematics. Thirteen (13) out of 16 teachers indicated that they allowed learners to question their views, and the same number indicated that they had no problem with their

learners using their own methods to solve problems. Eleven (11) out of 16 participants indicated that they were fine when their learners did not use the method the teachers would have spent time explaining. The same number also indicated that they did not insist on their learners using the given formulae to reach an answer. This shows that the respondents respected the view that learners have the ability to create their own patterns which can lead them to an acceptable conclusion. This view is consistent with constructivism and leads to a conclusion that teachers in the current study upheld the constructivist value of creating conditions through which learners critically created mathematical knowledge.

4.3.3.3 CATEGORY 3: LINKING MATHEMATICS TO THE REAL WORLD

Constructivist strategies emphasise that learners must be presented with learning situations that relate to their social and personal environment. The teacher's role is seen as that of a facilitator who selects relevant and meaningful learning activities for learners to work through. Table 9 shows the extent to which teachers in the current study related their learning activities to the real world.

Table 9

The extent to which teachers incorporate the real world into their teaching

Likert items 15 and 16

[NR = No Response or Neutral]

Item No.	***Statement***	***Results***		
		Yes	NR	No
15	I always link my learning activities to the real world	13 81.25%	2 12.5%	1 6.25%
16	Some topics in mathematics are not possible to link to my learners' social environments	9 56.25%	2 12.5%	5 31.25%

The majority of the participants, 13 out of 16, indicated that they always linked their teaching activities to the real world. Six (6) of these 13, however, also indicated that some topics were not possible to link to the real world. Seven (7) of the participants who indicated that they linked learning activities to the real world did not agree with the statement that some topics in mathematics are not possible to link to the real world. The results show that the participants had an understanding that mathematics learning ought to be related to the real world. Constructivist strategies place importance on linking learning content to the real world because knowledge is acquired in the context of the learner's environment.

4.3.3.4 CATEGORY 4: INTERACTION AMONGST LEARNERS

A constructivist learning environment is characterised by interaction among learners. Table 10 below shows a summary of the extent to which teachers in the study created conditions for learners to interact in their classrooms.

Table 10

The extent to which teachers allow learners to interact in class

Likert items 17, 18, 19 and 20

[NR = No Response or Neutral]

Item No.	***Statement***	***Results***		
		Yes	*NR*	*No*
17	I allow my learners to ask each other questions in class	16 100%	0 0%	0 0%
18	I allow my learners to explain their views to each other	16 100%	0 0%	0 0%
19	I allow my learners to assist each other	15 93.75%	1 6.25%	0 0%
20	I require that my learners work quietly in class	5 31.25%	5 31.25%	6 37.5%

The results indicate that 100% of the respondents allowed their learners opportunities to interact with each other in class. All the respondents also indicated that they allowed their learners to explain their views to each other as well as assist each other. This practice is consistent with socio-constructivist views which emphasise that learning takes place effectively when learners ask each other questions and express their views to each other.

4.3.3.5 SUMMARY OF RESULTS: TEACHERS' PERCEPTIONS OF CONSTRUCTIVIST CLASSROOM CHARACTER

The results show that respondents perceived their classroom environments to be constructivist in character. Allowing learners to express their views encourages reflective and interactive learning and this in turn enhances understanding. The respondents also indicated that they related learning activities to the real world. According to constructivist theorists, the learners' environment plays a vital role in knowledge acquisition. Learners who interact with each other benefit from each other according to Vygotsky's social constructivism because a more knowledgeable peer can explain certain aspects of the learning activity to the less knowledgeable. The respondents in the current study indicated that their learners were afforded ample opportunities to interact with each other in the form of asking questions.

There is evidence that the respondents practised constructivist principles in their classrooms although they did not always achieve high success rates.

4.4 QUALITAITIVE DATA ANALYSIS

4.4.1 ADOPTION OF LEARNER CENTRED METHODS BY MATHEMATICS TEACHERS

Section D explored factors that impacted on teachers' selection and adoption of constructivist strategies of teaching. Respondents were asked to share their views on

i. how their learners were affected by their pedagogical attempts to employ teaching methods that encourage understanding through discovery learning, reflective learning, interactive learning, creative and critical learning (Question 22)
ii. how school curriculum affected their pedagogical attempts to employ teaching methods that encourage understanding through discovery learning, reflective learning, interactive learning, creative and critical learning (Question 23)
iii. how school and social factors affected their pedagogical attempts to employ teaching methods that encourage understanding through discovery learning, reflective learning, interactive learning, creative and critical learning (Question 24)
iv. how other factors affected their pedagogical attempts to employ teaching methods that encourage understanding through discovery learning, reflective learning, interactive learning, creative and critical learning (Question 25)

The qualitative data were analysed by categorising them into themes that emerged from the respondents' views.

Question 21 sought to determine how many respondents found learner centred methods easy to implement in their circumstances. The following table shows the results.

Table 11: *Adoption of learner centred methods in mathematics classrooms*

Question No.	***Statement***	***Results***		
		Yes	NR	No
21	Do you find learner centred methods easy to adopt in your mathematics classroom?	9	1	6
		56%	6%	38%

Fifty six (56) per cent of the respondents found the learner centred methods easy to implement in their classrooms. There was no significant difference between this percentage of respondents and the 38% that indicated that learner centred methods were not easy to implement in their classrooms.

4.4.2 TEACHERS' VIEWS ON HOW THEIR LEARNERS IMPACT ON THEIR SELECTION OF CONSTRUCTIVIST TEACHING METHODS

Participants were asked to share their views about how their pedagogy affected their learners. The table below shows a summary of their responses.

Table 12**:** *Qualitative questionnaire responses: Factors relating to Learners*

Question 22: *How are your learners affected by your pedagogical attempts to employ teaching methods that encourage understanding through discovery learning, reflective learning, interactive learning, creative and critical learning?*

P. ID#	***Q #***	***Response*** *[NR = No Response]*
1	22	Too much independent involvement causes loss of focus. Learners take the opportunity to socialise. Learners get confused when left alone to investigate.
2	22	Lack of integrating ability of different concepts learnt across the curriculum. Too dependent learners due to the CASS policy on assessment
3	22	Enhances understanding
4	22	Learners operate at different levels. There is a lot to be covered and I find myself rushing because I need to finish
5	22	Learners are lazy to do things on their own. They believe in someone spoon feeding them
6	22	My learners are not ready to learn on their own. Attempts to encourage them to learn to discover on their own have most of the time failed. Learners do not discuss mathematical matters when put into groups. A handful of learners are creative and can think critically in solving problems. Learners are passive recipients.
7	22	NR
8	22	Learners do not have the understanding of "how to learn". Learners do not have a foundation on which to build. Learners lack language ability. Lack of ability to express their learning process. Lack of motivation. No parental involvement. Lack of critical skills. Learners view active learning as "free time". Learners expect me to dictate, prescribe or lead them.
9	22	Learners are used to being fed with information. Lazy to apply their minds. Lack of problem solving and research skills
10	22	My learners tend to understand the work better through peer teaching
11	22	Lower grades love creative learning but higher grades are pressed for time
12	22	Learners are too lazy to partake or reflect. Discovery learning often leads to a lot of noise
13	22	Learners pick up methods effectively through investigation and discussion among peers Teachers must ensure that discipline is maintained and the interactive lesson does not turn into chaos
14	22	Resources are an issue time. Enjoyable and more formative beyond mathematics realms
15	22	NR
16	22	Learning discovered by self is easily understood and recalled. Learners need help and guidance. When learners discover knowledge by themselves, they always come up with simplified versions to problems

From the responses to the above question, two themes emerged as possible factors that impacted on the participants' selection and adoption of constructivist teaching strategies. These themes are

i. Lack of necessary skills by learners
   a. Focusing skills
   b. Investigative /Problem solving skills

ii. Lack of motivation by learners

The themes are presented in the following section in more detail.

4.4.2.1 LACK OF SKILLS

Several teachers reported that learners' lack of skills of one kind or another was negatively impacting on their selection of constructivist strategies. The respondents highlighted that the following skills were lacking in their learners:

a. Focusing skills
b. Investigative / Problem solving skills

Lack of focusing skills by learners

Acquisition of mathematical knowledge through discovery, interactive and critical learning necessarily requires learners to work together and reflect on concepts and skills that are embedded in the learning activity at hand. This is consistent with constructivist views which require that learning should be interactive. However, respondents indicated that when learners were given the opportunity to discover knowledge with minimum involvement of the teacher, they tended to turn it into a social activity where they discussed other issues that were not related to the purpose of the activity. Participant # 12 stated that

"…*discovery learning often leads to a lot of noise which does not work*".

This is consistent with what Participant # 13 referred to as "chaos" and noted that

"…*teachers must ensure that discipline is maintained and the interactive lesson does not turn into chaos*".

This shows that there is a tendency by learners to take advantage of such arrangements and turn them into socialising sessions. Participant # 8 noted that

"…*learners view active learning as a free lesson*".

The results show that teachers face challenges when their learners get distracted and lose focus. Also, such distractions compromise the quality of learning and teachers may not be keen to employ such methods in their teaching. Clearly, teachers need to be equipped for effective implementation of collaborative learning strategies in order for them to deal with the problem of learners turning their planned activities into free lessons.

Lack of investigative and problem solving skills by learners

Problem solving and interactive activities give learners a chance to investigate patterns and draw conclusions. Some respondents observed that their learners lacked the necessary skills for problem solving, including investigative skills. Eight (8) respondents mentioned that their learners lacked critical and creative skills for problem solving. The following respondents exemplified the lack of investigative and problem solving skills by the following statements:

Participant #2: *'Too dependent learners due to CASS policy on assessment"*

Participant #5: "*They [learners] believe in someone spoon feeding them*"

Participant #8: "*Learners expect me to dictate, prescribe or lead them to do the learning process*"

The results show that the learners were not willing to engage in discovery and investigative learning and would rather prefer their teachers to do the thinking for them.

4.4.2.2 LEARNERS' LACK OF MOTIVATION

Acquisition of mathematical knowledge through creative and critical learning requires learners to apply themselves mentally and physically. Respondents observed that their learners did not have the necessary motivation to apply themselves and discover knowledge on their own. Most of the respondents who felt that their learners were not motivated for discovery learning stated that their learners were "lazy". Participant # 12 stated that

"…*learners are lazy to partake or reflect*" while Participant # 9 said that learners were "*lazy to apply their minds*". Participant # 5 said "*learners are lazy to do things on their own*". Constructivist methods need learners that are motivated and understand the importance of discovering knowledge. Participant # 16 noted that

"*Learning discovered by oneself is easily understood and recalled – but learners need help and guidance in some cases .When learners discover knowledge by themselves, they always come up with simplified versions/approaches to problems*".

Lack of motivation to learn through discovery methods among learners suggests that the learners did not have the awareness of the benefits of such learning approaches. Participant # 8 mentioned that "*learners do not have the foundation on which to build*". Learners come into the learning situation with a certain degree of academic background. Lack of foundation implies that learners were not ready for creating new knowledge through discovery. Participant # 6 echoed the same sentiments when he stated that "*My learners are not ready to learn on their own*". The lack of necessary background and readiness to learn could be the reason for lack motivation among the learners.

Conclusion

Teachers in the current study expressed concern about lack of important skills on the side of learners. In particular, the participants pointed out that their learners failed to focus on the task at hand and tended to use the time allocated for discovery learning to socialise and engage in personal conversations. The participants also pointed out that their learners lacked motivation to learn through discovery methods and preferred to be told. Lack of parental involvement was also highlighted as one factor that contributed towards learners' lack of motivation. According to the participants in this study, teachers' efforts to employ constructivist teaching and learning strategies can be undermined by learners' lack of learning skills and motivation.

4.4.3 THE SCHOOL CURRICULUM AND HOW IT AFFECTS CHOICE OF TEACHING STRATEGIES

Participants were asked to reflect on how the school curriculum affected their pedagogical strategies, particularly in the context of constructivist ideas. The participants mentioned the following aspects among others as part of the school curriculum that impacted on their selection of constructivist teaching and learning strategies: school subjects and CAPS, subject topics in the syllabus and resources. The table below shows the responses of the participants.

Table 13: *Qualitative questionnaire responses: Factors relating to School Curriculum*

Question 23: *How does the school curriculum affect your pedagogical attempts to employ teaching methods that encourage understanding through discovery learning, reflective learning, interactive learning, creative and critical learning?*

P ID#	*Q #*	*Response [NR = No Response]*
1	23	Too many chapters condensed into one year(CAPS)
2	23	Too many subjects
3	23	Government determines the curriculum and not the school
4	23	Too much work to be covered by learners (CAPS)
5	23	Overcrowded classrooms. Educator turnover. Learners moving in and out
6	23	Infrastructure (containerised classrooms). High staff turnover. Inadequate teaching resources
7	23	NR
8	23	The curriculum is prescriptive. Time allocation. Curriculum does not allow integration of subject areas
9	23	School curriculum accommodates all various methods of assessment and learning. Time allocation
10	23	Too much content. No time
11	23	Little time
12	23	Insufficient time. "The curriculum is overfull". The curriculum is "not conducive to learning properly"
13	23	Curriculum covers a number of various sections. Time constraints
14	23	Time is never enough. Curriculum locally tailored (school based) and very flexible
15	23	NR
16	23	Constructivist teaching strategies need time. Syllabus pressures

Participants were not given a definition of "curriculum". Their interpretation of the meaning of the term, as alluded to earlier, tended to be

i. The school syllabus and the content to be learnt

ii. Other school activities like, meetings and school assemblies

The following themes relating to school curriculum were evident in the responses given:

i. Resources
   a. Time constraints
   b. Teacher turnover
   c. Size of classes

ii. Curriculum content
   a. Volume of content to be learnt
   b. Development of curriculum

The results are discussed below.

4.4.3.1 SCHOOL RESOURCES AND SELECTION OF TEACHING STRATEGIES

4.4.3.1.1 TIME CONSTRAINTS, TEACHER TURNOVER AND CLASS SIZE

Nine (9) participants mentioned that there was not enough time to cover the syllabus using discovery methods. Time is an important resource in teaching. In order for learners to create their own meaning and knowledge according to constructivist theories, they require lots of time. Participant # 16 stated that "*constructivist teaching requires time*" while Participant # 1 noted that there were "*too many chapters condensed into one year*". These views suggest that lack of adequate time is caused by the congested curriculum in terms of the content to be covered and the number of subjects to be learnt. Participant # 2 and Participant # 4 echoed this belief when they stated respectively that there were "*too many subjects*" and "*too much work to be covered by learners*".

The problem of time was echoed again by Participant # 13 in section 4.4.4 who stated that time constraints were felt "*when lesson time is used for awards and assemblies*" and "*when learners are in civvies*".

Time constraints within the curriculum require adequate planning on the side of teachers. The knowledge that time is not adequate can potentially influence the teacher's choice of teaching strategies. Some teachers may be forced to adopt teacher centred approaches because they are under pressure to complete prescribed work. On the other hand, the need for effective teaching can potentially help some teachers to develop effective learner centred strategies which allow collaborative learning. Teachers can also minimise problems that emanate from learners' lack of discipline by selecting learning activities that are interesting, challenging and meaningful to the learners.

The majority of the participants echoed the same sentiments that the school curriculum was too large for the scantily available resources. High staff turnover was another area that two participants highlighted. The same respondents also mentioned that inappropriate infrastructure and crowded classrooms worked negatively against their attempts to employ discovery methods in line with constructivist views. This showed that the school curriculum and the school resources did not complement each other, and this worked negatively against the use of constructivist methods.

4.4.3.2 CURRICULUM AND SELECTION OF TEACHING STRATEGIES

Respondents raised concerns about the curriculum which was "prescriptive". One respondent noted that '*government determines the curriculum and not the school*". Participant # 6 in

section 4.3.5 specified how this affected his choice of constructivist strategies when he stated that

"*…the printing of lesson plans for teachers to follow on a daily basis does not promote creativity. Teachers must be allowed to plan according to the learners they have (when planning is done for them, this defeats the attempts to constructivist methods*".

Government efforts to assist teachers by supplying them with ready-made lesson plans was perceived as detrimental since the lesson plans did not take each leaner's needs into account. There was an outcry about the volume of the content that needed to be covered and the many subjects that needed to be studied by learners. In particular, the curriculum was perceived by the participants as divorced from reality in the sense that the participants did not feel that they owned it and their learners did not cope with its demands.

Conclusion

The participating teachers expressed concern over the school curriculum that did not match the available resources. There was no time and human resources to meet the demands of the school curriculum, and this impacted negatively on the teachers' selection and adoption of constructivist teaching and learning strategies.

4.4.4 SOCIAL FACTORS AND SELECTION OF TEACHING STRATEGIES

Participants were asked for their views on any social issues that impacted on their adoption of constructivist strategies. The responses show that two factors were of concern to the respondents, namely

i. Learners' family background
ii. Learners' lack of discipline

The table below shows the responses that were given by the participants.

Table 14*: Qualitative questionnaire responses: School and Social factors*

Question 24: *How do school and social factors affect your pedagogical attempts to employ teaching methods that encourage understanding through discovery learning, reflective learning, interactive learning, creative and critical learning?*

P ID#	*Q #*	*Response [NR = No Response]*
1	24	Laissez faire approach. Disinterested attitude. Peer pressure or concern for acceptance by others. Respect. Challenge authority.
2	24	Social background of learners. Single parent households. Household chores – no time for homework
3	24	NR
4	24	No resources
5	24	Poverty. Poor backgrounds. Over-aged learners. Drugs. Ill-discipline. Bullying. Parents not playing their role. No teacher-parent interaction.
6	24	Family background. Child headed families. Single parenting. No role models. Parents and school not working together.
7	24	NR
8	24	Poor dysfunctional social backgrounds. No motivation to learn. No parental involvement
9	24	Struggling background. No computers to use as tools of learning at home
10	24	School has computer centre to support learning
11	24	Use of white boards only – no smart and interactive boards
12	24	Interruptions. Social media much more important than spending time on their school work
13	24	Time constraints. Lesson time used for awards, assemblies and civvies. Rowdy behaviour.
14	24	Socio economic statuses sound on average. Most students well exposed fairly resourced and sponsored families and society well supportive. Multi religious - students from varying religious backgrounds. Each religion beliefs to be taken aboard to avoid segregation/apathy/prejudice
15	24	NR
16	24	Learners come from different backgrounds, some with serious educational challenges. To put them all in one basket and hope that they will all understand is detrimental. Learners from grounded backgrounds will always do better compared to their classmates

The impact of learners' family backgrounds and leaners' disciplinary issues is presented below.

4.4.4.1 LEARNERS' FAMILY BACKGROUNDS

Responses in Table 14 and Table 15 show that participants considered parental involvement in the education of their children as critical. The respondents expected parents to work cooperatively with teachers and schools in guiding children through their education. Participant responses showed that some learners came from single parent families, while others came from child headed families. This set up according to Participant # 6 and Participant # 8 inevitably left learners without role models and motivation. Highly motivated learners stand a good chance to benefit from discovery methods. Constructivist learning allows for learners to discover patterns and relationships and this requires interested learners.

The general observation by participants was that family background impacted on learners' opportunities to learn. Participant # 16 focused on the difficulty that resulted from teaching learners who came from different backgrounds, and pointed out that

"*Learners come from different backgrounds, some with serious educational challenges. To put them all in one basket and hope that they will all understand is detrimental*".

The respondent further elaborated that

"*Learners from grounded backgrounds will always do better compared to their classmates*".

The well-grounded backgrounds of learners was echoed by another respondent who stated that the socio economic status of his learners was

"*…sound on average. Most students [are] well exposed, fairly resourced and sponsored, families and society well supportive*."

The results suggest that the respondents' success in constructivist learning partly depends on parents' awareness of such learning and teaching strategies. Knowledgeable parents are likely to contribute positively by creating family backgrounds that support creative and critical learning. Parental involvement becomes a way of reducing the gap between home and school in terms of educational practices and expectations.

4.4.4.2 LEARNERS' DISCIPLINARY ISSUES

There were indications from the responses gathered that learners had disciplinary issues that interfered with effective constructivist teaching. According to Participant #1

"*Social factors are problematic as many learners adopt a laissez faire attitude/disinterested attitude in class due to peer pressure or concern of acceptance. Generations nowadays earn respect from their peers by their ability to shock and awe and challenge authority*".

The respondent's view was echoed by other participants who used such terms as "ill-discipline" and "rowdy" to describe the behaviours of their learners.

The social media was also blamed for learners' lack of academic discipline. Participant # 12 mentioned that

"*There are often interruptions with other things which take away time from learning. Learners find other things like social media much more important than spending time on their school work*".

The findings show that lack of discipline and other related issues affected teachers in their attempts to implement constructivist teaching strategies because learners lacked the discipline to balance social life with academic life. Creativity and discovery are reduced when learners spend their time in social media activities. Interaction is minimised when learners spend most of their time on their cell phones.

Conclusion

Participants in the current study indicated that they were affected by their learners' family backgrounds and their learners' lack of discipline in their efforts to create constructivist learning environments. Parents and teachers need to work together more closely in order to create a link between school and home.

4.4.5 OTHER FACTORS THAT IMPACT ON TEACHING METHODS

The table below shows some responses that the participants gave as other factors that impacted on their selection of constructivist teaching strategies. The other factors that some participants mentioned included: Government intervention policies and Curriculum policies.

4.4.5.1 GOVERNMENT'S INTERVENTION POLICIES

Participant # 6 was concerned about the lesson plans that were prepared for teachers by other education authorities. The respondent stated

"*While teachers are guided by schemes of work and assessment plans, the printing of lesson plans for teachers to follow on a daily basis does not support creativity on the part of the teacher. I believe anyone can be taught anything provided it is reduced to their level of understanding, hence teaching from known to unknown, simple to complex concepts. As a teacher one should plan according to the learners' he/she has. Now, when planning is done for one, this really defeats attempts to constructivist methods*".

This statement suggests that educational authorities had some doubts about the ability of teachers to plan, and hence they prepared lessons plans for them. It also raises questions about the quality of training teachers received before they were posted into schools to teach. The respondent felt that that practice reduced his creative powers.

4.4.5.2 CURRICULUM POLICIES

Participant # 14 alluded to some curriculum policies that schools found themselves having to follow when he stated that

"*Team teaching where teachers have to synchronise their paces and write common exams…*"

The respondent was referring to set ups where more than one teacher in the same school taught the same grade. Such teachers must ensure that they are covering more or less the same content and must pace their lessons so that there is no class that is disadvantaged when examinations come. One teacher in this arrangement might be more constructivist than the other and this is likely to cause problems.

Table 15 is a summary of the other factors that teachers raised.

Table 15: *Qualitative questionnaire responses: Other Factors*

Question 25: What other factors affect your pedagogical attempts to employ teaching methods that encourage understanding through discovery learning, reflective learning, interactive learning, and creative and critical learning?

P ID#	*Q #*	*Response [NR = No Response]*
1	25	Number of learners in the class too large. Resources scarce. Home background – upbringing. Mathematical grounding.
2	25	Negative attitude of learners Laziness of learners. Lack of intrinsic motivation.
3	25	No willingness by learners to discover knowledge themselves
4	25	Learners tend to "solve [problems] according to their understanding – not according to the steps that some theorists suggest
5	25	NR
6	25	The printing of lesson plans for teachers to follow on a daily basis does not promote creativity. Teachers must be allowed to plan according to the learners they have (when planning is done for them, this defeats the attempts to constructivist methods
7	25	NR
8	25	Technology (no access to computers/notepads/internet). Learners do not take responsibility for their own learning. Work ethic is poor.
9	25	Parental involvement lacking
10	25	NR
11	25	Time
12	25	Pupils' work ethic. Other teachers' resistance to creativity. Lack of basics. National examinations at the end of Matric
13	25	Size of class (smaller classes are easier to manage, hence class discussion and interaction is much more effective)
14	25	Team teaching where teachers have to synchronise their paces and write common scheduled exams
15	25	NR
16	25	Cultural background. Race and religious beliefs can affect learners' abilities to discover learning

4.5 CONCLUSION

The results and findings from the questionnaire were presented and analysed in this chapter. The quantitative data showed that participants were aware of constructivist theories. The results also showed that the teachers endeavoured to create constructivist classroom environments. Participants upheld learners' views and created environments that supported sharing of ideas through interaction. The teachers also related learning activities to the real world. Qualitative data results indicated that learners lacked necessary skills to focus on the learning activities without distraction. Learners also lacked the necessary motivation to acquire knowledge through discovery. The curriculum was viewed as too congested for the amount of available time and human resources. The fact that the curriculum was developed by authorities other than the teachers themselves posed a problem for the constructivist teacher because creativity was compromised. There were social factors that were identified as detrimental to all constructivist efforts. Poor family backgrounds and learners' lack of discipline impacted negatively on the selection of constructivist methods. Some government's intervention policies like preparing lesson plans for teachers and some curriculum practices like sharing of the same grade by more than one teacher had negative effects on the attempt to practise constructivist strategies.

5. DISCUSSION, RECOMMENDATIONS AND CONCLUSION

5.1 INTRODUCTION

This chapter presents the discussion, implications and limitations of the findings that emerged from the mathematics teachers' responses to factors that influenced their adoption of constructivist teaching methods. The findings showed that data collected from the quantitative and the qualitative survey complemented each other. Quantitative findings showed that respondents in the current study had an understanding of constructivist theories. Also, there was evidence that the participants made efforts to employ constructivist teaching strategies in their mathematics classrooms. Qualitative data findings confirmed that mathematics teachers faced challenges when they attempted to adopt constructivist teaching strategies. The two sets of data findings will be synthesised and viewed in relation to constructivist theories to determine their meaning.

5.2 DISCUSSION OF FINDINGS

5.2.1 TEACHERS' AWARENESS OF CONSTRUCTIVIST THEORIES

The problem of adopting constructivist teaching strategies in mathematics classrooms should start by addressing the question of awareness of these theories and strategies. Teachers who have undergone teacher training in the 21st and 20th centuries should have had an opportunity to gain knowledge of and insight into these theories during the course of their teacher education.

As noted in section 4.3.1, teachers in the survey showed some degree of awareness of constructivist theories. However, it was noted that there were some inconsistencies in the teachers' responses to certain statements in the questionnaire. Some respondents did not identify with certain constructivist belief statements in the questionnaire despite stating that they understood constructivist theories. In particular, statement # 4 in the questionnaire required teachers to indicate their degree of agreement or disagreement about the learners' environments as sources of mathematical information, and it stated that

"*Constructivist theories recognise the learner's environment as the source of mathematical information*".

Only 5 out of 16 teachers (31%) agreed with this statement. Arguably, acquiring mathematical knowledge through constructivist models cannot be realised without taking the learner's environment into account. It is very important that mathematics teachers develop a

clear understanding of what mathematics is, and how mathematical knowledge is acquired. This understanding will influence the teachers' choice of teaching methods.

As noted earlier in section 2.2, Platonic absolutists believe that mathematical knowledge is universal and absolute truth that exists independently outside the learners' minds (Taylor et al., 1994). Acquiring mathematical knowledge as implied by this point of view would require learners to rely on the teacher or some other valid source of mathematical knowledge since they themselves may not have acquired such knowledge yet. This would further imply that learners have no prior knowledge when they come into the classroom, and also that they cannot create their own mathematical knowledge from their circumstances since that would not be recognised as valid knowledge.

On the other hand, social constructivists see mathematics and mathematics knowledge as part of the knower. According to this view, mathematical knowledge is acquired when the learner interacts with his or her environment. This implies that the learner's environment has a huge impact on mathematical knowledge acquisition. According to Jonassen (1994) cited by Murphy (1997), the learner's environment plays an important role in knowledge acquisition. Jonassen states that in order to facilitate knowledge construction, the teacher must design instruction in such a way that reality and the complexity of the real world are presented. This means that learning activities must be designed around the learner's real world. Ernest (1995:485), cited by Murphy (1997) states that constructivist instructional design must create an

"*…awareness of the importance of social contexts, such as the difference between folk or street mathematics and school mathematics...*"

The above views prove that teaching in a constructivist environment is not complete without factoring in the learner's environment. Learners bring into the learning environment some knowledge that they would have created from the communities they live in, and such knowledge must be considered by the teacher as valid in the context of the learner's environment. For example, when I asked a Grade 8 learner to calculate the discount when a laptop that was initially marked at R5999.50 was sold at 6% discount, the learner gave the following response:

Discount = 6% of R6000 = R360

When the learner was asked to explain why he used R6000 instead of R5999.50, he stated that when shops say R5999.50, they actually mean R6000. There was nothing wrong

contextually about the learner's answer since this is what the real life economics had taught him, but mathematically, some degree of accuracy was compromised.

There is a need for more constructivist educational programmes to be planned for teachers in service so that they keep updated on the subject and they increase their awareness on constructivist teaching. Knowledge is revolving very fast nowadays because of technological advancement, and that means that what teachers learnt 5 years ago during their training must be upgraded since it is likely to be out-dated.

5.2.2 TEACHERS' PERCEPTIONS OF CONSTRUCTIVIST CLASSROOMS: LEARNER INVOLVEMENT

Participants in the current study indicated the extent to which they applied some constructivist principles in their classrooms. Their responses were collected under the following categories:

i. learner involvement
ii. learner views
iii. relating mathematics to the real world
iv. interaction amongst learners

The findings showed that learners were encouraged to share their views with the class as part of the practice of learning. Learners were also encouraged to interact with other learners in order to promote and enhance understanding. Participants also indicated that they sometimes related mathematics content to the real world, but noted that there were some topics in mathematics that were not easy to relate to the real world. There was no evidence that teachers involved their learners in the planning of learning and assessment activities.

The results confirmed that the process of creating a constructivist teaching and learning environment at times failed because of certain factors that worked against the teachers' efforts. In particular, the idea of involving learners in planning stages in my view is a very noble and necessary one for knowledge construction by learners. The reason teachers may not involve their learners in the planning of learning and assessment activities could be that they themselves are not fully involved in the planning and development of the curriculum. As stated in section 1.2, teaching and learning can be optimised when, according to Carl (2005), the teacher is given the opportunity to make his or her voice heard in the early stages of curriculum planning instead of just coming in as an implementer. As stated in section 4.4.3.2, some teachers found some government intervention policies as hindrance to constructivist

teaching. When teachers are given ready-made lesson plans to follow in their lessons, creativity and relevance are removed from the environment because those plans may not be appropriate for the learners that they aim to benefit. A teacher who is using a ready-made lesson plan, therefore, has no reason to try and involve his or her learners at the planning stages.

Learner involvement is crucial in constructivist learning because it ensures active and creative learning. Teachers can involve their learners at all the stages of their teaching. For example, all assessment dates and content can be discussed in class with the learners at the beginning of each school term. This will give learners some sense of responsibility because they would have been involved in choosing the dates, the time and the length of those assessments. Good questions are likely to emerge from such an approach because learners may want to understand the purpose of the assessment and so forth.

5.2.3 FACTORS IMPACTING ON ADOPTION AND SELECTION OF CONSTRUCTIVIST TEACHING STRATEGIES

Factors impacting on the selection and adoption of constructivist strategies by mathematics teachers were grouped into the following three categories

i. Learners
ii. School curriculum
iii. Social factors
iv. Other factors

This section discusses the findings from these categories.

5.2.3.1 HOW LEARNERS IMPACT ON THE SELECTION OF CONSTRUCTIVIST STRATEGIES BY MATHEMATICS TEACHERS

The current study explored the impact learners had on the selection of constructivist strategies by mathematics teachers. It was found that teachers in the survey believed that learners did not possess certain necessary skills that supported construction of knowledge. In particular, respondents indicated that their efforts to be constructivist were frustrated by learners who lost focus and motivation to investigate and create knowledge. Learners were also reported to be tending to turn constructivist environments into chaos by making noise or turning the lesson into a free lesson. In some cases, learners took advantage of the constructivist set up to earn popularity from their peers by displaying disrespectful behaviours towards their teachers. Respondents also reported that their learners lacked

motivation and did not display skills to investigate knowledge in problem solving contexts. In particular, teachers indicated that learners expected their teachers to supply them with solutions because they were lazy to apply themselves.

Constructivist theories of learning have implications for the role of the teacher and that of the learner. According to Plourde and Alawiye (2003), Tuncel (2009) and Anthony (1996), the teacher's role in constructivist learning is that of a facilitator; while that of the learner is to actively construct their own knowledge. The teacher, according to Woolfolk (2010) has the responsibility to provide leaners with situations that allow learners to actively construct knowledge. This, therefore, means that the objectives of employing constructivist approaches will always fail if learners choose not to cooperate with their teachers' efforts to create such learning environments. There is need for teachers to help learners understand why certain teaching strategies, particularly constructivist strategies, are beneficial to them. Taylor, et al. (1994) suggests that a constructivist learning environment must allow negotiation within a social context. Teachers can achieve this by finding creative ways of capturing their learners' interest so that the learners find reason to cooperate with constructivist approaches. There is likely to be some perceived resistance if learners do not have a sense of ownership of the learning environment. If knowledge must be constructed by the learners in their social context, then it follows that the learners must have a certain degree of freedom to define the classroom atmosphere that must prevail for them. Such an atmosphere may not be easy to create but it would be necessary for teachers to instil some sense of responsibility by affording their learners the opportunity to create a classroom environment that works for all of them. Learners who are involved in this manner are likely to support the teachers' efforts that allow them to construct their own knowledge.

The outcry by teachers about their learners having difficulties focusing attention on the task at hand is a major problem for teachers. As noted in sections 4.4.2.1 and 4.4.2.2, participants in the current study noted that their learners did not display acceptable behaviours during their lessons, and lacked the ability to work independently. Young, West, Li and Peterson (1997) argue that teachers who face such behavioural challenges need to adopt strategies that give the responsibility for good behaviour to the learner instead of the teacher. Young, et al. (1997) propose that learners should be taught self-monitoring and self-evaluation skills with which they can rate their own quality of behaviour during lessons and determine whether that level of behaviour meets the set or expected standards. The teacher then comes in to reinforce

positive behaviour so that it can be repeated. Unless learners take responsibility for their own learning, and respect the conditions that the teacher has set for the learning of a particular skill or concept, constructivist teaching strategies will be a frustration for the teacher to adopt.

According to Ang and Wang (2006), the learners' roles in active learning include learning through inquiry and taking responsibility for one's own learning. In other words, learners must be cognitively and affectively engaged in the learning process in order to construct knowledge. Learners are expected to do the exploration of knowledge instead of relying on the teacher for the outcome. The teacher's role should always be that of a facilitator and a guide. Self-management skills as suggested by Young et al. (1997) need to be inculcated in primary school so that learners grow up with the understanding that they must take responsibility for their behaviours and their learning so that the teacher can effectively meet their other academic needs.

5.2.3.2 HOW THE SCHOOL CURRICULUM IMPACTS ON SELECTION OF CONSTRUCTIVIST STRATEGIES

There was a general outcry from the participants about the mismatch between resource allocation and curriculum demands. The requirements of the curriculum did not, in the view of the respondents, have adequate resources allocated for them. Some of the scanty resources included time, learning space, teachers, learning and teaching tools like computers. Teachers expressed concern about too much work that needed to be covered in a year and little time to cover them in. In some cases inadequate teaching resources were a major hindrance. Participants also raised concerns about some curriculum policies including the printing of lesson plans for them to follow. The next section discusses the rationale for government intervention in the form of assisting teachers with drawing schemes of work and planning lessons.

The reasons for printing lesson plans for teachers to follow were given by the MEC for Education Ms Barbara Creecy in a speech she delivered on the occasion of the tabling of the annual report of the Gauteng Department of Education in the Gauteng Legislature on 6 September 2013. The minister mentioned that the Gauteng Primary Literacy and Mathematics Strategy (GPLMS) was an attempt to address the low levels of numeracy in the province. This intervention saw 6500 teachers in the project receiving lesson plans for every term (South Africa Government Online, 2013). This assistance by government was aimed at improving teachers' ability to deliver curriculum content. This stance is evidence that

shortage of resources is a real problem in the province. With respect to the teacher and the learner, time and teaching resources pose a challenge to effective constructivist teaching and learning. But, more disturbing is the reality that mathematics teachers may not possess the necessary skills to deliver effective lessons due to lack of appropriate training, leading to government intervening to try and address the matter. McCarthy and Oliphant (2013) give evidence of the poor state of mathematics teaching in South Africa when they mention that there are cases where teachers do not possess adequate content knowledge in the subject areas they teach, and they cannot even answer questions in that subject. McCarthy and Oliphant (2013:5) state that

"…in data collected in 2007, the majority of Grade 6 teachers in South Africa cannot answer a question that their learners ought to be able to answer based on the Grade 6 curriculum…"

This state of affairs is perceived by Taylor (2011), cited by McCarthy and Oliphant (2013), to be detrimental to learner performance. Taylor states that learners perform poorly in mathematics due to poor subject knowledge. This justifies some efforts by government to intervene and try to correct some anomalies, but in the process this might compromise some constructivist principles because too much planning for practitioners from the top can potentially take away their creativity.

A possible reason for education authorities to supply teachers with ready-made schemes of work and lesson plans is the fact that the majority of the teachers in schools are not competent enough to do it themselves. The schemes of work and the lesson plans that schools receive are not meant to be considered as prescriptive, but must help in giving the teacher some guidelines in implementing the requirements of the curriculum. The lack of competently trained teachers impacts negatively on the requirements of the curriculum. There is need for strategies to be found that will help equip mathematics teachers with skills to teach effectively. But, as alluded to in section 4.4.3.2, government intervention is not always perceived by some teachers to be working positively for an aspiring constructivist teacher. Too much spoon feeding by government is likely to reduce the levels of creativity on the side of the teacher. In order to engage learners in creating knowledge, learning tasks need to be realistic. A ready-made lesson plan created outside the context of the learners may not relate to the learners' experiences. Some of the learning tools that the lesson plan may suggest for the lesson may actually not exist. So, in addition to supplying teachers with teaching guidelines as suggested in ready-made lesson plans, government must equip teachers with

skills to plan for lessons. Well trained and adequately equipped teachers are in a better position to develop plans and activities that are contextually appropriate to their learners. Also, well trained and competent teachers should not have any problems with ready-made lesson plans because necessarily, they possess skills to pick from such lesson plans what works for them and their learners. As stated earlier, government can continue to supply teachers with ready-made plans, but deliberate plans to train and equip mathematics teachers with planning skills will go a long way to improve the quality of mathematics teaching.

5.2.3.3 HOW SOCIAL FACTORS IMPACT ON ADOPTIN OF CONSTRUCTIVIST STRATEGIES

Learners' background emerged as a major social factor that impacted negatively on adoption of constructivist strategies. In particular, participants alluded to the reality that learners from different family backgrounds did not have similar learning opportunities, and putting them in the same group could frustrate constructivist efforts by teachers. Lack of parental involvement and cooperation with teachers in the education of children were mentioned as areas of concern. Participants also linked learners' behavioural and disciplinary matters to family and social background.

OECD (2005) cited by Spaull (2013) concluded that learner background factors influence the learner's performance, although these factors are beyond the control of education policies. Parental involvement in the education of their children is undeniably critical. Teachers expect parents to assist them teach by assisting their children with resources, support and motivation. Some respondents raised concern that some learners did not have models to emulate in their society and this caused their efforts to teach constructively to be frustrated because the learners lacked motivation to learn.

Participants also mentioned that cultural background and upbringing were important factors that could impact on adoption of constructivist methods. Family background factors require that the learner's language, beliefs and socio-economic status be taken seriously when planning mathematics lessons. It makes a lot of sense, therefore, that parents should be actively involved in interacting with the school and teachers in order to appreciate their role in their children's construction of knowledge. Parents and teachers can develop a tradition of cooperating with each other which will help both parties to work as a team.

5.3 IMPLICATIONS OF THE FINDINGS

The findings have several implications for the teaching of mathematics in a constructivist manner. Some of these are presented below.

If mathematics teachers are not well grounded in constructivist teaching theories and methodologies, then mathematics classroom practices will continue to be characterised by traditional teaching methods where teachers simply tell learners what they need to know. As a result of this, opportunities for learners to acquire problem solving skills will be curtailed leading to the production of unskilled graduates who are not able to contribute effectively in the global society.

Empowered teachers who have full understanding of constructivist theories, stand a chance to influence all stakeholders in mathematics education to adopt constructivist learning attitudes. Teachers play a crucial role in shaping society, and if they are given adequate and appropriate support by government, school authorities, parents and learners, they can influence constructivist learning attitudes in schools. There is an urgent need for teacher development programmes that aim at improving the quality of constructivist teaching by teachers. These programmes should be aimed at equipping teachers with skills to handle their subjects, learners and their teaching methods. Some teachers who are rusty in some areas of mathematics content must be assisted to enrol for refresher courses. Some of these teachers have more than 10 years of teaching experience, and that means there is new knowledge that they need to keep abreast with.

This study shows a picture of mathematics teachers who are convinced that constructivist learning methods are the way forward. Unfortunately, these teachers are faced with challenges, some of which are beyond their control. If all other stakeholders were involved, the teachers would find their work easier to carry out. Parents need to understand that the way their children are brought up at home will affect their school performance. Learners, for example, who come from families where there is no cooperation and respect among family members, are likely to respond negatively to efforts by teachers to teach from a constructivist point of view. This calls for someone to bring to the attention of parents, the impact that family background has on learning and teaching. Children must not view school and home as two unrelated institutions that have nothing to do with each other. Instead, home must be an extension of school and vice versa.

5.4 LIMITATIONS OF THE STUDY

The current study was aimed at determining the factors that impacted on the selection and adoption of constructivist teaching strategies in Gauteng Urban schools. Data was collected from four (4) public schools. These schools had similar characteristics in the sense that they were located in the wealthy suburbs and towns in Johannesburg, namely Randburg, Sandton and Midrand. All the four schools were multi-racial and fees paying government schools. Out of the targeted 28 mathematics teachers, only 16, representing 57%, returned the completed questionnaires. The results obtained from this study, therefore, cannot be generalised to all other types of schools. In particular, the findings of this study cannot be assumed to be true for privately owned schools in the same areas of location because different cultures probably prevail in those schools.

The number of participants in the study was compromised when 43% of the questionnaires were not returned. This study was mainly qualitative in design and the 16 teachers who responded to the questionnaire gave complete and honest views on the subject matter. However, despite the accuracy and honesty of the responses they gave, this study cannot assume that all similar schools in the same location would have shared the same sentiments. The results obtained from the study, however, offered insightful knowledge that will help in future endeavours to improve the teaching of mathematics in a constructivist environment.

5.5 RECOMMENDATIONS

As alluded to earlier in sections 5.2 and 5.3, the following recommendations are made for future efforts to improve constructivist teaching as well as for future research.

5.5.1 INCREASE TEACHER CAPACITY TO LINK CONSTRUCTIVIST THEORIES WITH PRACTICE

The results of the study showed that participants had a fair understanding of constructivist theories although 87.5% of them indicated that they had an awareness of constructivism. The participants responded to many questions including questions about the learners, the school curriculum and the resources. The responses show that teachers have a big challenge linking the theory of constructivism with practice because, as an example, their learners are not cooperative and the curriculum is not supportive. The challenges that teachers face when their learners turn their constructivist efforts into chaos show that there is need for teachers to be empowered with skills to implement those constructivist strategies. This empowering might take the form of training teachers to be competent in selecting learning activities and

methodologies that support constructivist theories. It is recommended therefore, that deliberate and urgent efforts be made to equip teachers with constructivist skills. There is need for teachers to be trained on how to employ problem solving and problem centred teaching and learning approaches. A poor choice of learning activities and a book centred approach will possibly lead to learners' lack of interest and motivation, and this will ultimately lead to teacher frustration. Teachers who are competent in selecting and organising learning activities for their learners will possibly enjoy higher levels of cooperation from their learners. Teacher training institutions must continue to place emphasis on these theories in order to ensure that graduates have acquired the necessary skills to teach within the constructivist domain by the time they get to the classrooms. For teachers already in service, there is need for refresher workshops and short courses.

5.5.2 INVOLVE TEACHERS IN PLANNING THE CURRICULUM

The findings also showed that teachers did not always find it possible to meet curriculum demands. There were cases where curriculum expectations fell beyond the teachers' control. For example, teachers indicated that lack of resources impacted negatively on their efforts to teach constructively. This will always be the case when the teachers are not involved in curriculum planning. Teachers are in a good position to understand the contexts under which they and their learners teach and learn. They can plan with these contexts in mind, ensuring that they stand a good chance to put their plans into action. It is, therefore, recommended that teachers be involved in planning the curriculum on a larger scale. The policy statements, like CAPS, always specify the aims and methodologies of teaching and learning a subject. Teachers who are involved must know what these policies are so that they can plan the best way of successfully implementing them. Teachers, for example, find some mathematics topics difficult to relate to the real world. Such teachers probably inhibit feelings that such curriculum expectations are forced on them. Involving them at all stages will give teachers a sense of ownership and accountability, and therefore will most likely work hard to implement the curriculum.

Constructivist teaching and learning requires a lot of time. Both teachers and learners need to be afforded adequate time to plan and implement their plans. More time can be created by considering the possibility of reducing the number of subjects that learners study. Reducing Grade 12 subjects to five, for example, will not only ensure that learners get more time to master their subjects of choice in line with their career aspirations and tertiary education, but

will also release more time in the school timetable so that double lessons can be arranged where effective and thorough constructivist teaching can take place.

5.5.3 INVOLVE PARENTS TO REDUCE THE GAP BETWEEN HOME AND SCHOOL

Teachers in the study mentioned that parental involvement in the learning of their children was not of a pleasing standard. Learning must take place at school as well as at home. When learners go home, they should be able to continue learning. Teachers have limited control over family backgrounds of their learners but I recommend that ways be found by the school as well as by education authorities to educate parents on how their children learn. Schools can arrange for teacher parent meetings that aim at giving parents basic insight into how their children acquire knowledge. There are instances when parents and teachers do not agree on some aspects of the curriculum. For example, some learners are forced to choose mathematics instead of mathematical literacy by their parents who have high career hopes for them. Involved parents will be in a better position to understand their children's academic strengths and this will augur well with teachers' planning of the learning activities.

5.5.4 RECOMMENDATIONS FOR FURTHER STUDIES

The following recommendations are proposed for further investigations: Firstly, I recommend further investigation that might verify the findings of the current study to ensure that teachers and other stake holders have adequate data to tap from in their endeavours to improve teaching using constructivist strategies. In particular, a similar study could be undertaken which will include observations and interviews with the participants in order to strengthen methodological and data triangulation.

Secondly, it is recommended that further research be undertaken on the same subject covering the other type of schools which were not included in this study. This includes privately owned schools and public schools in low income townships, farming and mining areas.

Finally, I recommend that studies be carried out which aim at determining the possibility of educating parents on how children acquire knowledge with the hope of equipping them with skills to participate effectively in the education of children. The findings of such a study could help in closing the gap between school and home.

5.6 CONCLUDING REMARKS

The current study undertook to investigate factors that impact on the selection and adoption of constructivist strategies by mathematics teachers in Gauteng's urban schools. Literature study shows that constructivist strategies of teaching are more valuable than traditional strategies because they allow learners to actively and creatively construct knowledge. This study showed that although mathematics teachers understood the importance of constructivist strategies, they were not able to employ these strategies in their teaching due to several reasons including their own lack of qualifications in handling learners, parents and subject content in line with constructivist principles. Learners' family backgrounds and government intervention policies impacted negatively on the teachers' efforts to employ constructivism in their teaching. Addressing these factors as a matter of urgency will put teachers and all other role players in a better position to make the construction of mathematical knowledge a reality.

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APPENDICES

APPENDIX A: GDE RESEARCH APPROVAL LETTER

GDE Research Approval Letter.pdf

APPENDIX B: JOHANNESBURG NORTH DISTRICT APPROVAL LETTER

Jbg North Approval Letter.pdf

APPENDIX C: JOHANNESBURG EAST APPROVAL LETTER (SCHOOL 1)

HPH School.pdf

APPENDIX D: JOHANNESBURG EAST APPROVAL LETTER (SCHOOL 2)

NWK School.pdf

APPENDIX E: JOHANNESBURG EAST APPROVAL LETTER (SCHOOL 3)

MRD School.pdf

APPENDIX F: UNISA RESEARCH ETHICS CLEARANCE CERTIFICATE

REC CLEARANCE CERTIFICATE 2013 Sept Moyo.pdf

APPENDIX G: TEACHER CONSENT LETTER

Dear colleague

I, **Mr. Innocent Moyo**, am a student at the University of South Africa (UNISA), currently studying towards a Master of Education Degree in Mathematics Education. I am carrying out a research study in fulfillment of the requirements of my degree course. The study investigates the factors that impact on mathematics teachers' selection and adoption of constructivist teaching strategies for their classroom practices.

You are requested to participate in the study by completing the attached questionnaire. You were selected purposively to be part of the study because you have experience in the teaching and learning of mathematics and you can provide insightful knowledge of the factors that influence mathematics teachers in selecting effective teaching methods. The questionnaire will take you approximately 15 - 20 minutes to complete, and you are requested to complete it fully at your most convenient time during this week.

Your participation in this study is completely voluntary. If you agree to participate in the study, please sign the consent form below. If you wish to withdraw from participation at any stage, you are free to do so without any penalty. You can withdraw before or during your decision to participate even if you have signed the consent letter. You are also free to ask questions at any time should there be any issues that you want clarified.

There is no reimbursement or compensation for participating in the study. However, the results of the study will go a long way in improving classroom practices by highlighting the prevailing conditions that affect teachers in their attempt to teach mathematics effectively.

You are assured that the information collected from you will be treated in confidence and anonymity. It will not be disclosed to your superiors or to your colleagues, and will be destroyed six months after the completion of the study. You are requested to exclude your name from the questionnaire. No clues of your identity will be given in the final report.

For any research related queries, please contact my supervisor, Mr. M. Phoshoko, on +27 (012) 429 6993 or email, phoshmm@unisa.ac.za

If you need further information please contact me on the details below:

Name: Mr. Innocent Moyo

Mobile Number: 078 594 2264

Email: innoetho@gmail.com

If you agree to take part in the study, please sign the consent letter overleaf.

Your assistance will greatly be appreciated.

Kind regards

Innocent Moyo

APPENDIX H: CONSENT FORM

I……agree to participate in Innocent Moyo's research study.

The purpose of the study was explained to me in writing and I am voluntarily participating.

I understand that I can withdraw from the study at any time, before or during the study, without any penalties.

I understand that my identity will not be disclosed by the researcher, and my name may not be quoted in the final report.

Signed: ……

Date: ……..

APPENDIX I: CONSTRUCTIVIST QUESTIONNAIRE FOR TEACHERS

August 2013

Dear Mathematics Educator

I, Innocent Moyo, am a student at the University of South Africa (UNISA) currently studying towards a Master of Education Degree in Mathematics Education. For my dissertation, I am doing research to determine the factors that impact on the mathematics teachers' selection of constructivist teaching strategies.

I am kindly requesting you to participate in this research study by completing the attached questionnaire. The questionnaire should take approximately 15 - 20 minutes to complete. You are assured that the information gathered will be treated anonymously and confidentially, and therefore, your name need not be included.

Kindly answer all the questions honestly. Participation is strictly voluntary. Thank you for your willingness to assist me in my research.

Sincerely

Innocent Moyo
Student number: 48041750
Cellphone: 0785942264
Email address: innoetho@gmail.com

Section A: Background Information

Please supply your background information. You are assured that this information will be treated anonymously and confidentially. Please do not write your name on the questionnaire. Your cooperation is appreciated.
Indicate your choice by placing a cross (X) in the bracket [ ].

1. What is your gender? Male [ ] Female [ ]

2. What Grade(s) do you teach?
   Grade 8 [ ] Grade 9 [ ] Grade 10 [ ] Grade 11 [ ] Grade 12 [ ]

3. For how many years have you been teaching Mathematics?
   Below 5 [ ] 5 – 10 [ ] Above 10 [ ]

4. How many years ago did you obtain your Mathematics teaching qualification?
   Below 5 [ ] 5 – 10 [ ] Above 10 [ ]
5. What type of school do you teach at?
   Public [ ] Private/Independent [ ] Other [ ] (Specify)…….

Section B: Teachers' Awareness of Constructivist Theories of Learning

This section explores the extent of your awareness of constructivist teaching and learning models. Please circle your choice using the following scale. If you want to change your response, cross it out and circle the wanted one.

SA – Strongly Agree

A – Agree

N – Neutral

D – Disagree

SD – Strongly Disagree

1. I have a clear understanding of constructivist teaching theories	SA	A	N	D	SD
2. Constructivist teaching models allow learners to create their own mathematical knowledge.	SA	A	N	D	SD
3. Constructivist teaching models recognize the teacher as the source of mathematical information.	SA	A	N	D	SD
4. Constructivist theories recognize the learner's environment as the source of mathematical information.	SA	A	N	D	SD
5. The learner's language and culture do not influence his/her acquisition of mathematical knowledge.	SA	A	N	D	SD
6. Learners effectively acquire mathematical knowledge when they listen to the teacher's' explanation carefully.	SA	A	N	D	SD

Section C: Teachers' Perceptions of Constructivist Classroom Character

This section explores the extent to which teachers perceive their classroom environments to be constructivist in character. Please circle your response to indicate the extent to which you agree or disagree with the given statement. You can change the response by crossing it out and circling the right one.

SA – Strongly Agree A – Agree N – Neutral D – Disagree SD – Strongly Disagree

7. I always involve my learners in deciding the topics they will learn.	SA	A	N	D	SD
8. I always plan the assessment programme with my learners.	SA	A	N	D	SD
9. I always consult my learners for their views on learning activities.	SA	A	N	D	SD
10. I always allow my learners to question my views in mathematics.	SA	A	N	D	SD
11. I don't allow my lessons to be derailed by my learners.	SA	A	N	D	SD
12. I allow my learners to use their own methods in solving problems.	SA	A	N	D	SD
13. I am fine when my learners don't use the method I spent the whole lesson explaining to them.	SA	A	N	D	SD
14. I insist that my learners use the formulae that I give them to arrive at the correct answers.	SA	A	N	D	SD
15. I always link my learning activities to the real world.	SA	A	N	D	SD
16. Some topics in Mathematics are not possible to link to my learners' social environments.	SA	A	N	D	SD
17. I allow my learners to ask each other questions in class.	SA	A	N	D	SD
18. I allow my learners to explain their views to each other.	SA	A	N	D	SD
19. I allow my learners to assist each other.	SA	A	N	D	SD
20. I require that my learners work quietly in class.	SA	A	N	D	SD

Section D: Factors impacting on teachers' selection of teaching strategies

This section explores factors that impact on teachers' selection of constructivist teaching strategies. Constructivist strategies are generally learner-centred in nature. Please kindly share your beliefs and views on the following subjects. Use the spaces provided for your response. If you need more space please feel free to use extra paper.

21. Do you find learner-centred methods easy to adopt in your mathematics classroom?(Mark your choice with a cross (X))

    Yes [ ] No [ ]

22. How are your learners affected by your pedagogical attempts to employ teaching methods that encourage understanding through discovery learning, reflective learning, interactive learning, creative and critical learning?

    _____

    _____

    _____

    _____

    _____

    _____

    _____

    _____

    _____

    _____

    _____

    _____

23. How does the school curriculum affect your pedagogical attempts to employ teaching methods that encourage understanding through discovery learning, reflective learning, interactive learning, creative and critical learning?

    _____

    _____

    _____

    _____

    _____

    _____

    _____

    _____

    _____

    _____

24. How do school and social factors affect your pedagogical attempts to employ teaching methods that encourage understanding through discovery learning, reflective learning, interactive learning, and creative and critical learning?

25. What other factors affect your pedagogical attempts to employ teaching methods that encourage understanding through discovery learning, reflective learning, interactive learning, and creative and critical learning?