

https://dspace.org/

Teachers' selection and use of tasks in the old and new curriculum.

Modau, Aloysius Stephen

2008-07-08T11:36:06Z
http://hdl.handle.net/10539/5007

Downloaded from a DSpace repository. https://dspace.org/

Teachers' selection and use of tasks in the old and new curriculum

Aloysius Stephen Modau

Supervisor: Prof Karin Brodie

A research report submitted to the faculty of Science, University of the Witwatersrand, in partial fullfilment for the degree of Masters of Science by coursework and research report.

Johannesburg, July 2007

Declaration

I declare that this research report is my own unaided work. It is being submitted for the first time for the degree of Masters of Science by Coursework at the University of Witwatersrand, Johannessburg. It has not been submitted before for any other degree or examination in any other University.

Aloysius Stephen Modau July 2007

Acknowledgements

I would like to thank the following people for their contributions towards making this study a success:

- My supervisor Professor Karin Brodie for her ongoing and fruitful advices that she gave me throughout this study
- Rasheed, Nico and Zaheera for their valuable inputs which they provided during the data analyisis of this study
- The teacher who allowed me to observe and analyse his lessons
- Learners and parents for welcoming me at their school
- The grade 10 and 11 learners who participated in the study
- My wife Mapule for being patient and caring for my children Neo and Keabetswe during my studies

Abstract

This study investigates how a teacher selects and implements mathematical tasks in the old and new curriculum. Two theoretical perspectives: constructivist theories of learning and the socio-cultural theories were discussed in order to provide a framework from which to understand how teachers work with mathematics tasks to enhance or inhibit mathematical reasoning. Data was collected from one teacher in Grade 10 (new curriculum) and Grade 11(old curriculum) in 2006 through classroom observations, video recordings and interviews. The data was analysed using Stein et al's (1996) framework for tasks at both selection and implementation phase. The findings revealed that the teacher selected tasks that required higher- level cognitive demands in the new curriculum, but at implementation the cognitive demands of the tasks declined. The analysis also revealed that there was a mismatch between theory and practice. There was little difference in approach, contrary to the teacher's claim that he was teaching the two grades differently. The study suggests that there is still a gap between theory and practice in relation to how the new curriculum had to be implemented. The study recommends that the kind of training offered to teachers on the implementation of the new curriculum has to include both theory and practice, and not theory alone.

TABLE OF CONTENTS

Contents		Page
Title page		i
Declaration		iii
Acknowledgements		v
Abstract		vii
Table of content		viii
Chapter 1: Introduction		**1**
1.1	Background to the study	1
1.2	Research questions	2
1.3	Rationale	2
1.4	The report	7
Chapter 2: Theoretical and analytical framework		**9**
2.1	Introduction	9
2.2	Mathematical reasoning	9
2.3	Tasks that enable mathematical reasoning	12
2.4	Teachers and tasks	15
2.5	Constructivism, teaching and learning	16
2.6	Socio-cultural theories, teaching and learning	20
2.7	Relationships between constructivist and socio-cultural theories	22
Chapter 3: Methodology and research design		**27**
3.1	Introduction	27
3.2	The teacher	27
3.3	The school	28
3.4	Data collection	29
	3.4.1 Video recordings and observations	29
	3.4.2 Interviews	30
3.5	Limitations in data collection	30
3.6	Validity and reliability	32
3.7	Ethical issues	33
3.8	Procedure for data analysis	34
3.9	Conclusion	35
Chapter 4: Data analysis: teacher's selection and implementation of tasks		**36**
4.1	Introduction	36
4.2	Task analysis	36
	4.2.1 Grade 10 tasks	38
	4.2.2 Grade 11 tasks	40
4.3	Task decline	42
	4.3.1 Example 1 Grade 10: Decline	45
	4.3.2 Example 2 Grade 10: Non- decline	53
4.4	Grade 11: Non- decline	54
4.5	Discussion	57
4.6	Summary	59

Chapter 5: Conclusions, implications and recommendations **60**
5.1 Findings 60
5.1.1 Criteria for selecting tasks 60
5.1.2 Tasks implementation 61
5.2 Implications 62
5.3 Recommendations 63
5.3.1 Understanding the pedagogical theories that underlie school mathematics changes 63
5.3.2 Understanding learners' mathematical thinking 64
5.4 Limitations 64
5.5 Conclusions 65

References **66**

Appendix 1: Interview schedule **71**
Appendix 2: Interviews **73**
Appendix 3: Activities presented to learners **A**

CHAPTER I
INTRODUCTION

1.1 Background to the study

I have been teaching mathematics for the past nineteen years in a secondary school. I have also been involved in marking the grade 12 examinations. In the past twelve years I have been a marker and senior marker in both mathematics paper I higher grade and standard grade. My experience as a teacher and a marker has shown me that many learners are not comfortable answering questions where they have to explain their solutions. Recently the new curriculum has been implemented and it requires learners to explain their solutions. The new curriculum encourages learners to make sense of their solutions rather than accepting them as either right or wrong. With the call for such responses from learners, teachers are expected to give learners opportunities to explain their solutions and also to listen to their understanding of the problems they are working with. The new curriculum also requires that teachers give tasks to learners that enable them to reason mathematically and explain their thinking.

This study investigated ways in which a teacher selected and implemented mathematical tasks in the new and old mathematics curriculum, and whether the selected tasks promoted mathematical reasoning in similar or different ways. Teachers had undergone two-weeks of training on how to implement the new curriculum. It is worth investigating whether the content discussed during training was applicable in the mathematics classroom. Working with the new and old curriculum will enable me to compare whether the teacher did differentiate between the different approaches in the two curricula.

This research focused on how a teacher selected and used mathematical tasks at Grade 10 and 11 levels. The current Grade 11 curriculum was the last to be used in South Africa in 2006 and the Grade 10 new curriculum was introduced in the same year. It is therefore interesting to find out the how the same teacher teaching two different curricula will select and use tasks that will enable mathematical reasoning. The purpose of this study is to investigate a teacher's selection and use of tasks in relation

to the old and new curriculum in South Africa and the extent to which the selected tasks promoted or inhibited mathematical reasoning.

1.2 Research questions

This study focuses on responding to the following questions:

- Does the teacher use different criteria for selecting tasks when working with the new and old curriculum?
- Does the teacher implement tasks differently in the new and old curriculum?
- Do the tasks in the Grade 10 and 11 classrooms promote mathematical reasoning in similar or different ways?

1.3 Rationale

The education system in South Africa is changing due to the introduction of Curriculum 2005 and the National Curriculum Statement (NCS). The changes means that new curriculum material and new teaching methods have to be implemented to support the standards stipulated by the NCS. There have been debates on whether the new curriculum will be successfully implemented in South Africa. The new curriculum started in grade 1 in 1998 and some educational experts critisised the way it was implemented. Lack of enough training offered to educators was cited as one obstacle that inhibited the proper implementation of the new curriculum. Jansen (1999) pointed out some of the factors that could make the new curriculum fail. Some of the problems he outlined include the fact that the language associated with Outcomes-Based Education (OBE) is complex and confusing, that there are incorrect assumptions about what happens inside schools and classrooms, and that teachers within the system will struggle to work in new ways, and also that the management of OBE by the teachers will multiply their administrative burdens. Chisholm et al (2000) were given the task of reviewing Curriculum 2005. The Report of the Review Committee showed that there was overwhelming support of the principles of outcomes-based education and Curriculum 2005. Implementation of the curriculum however had some areas that required attention. These included:

- A skewed curriculum structure and design
- Lack of alignment between curriculum and assessment policy
- Inadequate orientation, training and development of teachers
- Learning support materials that are variable in quality, often unavailable and not sufficiently used in classrooms
- Shortage of personnel and resources to implement and support Curriculum 2005
- Inadequate recognition of curriculum as the core business of education departments. (p.4)

Jansen (1999) provided evidence about the implementation of Curriculum 2005 in grade one classrooms by observing thirty-two schools in Kwazulu-Natal and Mpumalanga Provinces in 1998. In his findings Jansen found that teachers have different understandings of OBE. Most teachers referred to OBE as learner-centered instruction, activity-based education, group work, less direct teaching and more teacher facilitation. The various meanings of OBE were due to the range of terms and concepts used in official documents. Teachers interviewed said they were not sure whether they were "doing" OBE in their classrooms. They mentioned that there should be a clear distinction between past and present practices. The lack of in-depth training, the uncertain knowledge they obtained from the trainers and the lack of on-site supervision were some of the reasons given by the teachers why they were uncertain about what OBE is and how it should be implemented.

Recently there have been many attempts by different people to address the difficulties associated with curriculum 2005. Taylor and Vinjevoid (1999) provide a plan for the future planning and delivery of teacher development and support programmes. They concentrate on issues of teacher practices, curriculum, and the use of teaching and learning material. In their findings in the area of curriculum development, the teachers observed did not have the knowledge base to interprete the broad guidelines of Curriculum 2005 or to ensure that the everyday approach prescribed by the new curriculum would lead to conceptual development of learners. "On the issue of pedagogy, many teachers model the surface forms of learner-centered activities, without apparently understanding the learning theories underlying them, and certainly without using them as a medium for enabling learners to engage with substantive knowledge and skills" (Taylor& Vinjevoid, 1999, p.230).

The President's Education Initiative Research (PEI) Project made recommendations on the issues discovered by the project most of which overlap with concerns earlier reported by Jansen (1999) and the recommendations by the Chisholm et al (2000) review committee. On the issue of teacher training the Chisholm review committee recommended:

> A national teacher education strategy which locates teacher preparation and development for the new curriculum in higher education and identifies, selects and trains a special cadre of regional and district curriculum trainers working with NGOs and higher education for short-term orientation (Chisholm , 2000,p.5).

The PEI made the following recommendations on the issue of teacher training:

> No amount of exhortation by politicians or pedagogical guidance by curriculum planners, universities and college academics or NGOs is likely to change this situation unless the knowledge base of teachers is simultaneously strengthened (Taylor and Vinjevold, 1999,p.230).

Although the two recommendations are not in agreement with each other on how to train teachers in implementing the new curriculum, they both offer a base on which teachers might be trained in order to successfully implement the new curriculum.
Academics from Wits University and others took a different approach at addressing issues raised by the implementation of the new curriculum. Through the launch of the Further Diploma in Education (FDE) they developed an inservice programme which they then researched. The main focus of the book written about the research findings was teachers' classroom practice. In their findings after working with different teachers they concluded that teachers take up new ideas differently, which is the same as Jansen's (1999) argument. They also found that teachers struggled to match lesson plans with purposes (Brodie et al, 2002, p.115) and to implement various aspects of learner-centred teaching.

Change is not only necessary because of South Africa's apartheid history but education is changing everywhere in the world. In England, Boaler (1997) analyzed the mathematical curriculum in two different schools, namely Phoenix Park and Amber Hill. The analysis of the curriculum in the schools is valuable to this study in that the two schools did not approach the curriculum similarly. One school used

approaches that were similar to those practiced in South Africa in implementation of the old curriculum. The other school implemented similar practices to those in the new South Africa curriculum statement. It was therefore worthwhile to investigate how a particular teacher in South Africa implemented two different curricula. Boaler's findings show that learners gained different kinds of knowledge from the different curricula. At Amber Hill she found that the learners used textbooks throughout the lessons she observed. Teachers gave learners tasks, which they solved individually, and they were not given opportunity to explain their solutions. Most of the tasks had only one solution, which was either right or wrong. In terms of Cornbleth (1990) the teachers at Amber High were using a technocratic type of curriculum which can be "seen as a product, or plan for teaching, that was developed according to procedures of task analysis by outside experts and then made available to classroom teachers in various school settings"(p.19). Such a curriculum does not give learners opportunities to learn on their own, they depend on what is given to them by the teacher.

At Phoenix Park teachers gave learners opportunities to work on their own and to come up with their own solutions in their own time. The students at Phoenix Park were not given specific paths through their activities, they were merely introduced to starting questions or themes and expected to develop these into extended pieces of work (Boaler, 1997,p.40). Cornbleth (1990) refers to a critical curriculum as focusing on the actual, day-to-day interaction of students, teachers, and knowledge. Such a curriculum allows learners to have more learning opportunities rather than following certain procedures only. The new curriculum in South Africa has characteristics of a critical curriculum, and the old curriculum has those of a technocratic curriculum. In the case of curriculum change in high schools in South Africa it is important to investigate how a teacher works with the two different curricula, and the effect that these of the different curricula and the change in teaching approach has on mathematical reasoning. In her analysis of the two schools Boaler has shown that the curriculum used at the two schools develops a different kind of mathematical knowledge among learners

Stein, Smith and Silver (1996) used the concept of mathematical tasks to study the connections between teaching and learning in classrooms. They viewed the

curriculum as a progression of academic tasks. In their article they defined a mathematical task "as a classroom activity, the purpose of which is to focus students' attention on a particular mathematical idea" (p.460). They argued that if the teacher selects and uses tasks that require learners to carry out calculations or procedures only, he/she is unlikely to promote mathematical reasoning. They have the same argument as Boaler and the NCS since they also emphasize that learners should be given opportunities to solve problems, look for patterns, make conjectures, examine constraints, make inferences from data, explain, justify challenges, and so on. My study will investigate whether a teacher tends to select and use tasks that promote higher order thinking and whether his selection and use depends on the curriculum he is teaching. I will also see whether mathematical reasoning is promoted differently in the two curricula. Understanding the relationship between how teachers set up and implement tasks in the old and new curriculum is vital in order to promote mathematical reasoning.

Tasks provide opportunities to show how teachers work with the curriculum. The types of tasks that the teacher selects and implements in mathematics classrooms play an important role in delivering the outcomes of the NCS. Remillard (2005) argues that there are many studies on how teachers use curriculum materials and the role that textbooks and curriculum materials have played in mathematics classrooms. "Although these studies offer insight into influences underlying curriculum use, as a set, they provide little clarity on how teachers use curricula or on the teacher-curriculum relationship" (p.212). My study aims to investigate how a teacher interacts with mathematical tasks from the new and old curriculum. Remillard further said that "curriculum use refers to how individual teachers interact with, draw on, refer to, and are influenced by material resources designed to guide instruction" (p.212). This study draws on Remillard's and Stein's et al work on how a teacher using the curriculum material of the new and old curriculum promotes or inhibits mathematical reasoning; and thus focuses on the interaction between a teacher and the curriculum. It investigates the teacher's selection and implementation of mathematical tasks in the old and new curriculum and the ways in which these inhibit or enhance mathematical reasoning.

In the above, I have shown how the literature on curriculum reforms provides a rationale for my study. The above research has been conducted at primary level in South Africa or at secondary level internationally. My study focuses on curriculum change at high school in South Africa. There is also a personal rationale which I had stated earlier. In the past twelve years while marking grade 12 papers, I realized that learners do not perform well in tasks that involve higher order mathematical reasoning. In my opinion learners are more comfortable in responding to tasks that do not ask them to explain or to justify their solutions. I believe that it is because of a lack of such tasks in most of the present textbooks. Also, tasks that require learners to explain their solutions are given fewer marks in the examination. Teachers who spend time encouraging learners to work on such tasks will end up not having satisfied the requirements of the curriculum which is more focused on learners passing their exams rather than on how they obtained their solutions.

This study could benefit teachers and researchers who are interested in the relationship between the teacher and the kinds of tasks that are selected and used in mathematics classrooms to promote mathematical reasoning. The study could also benefit textbook writers on the type of tasks that could be included in their textbooks, especially those involving higher order mathematical reasoning. Findings from this research might provide curriculum designers with ways in which teachers can be trained whenever a new curriculum is implemented. Finally, this study will add to the research on changing curricula described above and in addition will make unique contribution in relation to the implementation of the new curriculum in the FET phase in South Africa.

1.4 The report

This report is divided into five chapters. In this first chapter I have outlined the aim, the critical questions, and rationale that guided my study. Chapter 2 deals with the theoretical framework as well as the literature review on how mathematical tasks are used to promote mathematical reasoning and how teachers select and implement tasks in mathematics classrooms. Chapter 3 discusses the methodology used to collect and analyze data. Chapter 4 presents data as well as the findings obtained from the

research. Chapter 5 discusses conclusions and recommendations from the study as well as the limitations of the study.

CHAPTER 2

THEORETICAL AND ANALYTICAL FRAMEWORK

2.1 INTRODUCTION

In this chapter I will discuss the theoretical and analytical framework that guided my research. I discuss mathematical reasoning as it is envisaged by the National Curriculum Statement and its relationship to Kilpatrick et al's (2001) strands of mathematical proficiency. Stein et al's (1996) four levels of cognitive demands of mathematical tasks will be discussed in relation to mathematical reasoning. Two theoretical perspectives: constructivist theories of learning and socio-cultural theories which are consistent with Stein et al's framework will be discussed as well as their relationship to teaching and learning. The two theories are helpful since they provide a framework from which to understand how teachers work with mathematical tasks to enhance or inhibit mathematical reasoning. I needed to use both theories since they each have their own weaknesses and strengths. Also, the two theories both underlie my analytic framework (Stein et al). Since these theories have a number of similarities and differences, part of the work on this chapter will be to show how they can be used together.

2.2 MATHEMATICAL REASONING

The National Curriculum Statement Grades 10-12 (2002) describes the purpose of mathematics in the new curriculum. Mathematics will enable learners to:

- Communicate appropriately by using descriptions in words, graphs, symbols, tables and diagrams
- Use mathematical process skills to identify, pose and solve problems creatively and critically
- Organise, interpret and manage authentic activities in substantial mathematical ways that demonstrate responsibility and sensitivity to personal and broader societal concerns
- Work collaboratively in teams and groups to enhance mathematical understanding
- Collect, analyse and organise quantitative data to evaluate and critique conclusions arrived at; and
- Engage responsibly in quantitative arguments relating to local, national and global issues. (p.72)

These broad curriculum outcomes show the intention of the new curriculum to produce learners who can work with mathematics in a variety of ways. It argues that learners should be given opportunities to communicate their ideas critically and creatively as well as making conclusions from mathematical tasks. The intention has moved away from learners who are to use calculations and formulas as the only notable ways of solving mathematical problems, and also away from right and wrong solutions as the "universally" accepted correct solutions**.** As stated by the NCS, there are many ways that are necessary for learners to learn mathematics successfully. In the next section I will begin to elaborate on those ways which are necessary for meaningful learning to take place as well as the role of tasks in mathematics classrooms.

Kilpatrick et al (2001) came up with a set of mathematical strands which make up mathematical proficiency. In their discussion they described the kinds of cognitive changes that should be promoted in children so that they can be successful in learning mathematics. The term mathematical proficiency was used to capture what they believe is necessary for everyone to learn mathematics successfully. Mathematical proficiency is divided into five components or strands, which are interwoven and interdependent, namely**:** conceptual understanding, procedural fluency, strategic competence, adaptive reasoning and productive disposition. The five strands are consistent with aspects of the new curriculum.

"Conceptual understanding refers to an integrated and functional grasp of mathematical ideas" (Kilpatrick et al, 2001, p.118). Learners with conceptual understanding put their facts together and organize them in such a way that the organized facts can help them to learn new ideas by using ideas that they have learned before. For example learners use their knowledge of drawing a graph to interpret, compare and make conjectures when given different graphs. Kilpatrick et al (2001) described procedural fluency as a set of skills, which are used in carrying out procedures flexibly, accurately, efficiently and appropriately. A certain level of skill is required to learn many mathematical concepts with understanding and using procedures can strengthen and develop that understanding. Kilpatrick et al (2001) refer to strategic competence as the ability to formulate, represent and solve

mathematical problems. To represent the problem accurately, learners must first understand the situation including its key features. They need to capture the core mathematical elements and ignore the irrelevant features. Solving challenging mathematical problems depends on the ability to carry out procedures readily, and problem-solving experience helps them acquire new concepts and skills. In this way conceptual understanding, procedural fluency, and strategic competence all depend on each other and need to be developed simultaneously in learners.

Adaptive reasoning refers to the capacity to think logically about the relationships among concepts and situations (Kilpatrick et al, 2001, p. 129). Learners should reason appropriately to develop conjectures and conclusions and be able to justify these. Learners need to be able to justify and explain ideas in order to "make their reasoning clear, hone their reasoning skills, and improve their conceptual understanding" (Kilpatrick et al, 2001, p.130). If learners are to understand the concepts and algorithms of mathematics they need to be able to explain and justify them as well as use them in different problems.

Productive disposition refers to the tendency to see the sense in mathematics, to perceive it as both useful and worthwhile (Kilpatrick et al, 2001, 131) and to believe that you can do mathematics and make sense of it. When learners see themselves as capable of learning mathematics and using it to solve problems, they become able to solve problems, and to develop further their procedural fluency or their adaptive reasoning abilities.

The five strands are important for my study since they form a conceptual frame for understanding mathematical reasoning and provide me with a way to understand the criteria that the teacher in the study used to select and implement tasks. The five stands will also enable me to detect whether the purposes mentioned in the NCS mentioned above are being implemented in the grade 10 mathematics classroom. In the next section I will discuss the mathematical tasks that are used as vehicles to encourage or inhibit mathematical reasoning.

2.3 TASKS THAT ENABLE MATHEMATICAL REASONING

A mathematical task is given to learners by the teacher to engage them in mathematical activity. The teacher gives tasks according to the goals of the lesson. Stein et al (1996) define a mathematical task as a classroom activity, the purpose of which is to focus students' attention on particular mathematical ideas. Once the teacher has set up learning goals, s/he can give tasks that match with her/his goals. It depends on the teacher what type of thinking s/he would like the learners to engage in. If the teacher wants learners to memorise mathematical facts and procedures s/he will give activities that require memorising. If s/he wants the learners to explain and justify their solutions, the teacher will give learners tasks that will require them to explain their thinking**.**

Stein et al (2000) defined four levels of cognitive demand of mathematical tasks.

- Lower level tasks are classified as memorization, and procedures without connections to understanding, meaning or concepts.

- Higher-level tasks are classified as procedures with connections to understanding, meaning, or concepts and as doing mathematics i.e. asking learners to explore the relationships among various ways of representing quantities.

Memorization involves reproducing previously learned facts, rules, formulae, or definitions. Memorization tasks do not require any explanation from learners; they are straightforward and learners use well known facts to solve them. Procedures without connection to meaning require reproduction of a procedure but without connection to underlying concepts. Such tasks are focused on producing correct solutions rather than developing mathematical understanding. Procedures with connection to understanding meaning focus learners' attention on the use of procedures for the purpose of developing deeper levels of understanding of mathematical concepts and ideas. Such tasks focus learners on the procedure of solving mathematics problems, but in a meaningful way. Doing mathematics does not require any procedure to be followed. There is no predictable way of solving

the problems. In such activities there are more than one way of solving the activity. Learners working with such tasks need to analyse and actively examine task constraints that may limit possible solution strategies and solutions. The following table shows the characteristics of mathematical tasks at each of the four levels of cognitive demand:

Lower-Level Demands	**Higher-Level Demands**
1.**Memorization Tasks**	3.**Procedures With Connections Tasks**
Involves either reproducing previously learned facts, rules, formulae, or definitions to memory	Focus students' attention on the use of procedures for the purpose of developing deeper levels of understanding of mathematical concepts and ideas
Cannot be solved using procedures because a procedure does not exist or because the time frame in which the task is being completed is too short to use procedures	Suggest pathways to follow (explicit or implicit) that are broad general procedures that have close connections to underlying conceptual ideas as opposed to narrow algorithms that are opaque with respect to underlying concepts
Are not ambiguous----such tasks involve exact reproduction of previously seen material and what is to be produced is clearly and directly stated	Usually are represented in multiple ways (e.g., visual diagrams, manipulative, symbols, problem situations). Making connections among multiple representations helps to develop meaning
Have no connection to the concepts or meaning that underlie the facts, rules, formulae, or definitions being learned or reproduced	Require some degree of cognitive effort. Although general procedures may be followed, they cannot be followed mindlessly. Students need to engage with the conceptual ideas that underlie the procedures in order to successfully complete the task and develop understanding
2.**Procedures Without Connections Tasks**	4. **Doing Mathematics Tasks**
Are algorithmic. Use of the procedure is either specifically called for or its use is evident based on prior instruction, experience, or placement of the task	Require complex thinking (i.e., there is not a predictable, well-rehearsed approach or pathway explicitly suggested by the task, task instruction, or a worked-out example).
Require limited cognitive demand for successful completion. There is little ambiguity about what needs to be done and how to do it.	Require students to explore and understand the nature of mathematical concepts, processes, or relationships
Have no connection to the concepts or meaning that underlie the procedure being used	Demand self-monitoring or self-regulation of one's own cognitive processes
Are focused on producing correct answers rather than developing mathematical understanding	Require students to access relevant knowledge and explanation and make appropriate use of them in working through the task
Require no explanations, or no explanations that focus solely on describing the procedure that was used	Require students to analyse the task and actively examine task constraints that may limit possible solution strategies and solutions
	Require considerable cognitive effort and may involve some level of anxiety for the student due to the unpredictable nature of the solution process required

Source: Stein et al. (2000) Four levels of cognitive demand

The cognitive demands of the tasks depend on the level of the learner, not only on the tasks itself, the cognitive demands also can depend on the individual. Learners can solve a task that looks like it will require learners to use procedures without connections as if it requires procedures with connections to meaning. Learners can raise and also lower the level of the tasks, by the way they solve them. In order to encourage mathematical reasoning, as is suggested by the new curriculum, teachers should to give learners tasks that are of different levels, including the higher levels. If learners are given only tasks that are of a lower level, they will find it difficult to tackle higher-level tasks. Most textbooks give tasks like " Sketch the graph of $y = (x – 3)^2 + 2$". The learners will then use the usual procedure of finding the x and y intercepts, the turning point and draw the graph. They usually use these procedures without connections. They do not connect what they are doing to the meaning of the graph. They are not yet exposed to tasks that need them to make comparisons, generalise, verify, make conjectures and justify their reasoning. Stein et al (2000) state "hence, students also need opportunities on a regular basis to engage with tasks that lead to deeper, more generative understanding regarding the nature of mathematical processes, concepts and relationships" (p.15).

The new curriculum does actually ask for higher-level tasks. Here is an example from Focus on Mathematics Grade 11 (Bennie, 2006):

(a) Draw a sketch of $y=x^2$. Use a table if necessary
(b) Consider the graphs with equations $y=ax^2$. Make a conjecture about the effect on the graph when you change the value of a. Test your conjecture by drawing the graphs of $y=2x^2$, $y=3x^2$,and $y=1/2x^2$ on the same system of axes you used in (a).
(c) What will happen if the value of a in $y=ax^2$ is negative? Choose suitable values for a and test your conjecture.
(d) Summarise your observations in questions a and b above etc.

The above example from a textbook meant for the new curriculum shows the intention of the new curriculum to give learners higher-level tasks. The example requires learners to go beyond drawing the graph and to make conjectures from the graph. It also requires them to summarise their observations which is something that was not visible in the old curriculum.

2.4. TEACHERS AND TASKS

Stein et al (1996) used their framework in the QUASAR project with middle school mathematics teachers in the USA who were trained to provide instruction based on thinking, reasoning and problem solving. The project was initiated by the fact that marginalized students from poor backgrounds were failing not because of lack of ability, but because they did not have opportunities to participate in challenging learning experiences. The project investigated the relationship between instruction and students' thinking by using Stein's framework discussed previous. Mathematical tasks were used as a vehicle for building students' capacity for mathematical thinking and reasoning.

The study focused on the relationship between *task set up* and *task implementation*. "Task set up are those that are selected by the teacher. They can include verbal instructions, distribution of materials or tools, or a discussion of what is expected. Task set up can also be as short and simple as telling students to begin work on a set of problems displayed on the blackboard. Task implementation is defined by the manner in which students actually work on the tasks. Do they carry out the tasks as they were set up? Or do learners and teachers somehow alter the task in the process of working their way through it? " (Stein et al 1996, p460).

Stein et al (1996) then introduced task features which are visible at both selection and implementation phase.

> The *task features* refer to aspects of tasks that mathematics educators have identified as important considerations for the engagement of students thinking, reasoning, and sense making. At the set up phase, task features refer to the extent to which the task as announced by the teacher incorporates or encourages the use of each of these features. At the task implementation phase, task features refer to the enactment of the features by students as they actually go about working on the tasks. Do students really explain their mathematics or justify their solutions? Cognitive demands of the task during the set up phase refer to the kind of thinking process entailed in solving the problem as announced by the teacher. (Stein et al, 1996, p.461)

The task features show the level of the task which were discussed earlier. At the task implementation phase cognitive demands are analyzed as the actual way in which learner's worked on the tasks.

Stein et al (1996) then identified factors that can influence the way in which tasks are implemented in the classroom, which include classroom norms, task conditions, and the teachers' and students' habits and dispositions. In their findings, tasks that were set up to require the use of procedures with meaningful connections declined to tasks in which procedures were used, but without connection to concepts or meaning during the implementation phase. Tasks used in mathematics classrooms highly influence the kind of thinking processes in which students engage, which in turn, influence students' learning outcomes. Whenever mathematical tasks are used, it is important to ensure that learners actually engage in the same tasks that were set up by the teacher, otherwise they can easily slip into rote learning applications of formulas and algorithms.

In this section I have discussed the literature that guided my study and that formed the analytical framework. In the next section I will discuss the constructivist and socio-cultural theories of learning theories that support my analytic framework. Socio-cultural theories argue that children do not develop in isolation, but learning takes place when the child interacts with the social environment. "It is the responsibility of the teacher to establish an interactive situation in the classroom, where the child is an active learner and the teacher uses her/his knowledge to guide learning" (Daniels, 2001). From a constructivist point of view children reflect on their own thinking as they explain or demonstrate. In discussing the two theories I will show firstly that they are both important for my study, and secondly how they inform Stein et al's framework.

2.5. CONSRUCTIVISM, TEACHING AND LEARNING

From a constructivist point of view learners are actively involved in their learning.
This involvement comes through activities that are given to the learners by the teacher in the mathematics classroom. Learners need time to reason, to try ideas, and to struggle for ways to describe or communicate ideas. Hatano (1996) stated that "knowledge acquisition involves restructuring; that is, not only does the amount of knowledge increase but also one's body of knowledge is reorganized as more pieces

of knowledge are acquired"(p.12). If the structures are being reorganized, learning takes place. Piaget uses the process of equilibration as a factor that guides learning.

> Equilibration is how the person organizes pieces of information into a noncontradictory system of knowledge. It does not result from what a person sees, rather, it helps the person understand what he/she sees. With this inherited capability called equilibration, the individual gradually constructs inferences about how things in the world must be (Forman, 1983, p.254).

The main purpose of equilibration is to eliminate contradictions. When learners are given mathematics problems to solve, they are not expected only to solve them, without attempting to understand the demands of the problems. They are expected to organize pieces of information that will enable them to solve the problems or the problems can serve as a source of equilibration, and then reorganization of knowledge. Higher-level tasks which require learners to use procedures with connections to meaning can assist learners to move from one process of equilibration to the other. This is because learners engaged in such tasks must attempt to understand the underlying conceptual ideas as opposed to narrow algorithms. Eventually, through other higher-level tasks and after working with many of these tasks the learners will begin to understand the underlying conceptual ideas.

The process of equilibration involves two other important sub processes, assimilation and accommodation.

> Assimilation is a process of changing the new experience into a familiar experience. Accommodation, on the other hand, is a process of an exclusive attention to the new experience, independent of the past experience. Assimilation without accommodation, even distorts the new experience. Accommodation, without assimilation, can lead to incorrect conclusions (Forman, 1983, p.255).

Assimilation and accommodation are intertwined. In working with higher-level mathematical tasks learners encounter new experiences and through working with the tasks they relate the new experiences to what they had learned before. After learners have solved tasks and experienced new information they are in a position to work with other tasks that are similar to those that they have just learned. At the same time learners have to use the information that led them to discover new experiences as a build up to solve higher-level mathematical tasks. If learners use only the information

obtained from their new experiences, there is a likelihood that there will be a gap between the new and the old experiences which in turn can lead to incorrect conclusions. Constructivist theories emphasize that learners should be given time to use their skills to solve problems rather than only presenting them with information in order to cover the curriculum (Hatano,1996). Teachers need to select and use mathematical tasks that will enable learners to reflect on their thinking and to develop the skills to explain or justify their responses. When a learner explains his/her reasoning the teacher learns of the reasoning and understanding that shape the learners' response.

Piaget's theory states that for genuine learning to take place, the teacher has to encourage the learner's activity in all forms. If the teacher can skip some of the activities that the learner could have done on their own, "for example, by lecturing at a class, the result is often is often superficial learning" (Ginsburg and Opper, 1979, p.224). This implies that if learners are told or shown what they could have investigated on their own, they tend to forget such information. The teacher needs to give learners a sequence of activities which can lead them to develop new ideas by actively working on the activities rather than the teacher being the most active participant. The teachers' role is that of a facilitator, rather than being the presenter of knowledge.

Piaget's theory clearly emphasize that social factors contribute to the development of the child's learning. "Human intelligence is subject to the action of social life at all levels of development from the first to the last day of life" (Piaget, 1995a, p. 278). Piaget's theory starts with the individual child who progressively becomes social primarily with social influences or interpersonal contact.

> Social factors of an interpersonal nature play an even larger role in children's development once the children are able to take another's perspective into account, and peer social relations takes on a key role in adolescence. Indeed, the organization of formal structures must depend upon the social milieu as well. A particular social environment remains indispensable for the realization the possibilities accorded by the maturation of the nervous system (Inhelder and Piaget, 1955/1958, p.337).

Piaget argued that peer interaction is different form the adult-child interaction in that in child-adult interaction there is unbalance of power. The child is unlikely to undergo the cognitive restructuring under such conditions, instead she/he will accept the adult views.

Tasks that involve higher levels of mathematical reasoning give learners opportunities to integrate their knowledge in different areas to each other so that the knowledge can make sense to them. In so doing learners can reorganize their knowledge. Tasks that the teacher selects and uses determine whether they expect learners to take time to solve them and justify their mathematical reasoning or whether the solution without any explanation is sufficient. In order for social interaction to be fruitful at least two conditions must be fulfilled. The first condition means that learning can take place if a peer with an opposing viewpoint confronts a learner. A learner after solving a mathematical task can only start to go deeper into thinking about the solution if a fellow learner comes with a different solution. The two learners through their different viewpoints can now start to compare their solutions and come to an agreement as to which is correct or whether there is another, better solution. The second condition means that certain cognitive skills are needed for the learner to benefit from the confrontation of a peer, which in turn, strengthens his or her competencies.

One of the strengths of Piaget's theory is that it emphasizes peer interaction that is visible at implementation phase when learners are working with tasks of higher cognitive level. In my study I am interested in how the teacher selects and implements tasks in the new and old curriculum. The new curriculum clearly requires learners to make sense of the mathematics they are working with, which is in line with constructivism. It is for this reason that I use constructivist theory to inform my study. There are of course some weaknesses in Piaget's theory in that it "have focused on the individual as a unit of analysis and examined the child's solitary attempts to make sense of the physical, logical, or mathematical world" (Tudge and Winterhoff, 1999, p.325). More on the weaknesses and strengths will be discussed in section 2.7.

2.6. SOCIO-CULTURAL THEORIES, TEACHING AND LEARNING

Socio- cultural perspectives emphasizes that children do not learn in isolation but in an environment with assistance from other people (adults and peers). Learning takes place between people and then inside the child. Socio-cultural perspectives also emphasize that social factors contribute towards the development of the child. “The entire history of the child’s psychological development shows us that, from the first days of development, its adaptation to the environment is achieved by social means” (Vygotsky, 1994, p. 116). Vygotsky made a link between the social factors of a cultural and historical nature to those of an interpersonal nature. Interpersonal interactions can only be understood with reference to these historical (communication) and cultural forms.

> For example, the nature and processes of interaction between an adult and a child in a school setting cannot be fully understood without reference to the meaning imparted by the historically and culturally organized context (school), to the tools of learning, and to the meaning that the interaction itself has for the participants. Thus, social and cultural institutions, technologies, and tools channel the nature and focus of interpersonal interactions, which in turn mediate the development of children’s higher mental functions such as thinking, reasoning, problem solving, mediated memory and language (Tudge and Winterhoff, 1999, p. 317).

This means that the social interaction can be understood through a number of participants, not only through peer interaction but through a child and an adult with appropriate tools. “Vygotsky’s theory focused attention on the mental growth that takes place as a consequence of social intervention without any corresponding physiological, neurological, or biological changes” (Moll, 1999, p. 41). Vygotsky (1978) said that: “Every function in the cultural development of the child appears on the stage twice, on two planes. First, on the social plane, and then on the psychological; first between people, and then, inside the child.” (p.57). Socio-cultural perspectives argue that learning takes place through the collective activity of the child and adult, and among children themselves. This led Vygotsky to introduce the concept of the zone of proximal development (ZPD). Vygotsky (1978) said that “the zone of proximal development defines those functions that have not yet matured but are in the process of maturation, functions that will mature in the future but are currently in an

embryonic state" (p.80). This point was further emphasized by Davydov (1995) when he said that " what the child is initially able to do only together with adults and peers, and then can do independently lies in the zone of proximal psychological development" (p.18). The ZPD implies that in collaboration the child can always do more than he/she can independently. The ZPD is thus created in the course of social interaction.

The teacher plays an important role in developing the ZPD. It is the role of the teacher to guide the learners to move towards those functions that have not yet matured. The teacher through his/her selection and use of mathematical tasks that involve higher order mathematical reasoning can work with learners to move from initial understanding of concepts to broader, reorganized knowledge. Hedegaard (1990) argues that to work with the zone of proximal development in classroom teaching implies that the teacher is aware of the current knowledge of the learners and is able to plan for qualitative change in the teaching towards a certain goal.

Minick (1999) also uses the concept of mediation to explain the origin of higher mental functions. He argued "the higher mental functions rely on the mediation of behavior by signs and sign systems, the most important of which is speech. Higher voluntary forms of human behavior have their roots in social interaction, in the individual's participation in social behaviors that are mediated by speech" (p. 33). He regarded speech as a means of social interaction and communication. It is within this mediated social interaction that internalization process takes place. Speaking in the classroom involves learners in a setting using language tools provided by the teacher to create utterances. Speech therefore plays an important role as a mediator between the learners and the teacher in mathematics classes. While learners are working on higher level mathematical tasks they are required to explain and justify their solutions. In explaining their solutions learners use language as a tool to explain their solutions and through the teacher's assistance they start to change what they initially thought was the correct solution. The teacher acts as a mediator through asking learners questions.

2.7. RELATIONSHIP BETWEEN CONSTRUCTIVIST AND SOCIO-CULTURAL THEORIES

In discussing the two theories I would like to note that some ideas are unique to the constructivists and some ideas are unique to socio-cultural perspectives, while some ideas are common to both. The two theories are both consistent with and inform Stein et al's framework. Their different and similar views provided me with the conceptual tools to frame my analytical framework, Stein et al's framework. In showing their differences and similarities I will work with four dimensions namely: social factors, action/activities, explanatory mechanisms, and learning and development.

As I have mentioned in the previous sections both theories emphasizes that social factors contribute towards the development of the child's learning. Vygotsky's theory clearly states that one cannot consider social interaction between peers or between adults and children without understanding the historically formed cultural context within which that interaction takes place. Vygotsky's theory argues that social organizations like schools contributes to education and this means that collaboration between the learners and the teacher play an important role in the learning process.
Piaget's theory begins with the individual child who progressively becomes social, whereas for Vygotsky the child is social from the start. Piaget's interest in the social world is primarily interpersonal. He emphasized the importance of peer interaction, rather than adult-child interaction.

> Social factors of an interpersonal nature play an even larger role in children's development once children are able to take another's perspective into account, and peer social relations take on a key role in adolescence. Indeed, the organization of formal structures must depend upon the social milieu as well (Piaget, 1945/1977).

The two theories both emphasize action and activity as a necessity for intellectual development. A main difference is that each theory uses active involvement in different ways. Piaget's active involvement is mental and social through stages while Vygotsky's is mental and social, between people, through the zone of proximal development. Davydov (1995) said, "that the social interaction, the collective activity of the child and adult, and among children themselves, is the genetically fundamental

form of their individual psychological functions, and in particular of the functions of assimilation. In fact, this is what is really collective activity of a group of people and not the one sided activity of one child with one adult." (p.17). Davydov's view suggests that there should be different people that are involved for learning to take place.

Piaget's theory argues that action is only constructive when it involves the participation of the child himself working with an activity. Ginsburg and Opper (1979) also emphasized, the role of activity by mentioning that "the children or individuals of any age learn best from self-initiated activity is perhaps the most single proposition that educators can derive from Piaget's work" (p.224). "It is necessary for learners to form their own hypotheses and verify them or not verify themselves through their own active manipulation" (Almy, 1979, p.174). Piaget's theory uses the concept of equilibration as one of the four factors (maturation, experience, social transmission and equilibration) that describe development. "Equilibration refers to the child's self-regulatory processes. As a result of these, he progressively attains a higher degree of equilibrium at each stage of development."(Ginsburg and Opper, 1979, p.214). Throughout development the child moves from a state of lesser to a greater degree of equilibrium. In order to attain a higher degree of equilibrium the learner has to use her/his existing knowledge in order to be able to engage with the demands of the new task. Equilibrium implies an active balance of what the learners know and not know. The information that the learners use to attain higher degrees of equilibrium is therefore not at rest. In other words equilibrium involves activity and openness for new situations. The equilibrium process is the mechanism by which the learners move from one state of equilibrium to the next.

Piaget maintains that learning cannot explain development, instead development explains learning. He emphasized that the general structures develop through a process involving maturation, experience, social transmission and equilibration and this is a complex process involving self-regulation.

> Learning in the wider sense involves the acquisition of general cognitive structures. Indeed, these are used to give meaning to specific learning and often make it possible. Thus, development explains learning. Further, development occurs through a self-regulatory process

> involving the four factors, not through the acquisition of specific information or responses. Learning therefore cannot explain development (Ginsburg and Opper, 1979, p.221).

The implication of this is that teachers need to make an effort to understand the learners' experience and ways of thinking. The teacher might feel that a certain idea is simple and self-evident; the learners may find it difficult. It is not safe for the teacher to assume what he thinks is easy will automatically be the same for learners. The teacher needs to watch and listen and try to understand the learners' perspective. A willingness to be patient and observe learners working on mathematical tasks will enable the teacher to begin to understand the learners' experience. Piaget's theory therefore supports the concept of a learner-centered perspective.

Socio-cultural theory on the other hand uses the relationship between spontaneous and scientific concepts to explain learning and development.

> Scientific concepts typically are learned in school settings as part of a system of knowledge; they have explicit verbal definitions; their learning is made conscious; they are taught in the context of academic subjects such as social studies, language instruction and mathematics. Spontaneous (sometimes called 'everyday') concepts are those the child learns in the course of her or his daily life. Their learning is not usually made conscious; the child uses such concepts with ease and without any awareness that there is such a thing as a 'concept'. Some examples of spontaneous concepts are: brother, numbers, the past (Vygotsky, 1993, p.61).

The two concepts have a different relationship to how children learn. Spontaneous concepts can be learned through the relationship between the objects that children encounter in their daily life. Scientific concepts are learned through instruction using true concepts. Scientific concepts are developed at school which in turn increases the learner's spontaneous knowledge. Scientific knowledge is therefore produced in a systematic setting at school between the teacher and the learners while spontaneous knowledge is attained at home or in any informal setting. Although the two kinds of concepts are developed from different settings, they cannot be separated from one another. What the child has learned at home becomes clearer when she or he encounters a similar concept at school and school concepts are given meaning by home concepts.

The two theories are important for my study since they both argue for active involvement and social explanations of learning which can be achieved in mathematics classrooms by using tasks that involve higher order mathematical reasoning. In the mathematics classrooms sometimes it is necessary for learners to work on their own or in groups in order to investigate and discover new mathematical concepts without the assistance of the teacher. The teacher's role in such situation is to try to understand the learners' ways of thinking. Also, there are times where the teacher's role is important in mediating between the knowledge to be learned and the learners' current knowledge while still respecting the integrity of the learners' thinking (Brodie et al, 2002, p.95). Sometimes learning takes place in a context with other people, and at other times it will occur when a child is on her own, which is still a social context. The two theories are therefore important for my study since in mathematics classrooms sometimes learner's work with their peers to solve mathematics tasks, which is an emphasis from Piaget's theory. The teacher also plays an important role in the guiding the learners, which is an emphasis from Vygotsky's theory. In mathematics classrooms, the learners and the teacher are important role players for genuine learning to take place. Using only Piaget's theory will not address the issue on how the teacher implements the tasks and using Vygotsky's only will not show how learners construct their own knowledge while working with higher level tasks.

Here I will show that Stein et al's framework is consistent with the theoretical framework that I had discussed above. Their framework is informed by both constructivism and socio-cultural theories. The notion of cognitive demands suggests a focus on constructivist principles. From Piaget's constructivist perspective, children learn when they are engaged in action. For learning to take place, there must be action that will influence the learning. It is a particular type of action that makes up logical structures. Learners learn when engaged in mathematical action while working on mathematical tasks. When learners are engaged in mathematical tasks they undergo a certain kind of thinking process that will enable them to gain another form of experience. It is from this experience of the actions of the subject that learners increase their knowledge in order to be able to cope with the cognitive demands of the tasks. Therefore, tasks play an important role in provoking the learners to gain other forms of experience, which is consistent with Piaget's theory.

From a socio-cultural perspective, the zone of proximal development (ZPD) plays an important role in the learning process. Vygotsky (1978) argues that “what a child can do with assistance today she will be able to do by herself tomorrow” (p.87). The teacher by assisting learners with mathematical tasks in the classroom will give learners experiences that they will utilize while working alone with other tasks of similar cognitive demands. The way the teacher interacts with the tasks will enable learners to see the shift from working with lower level tasks to higher-level tasks. The teacher will be responsible to promote changes that are necessary for learners to learn mathematics successfully. If the teacher selects tasks that involve higher order mathematical reasoning, she/he has to ensure that the cognitive demands of the tasks remain the same at implementation phase. If the selected tasks change from higher level to lower level at implementation, the cognitive demands of the tasks decline. It is from the above that I believe that both the constructivist and social-cultural perspectives are relevant for my framework

In this chapter I have described the theoretical framework that guided my study by drawing on constructivist and social-cultural theories of learning. Both theories support my analytical framework and their similarities and differences shaped my study. I have also presented Stein et al’s framework that I will use in chapter 4 to present and analyze data. In the next chapter I will discus the methods that I used to collect data for my study.

CHAPTER 3

METHODOLOGY AND RESEARCH DESIGN

3.1 INTRODUCTION

In the previous chapter I discussed the two theories as well as the analytical framework that informed my research. In this chapter I will discuss the methodology that I used in order to answer my research questions: According to Opie (2004) a case study can be viewed as an in-depth study of interactions of a single instance in a closed system. A case study approach was relevant for my study since I observed one teacher teaching two different grades in order to see how he selected and implemented tasks in two different curricula. The interaction between the teacher and the tasks from the two curricula was studied in depth in his mathematics classrooms. “The important thing about a case study is that it is methodologically prepared and the collection of evidence is systematically undertaken. A case study is on real situations, with real people in an environment familiar to the researcher” (Opie, 2004,p.74).

3.2 THE TEACHER

The most important selection criterion was to find a teacher who was teaching both Grades 10 and 11. In most of the schools in our district there are no such teachers. A colleague in school made me aware of one teacher who had just being appointed as a deputy principal at the school in our area who was teaching both grades. After talking to the teacher I realized that he understands the process of doing research since he had previously conducted a research project himself. A colleague in the same research group (Jina, 2007) worked with me to collect data from the same teacher in the same lessons because she also needed a teacher teaching grade 10 and 11. Her analytic focus was on the teacher’s questions and interaction.

The teacher has been teaching mathematics in both Grades 10 and 11 for nine years. He has recognized teacher’s qualifications (Higher Diploma in Education, B.SC ED, B.ED HONS, ACE) and attended the NCS training in 2005 that focused on the

implementation of the new curriculum for grade 10 in 2006. He also attended follow up training in 2006 that supplemented the 2005 training and focused on grade 11 implementation. The teacher was therefore aware of the changes that are taking place in the curriculum through the in-service training that was offered by the Gauteng Department of Education in the past two years. The teacher was thus suitable for my study since he had experience in teaching the old curriculum and has undergone training in teaching the new curriculum.

3.3 THE SCHOOL

The school is situated in a township and all learners are from the black community. There were 1800 learners enrolled at the school and it had a staff of 45 teachers. The teacher learner ratio is 1:50. The school does not have enough classrooms due to the increasing number of learners enrolling at the school. In recent years the school's matric results has improved and their average pass rate was 70% in 2005. The majority of learners are from poor families most of whom cannot afford to purchase scientific calculators for their children and this resulted in learners taking a longer time to complete their tasks since they had to borrow calculators from each other.

The study was conducted in two mathematics classes, one in grade 10 and the other in grade 11. There were 40 learners in the grade 10 classroom and 9 learners in grade 11. The latter situation is unusual in township schools. The reason given by the teacher for the small number of mathematics learners in grade 11 was because of the choice of subjects by learners. The 9 learners form part of a class with 43 classmates who share the same subjects except mathematics. The 9 learners were the only ones who were doing mathematics; the others were doing Travel and Tourism. In addition, the 9 learners were all repeating grade 11.

Due to the unavailability of classrooms, the teacher did not have a stable classroom and he used different classrooms to teach. In classrooms where there was enough space he let learners work in groups in his grade 10 lessons. Because the majority of the learners did not have scientific calculators and rulers, in most cases this inhibited the flow of the lessons.

3.4 DATA COLLECTION

I used a qualitative approach to collect and analyze my data. Qualitative data is in the form of words rather than numbers. In observing a teacher using two different curricula, I was not interested mainly in how many tasks he selected, or how many of each kind, but in the nature of the tasks and how the teacher interacted with tasks and learners. “With qualitative data one can preserve chronological flow, see precisely which events led to which consequences, and derive fruitful explanation” (Miles and Huberman, 1994, p.1). In order to investigate a teacher selecting and using tasks from the two curricula, the teacher was in the classroom that was his familiar context. Kincheloe (1999) argues that one of the most important aspects of qualitative research is its concern with context. Human experience is shaped in particular contexts and cannot be understood if removed from those contexts. Research must take place in the normal, everyday context of the researched. I used classroom observations, video recordings and teacher interviews to collect data.

3.4.1 VIDEO RECORDINGS AND OBSERVATIONS

I observed the teacher teaching his Grade 10 and 11 classes for one week. I observed five grade 10 and five grade 11 lessons and all lessons were continuous. As mentioned earlier a colleague and I collaborated in collecting the data. She videotaped and I wrote detailed classroom observations. My colleague, with two other members of the research group, practiced using the video camera at my school prior to the real filming. Using a videotape was important, since as an observer I might not have captured all events during the lessons; I had an opportunity to watch the lessons again for analysis. The tapes were also useful during the teacher interviews. If there was anything that the teacher did not agree with, in my observations, we could refer to the videotape and discuss it. The classroom observations gave me the opportunity to see which mathematical tasks the teacher selected and implemented in Grade 10 and 11 classrooms and how he did so. This was possible since I took notes during all lessons observed.

3.4.1 INTERVIEWS

Two interviews were conducted with the teacher, one for each grade. The purpose of the interviews was to obtain a better understanding from the teacher as to how he selected and implemented tasks in the lessons and how he understood the tasks played out in the classroom. The interviews took place after all lessons were observed. The interviews were tape-recorded so that I could listen to them carefully afterwards. I practiced interviewing with my colleagues and conducted pilot interviews prior to the actual data collection. A draft interview schedule is outlined in Appendix 1. After I had viewed all the lessons and listened to the interviews, the teacher and I watched some of the recorded lessons together so that I could be able to a better picture from him as to why he implemented and selected tasks in particular ways. Watching the video with the teacher was helpful since he answered some of the questions more clearly than in the interviews. Transcripts from parts of the interviews were used for data analysis.

3.5 LIMITATIONS IN DATA COLLECTION

Interviews in particular have some disadvantages: the respondent may feel uneasy about answering certain questions and adopt avoidance tactics if he is not sure about the answer. Sometimes the respondent and the interviewer might interpret each other's questions and answers differently and a wrong impression can be developed. Also the teacher might try to say what he thinks the researcher wants to hear particularly since we were both together during the NCS training i.e. he may be influenced to give responses according to what he thinks is acceptable in the new curriculum.

Although interviews and videotaping were helpful in support of the data from the observations, they have limitations. The teacher may consciously or unconsciously change the way he usually teaches because of my presence and that of the video camera. Learners may also change their normal classroom behavior because of the observer and the video camera. In the letter that I wrote to the teacher, it is explained that my research is on teachers' practices. This general statement means that the

central aspects of my study, a focus on tasks, were therefore not known to the teacher prior to the research. I went to the school a week before the data collection time and visited the two research classes. I talked informally to the learners so that they could get used to me and also told them about my colleague who would be videotaping the lessons. This was helpful since during the lessons I did not see any suspicious behavior from the learners. At the beginning of the first lessons the teacher introduced us to the learners and reminded them about our presence and that of the video camera. Learners from the two classes were therefore made aware of our presence and asked to behave naturally during the study. Despite their limitations, lesson observations, interviews and videotaping provided me with important data for my study. Listening to the teacher's interviews by rewinding the tape recorder enabled me to have a clear understanding of what he was saying. As I have mentioned before it also assisted me to ask the teacher further questions after the interviews about the videotaped material.

Although using qualitative approaches in case studies are important, they are not without their limitations. It is possible for the researcher to be subjective and biased. Also, case studies are not generalisable to other situations. The teacher that I observed might not select and use mathematical tasks or promote mathematical reasoning in ways similar to other teachers. As I was observing a grade 10 class where a new curriculum had just being introduced, it might have been too soon to observe changes in the teacher's ways of selecting and implementing tasks in relation to the NCS. This could lead me to be biased towards what I was observing in his teaching. However I was alert to this possibility and took it into account in my analysis.

As I have mentioned before the teacher did not have a stable classroom, and this resulted in me, the teacher and my colleague spending time looking for free classrooms where the lesson could take place. This resulted in some lessons being shorter than the others; I also had to put off my data collection for a day since an event was organized for the three high schools in the area. The teacher, being a deputy principal, had to attend emergency meetings which led to some lessons being postponed to the next day. Instead of collecting my data in five school days I ended up having to spend nine days. This affected my study since most of the grade 10 lessons were based on the previous ones and the learners, after skipping a day without engaging in any mathematical activities, had to be reminded of what happen in the

previous lessons. This wasted a lot of time. The learners, knowing that there was an event at school that would mean not attending lessons for one day, did not do their homework. The teacher ended up doing the homework with them in class and this resulted in the decline of the cognitive demands of the tasks, as I will discuss in the next chapter.

3.6 VALIDITY AND RELIABILITY

It is an ongoing challenge to establish and maintain rigour in qualitative research. Rigour includes the concepts of reliability and validity. Bassey (1999) defined reliability as the extent to which research facts or findings can be repeated, given the same circumstances, and validity is the extent to which a research fact or finding is what it is claimed to be. Guba and Lincoln (1985) use four criteria that can be useful to ensure rigor in research: credibility, transferability, dependability, and cornfirmability. Credibility was achieved in my research by confirming with the teacher whether or not I captured his views correctly. I watched the video with the teacher and asked him why he implemented tasks in particular ways. His responses enabled me to capture his views clearly.

Being in the classrooms for the whole week observing lessons enabled me to have enough time with the learners and the teacher to build their trust and it enabled me to gain "genuine" data from both of them. I was also aware that the teacher may have wanted to impress me by changing his teaching during my presence. Therefore, I always watched how the learners responded to his teaching, which would indicate to me whether or not he was doing something unfamiliar in the lessons. As I have mentioned before the central aspect of my study was not known to the teacher prior to the research. If the teacher had tried to impress me, he would not have known on what to direct his attempts; although he might have tried to do what he learned in the workshops. I think that both the teacher and the learners acted as naturally as possible during the data collection.

Transferability refers to the extent to which some of the findings in my study might be transferable to other settings that are similar to the setting of my study. Guba and Lincoln (1985) argue that comfirmability corresponds to objectivity and lies in the

comfirmability of the data and not in the neutrality of the researcher. “It is the idea that the researcher should keep a systematic record which will allow an auditor to check stage by stage of the research in order to certify that the conclusions are justified” (Bassey, 1999, p.77). The documents that were used in my study included classroom observation notes, interview transcripts, video transcripts and worksheets provided by the teacher during the lessons. All the above-mentioned documents are attached at the back of my report so that they can be seen by anyone who is reading this report for comfirmability purposes. I also watched the video with the teacher and asked him questions to cormfirm the validity of the data. In addition, I worked in a group with other researchers, my supervisor, a doctoral student and two masters students throughout the process of analysis and of writing this report who gave me valuable advice. I also worked with another researcher on the same case but with a different research topic and this helped since she kept on reminding me of some of the issues which I did not capture well during the lessons.

3.7 ETHICAL ISSUES

There were important parties with whom I negotiated with before undertaking my research namely: Gauteng Department of Department by filling in the standard GDE forms which are compulsory for anyone who is to conduct research within the Province. I had to wait for their approval before conducting the research. I also received ethics clearance (protocol no: 2006ECE08) from the Ethics Committee of Wits University. A letter was written to the principal of the school where the research was to be conducted asking to use the school as a research site. All learners involved in the study were given letters that asked for permission to be part of the study and to be videotaped. I received permission from the teacher and the learners to use the video in professional conferences and in any developmental teachers workshops. Letters were sent to the parents/guardians for permission that their children could be part of the research. All participants were assured of confidentiality, anonymity and their right to withdraw at any time.

3.8 PROCEDURE FOR DATA ANALYSIS

I used Stein et al's (1996) framework to analyze my data on task selection and implementation in the classrooms. This framework enabled me to identify criteria that the teacher used to select tasks and determine whether they promoted reasoning that is, the framework helped me to answer my first and third research questions. For my second question on implementation I looked at how the demands of the tasks changed. I focused on Stein et al's two levels of cognitive demand of mathematical tasks; namely, lower level tasks and higher-level tasks and the task features that they entail.

After all the lesson observations and teacher interviews, I made transcripts or notes from the videos and the interviews in relation to my research and the framework. This provided me with ways of linking the video and interview data. I then began to investigate similarities/differences in how the teacher selects tasks in the two grades and categorized them according to Stein et al's, (1996) framework, namely:

- Lower-Level Demands that include *Memorization, Procedures Without Connections To Meaning, and*
- Higher-Level Demands that include *Procedures With Connections To Meaning, Doing Mathematics.*

A full description of Stein et al's framework was discussed in chapter 2. Initially for both grades 10 and 11, I wanted to answer my research question on how the teacher implements tasks by looking at how the learners actually work with tasks in the classroom. I had to change my criteria since I realized that the teacher actually gave the Grade 10 learners work during the lessons and the Grade 11 only at the end of the lesson. In my analysis I looked at how the teacher implemented tasks in the Grade11 class by observing how the teacher actually worked with the tasks, rather than the learners. In the Grade 10 class I used the initial criteria.

3.9 CONCLUSION

In this chapter I have discussed the methodology that I used to collect data. I have also given a description of the context in which the study took place. Issues of validity and reliability were discussed. This research study investigated how a teacher selects and implements mathematical tasks in the old and new curriculum. The findings will not be generalisable to all teachers because of the research methodology. However it will benefit teachers and researchers in working with the old and new curriculum, now, and in future. It will also add the literature on curriculum change. In the next chapter I analyze the tasks according to Stein et al's categories and show how the cognitive demands declined in grade 10 and remained the same in grade 11.

CHAPTER 4

DATA ANALYSIS: THE TEACHER'S SELECTION AND IMPLEMENTATION OF TASKS

4.1 INTRODUCTION

In this chapter I present the analysis of task selection and implementation in both Grades 10 and 11 classes. I classify each task according to Stein's et al categories. Throughout the chapter I will compare what was happening in the two grades using the teacher's interviews and the lesson transcripts. I argue that although the teacher was able to select the tasks in relation to the new curriculum in the Grade 10 lessons, at implementation the cognitive demand of the tasks declined. In the grade 11 lessons, the cognitive demands at selection were of a lower level and remained the same at implementation phase.

4.2 TASK ANALYSIS

According to Stein et al (1996) "a mathematical task is defined as a classroom activity, the purpose of which is to focus learner's attention on a particular mathematical idea" (p.460). In my data I will refer to a task as a subsection of an activity given by the teacher. In the grade 10 lessons three activities were given to learners, each having subsections. Activity 1 was divided into eight tasks, activity 2 into thirteen tasks, and activity 3 was divided into eight tasks. The tasks used in the grade 10 lessons were taken from a textbook written according to the new curriculum. It took one lesson to do some of the tasks in the first activity, three lessons to finish the second activity and one lesson to finish the third activity.

In the grade 11 lessons the activities were from a textbook called Classroom Mathematics. The textbook was written according to the curriculum that was phased out at the end of 2006. Two activities were given in the grade 11 lessons. The first activity was divided into seven tasks and the second activity into eleven tasks. It took two lessons to finish the first activity and three lessons to finish the second activity. In

the next section I discuss tasks that were selected and implemented during the lessons in grades 10 and 11 lessons.

In both grade 10 and 11 I classified all the activities according to Stein et al's framework as indicated in chapter 2. As indicated in the table below most of the grade 11 tasks required learners to use procedures without connections to meaning at selection and in grade 10 they required learners to use procedures with connections to meaning. The table below summarizes the results:

Stein's framework	Grade 10 New curriculum	Grade 11 Old curriculum
Memorization	0	0
Procedures without connections	5	16
Procedures with connections	24	2
Doing mathematics	0	0
Total number of tasks	29	18

TABLE 1: Number of tasks as selected in grade 10 and 11

Table 1 shows that the teacher selected 24 tasks that involve procedures with connections to meaning in grade 10 as compared to only two in grade 11 lessons. The table reveals that in the grade 10 classes learners were mostly engaged in tasks that involved procedures with connections to meaning. Twenty four out of the twenty nine selected tasks required learners of some cognitive effort to successfully complete them. In grade 11 only two out of eighteen selected tasks required learners to use procedures with connections to meaning. Table 1 shows that the teacher in grade 11 selected sixteen tasks that did not require learners to explain how they obtained their solutions but the emphasis was rather on the procedures used to obtain the solutions. None of the selected tasks involved memorization or doing mathematics. Zweers (2005) in her research using Stein et al's framework compared two textbooks on the topic of functions, one from the new curriculum textbook and the other from the old curriculum.

In her findings there were no memorization and doing mathematics activities in either textbook. She found that sixty seven percent of the activities from the old curriculum required learners to use procedures without connection to meaning as compared to sixty five percent in the new curriculum and vise versa. This is a big shift when one considers that even the textbook writers were still on the learning process of selecting relevant tasks for the new curriculum.

In the grade 10 lessons the teacher selected tasks that were in accordance with the new curriculum. The new curriculum encourages tasks that will enable learners to investigate, explore and explain their solutions. Such tasks usually require the use of procedures but with connections to meaning, which is why the selected tasks were of higher cognitive demand. In the grade 11 lessons the teacher selected tasks from the textbook in order to satisfy the requirements of the curriculum, which is more concerned on obtaining the correct solutions than on how learners arrived at the solutions. Such tasks usually require learners to use previously taught concepts, and they are of low cognitive demand. In the next section I analyze some selected tasks, showing why they were categorized under Stein et al's categories in Table 1.

4.2.1 GRADE 10 TASKS

The teacher in the first lesson issued a worksheet whereby learners had to investigate the effect of the parameters a and q on the graphs of $y = a \sin(x) + q$, $y = a \cos(x) + q$, $y = a \tan(x) + q$ (See Appendix 2 for the complete worksheet). In the first task learners were supposed to fill in a given table and sketch a graph from the information found from the table. Although learners were required to use a familiar procedure to fill in the table, the second task required them to follow up on the first task by asking them to sketch the graph of $y=\sin x$ using the information from the table. The first task was focusing their attention on the use of the procedure for the purpose of developing a deeper level of understanding of mathematical concepts and ideas in the second task. Also is evident in the third task that asked learners to sketch the graph of $y = 2\sin x$ and state what did they notice. The question required learners to make connections between the graph of $y = \sin x$ and $y = 2\sin x$ and make meaning from the two. It required learners to make connections among multiple representations that help to develop meaning. The fourth task was also linked to the first three tasks in that

it required learners to use a table of values to sketch the graph of y = 2sinx+1. Learners were not given any table of values as in the first task to sketch the graph, instead they are to use the knowledge gained in the first task to sketch the graph of y = 2sinx+1. It is linked to the second and third tasks in that the information needed to successfully complete the task is dependent on the information learned from the two tasks. The four tasks altogether aimed at engaging the learners on the effect of a and q in any graph.

An analysis of the first four tasks in accordance with Stein et al's categories and criteria shows that tasks they are tasks that require procedures with connections to meaning. The first task focused learner's attention on the use of procedures (drawing the graph) for the purpose of developing deeper levels of understanding of mathematical concepts and ideas. The tasks were therefore of higher-level demands. The activity provides a procedure for drawing the graphs but connects the procedure to meaning i.e. the effect of the parameters a and q and the relationships between different graphs. The tasks did not allow learners to follow procedures mindlessly but to make sense of the mathematics they are dealing with. The follow up of the first task was to sketch the graph of y = sinx, y = 2sinx and y = 2sinx+1 which engaged learners to move to a higher level of thinking. It required them to make use of the initial ideas of sketching the graph of y = sinx, to think about how the +1 and+2 affects the graph, and to make a generalization about the effect of a and q. The tasks required learners to use procedures at the beginning but the questions after the first required more than procedures for learners to successfully answer the questions.

During the fifth lesson the teacher showed the learners how to sketch the graph of $y = 2x^2 - 8$ by finding the x and y-intercepts as well as the turning point. He the gave learners a worksheet which required them to sketch the graphs of $y = x^2 - 9$ as the first task, $y = -x^2 + 4$ as the second task and $y = 3x^2 - 12$ as the third task by showing all the necessary details i.e. the x and y intercepts and the turning point. In Stein et al's category these tasks falls under procedures without connections to meaning. The tasks focused learners on producing correct answers rather than developing mathematical understanding. The tasks required learners to use a previously taught procedure to sketch the given graphs. They were straightforward and needed limited cognitive effort to solve, as they did not require much thinking

from the learners. Rather, the learners were required to recall something they have learned and should know well. The fourth task was on application of the parabola. It was a follow up on how the graph of the parabola can be used in a real life situation. The task required learners to use procedures with connection to meaning.

In general, as shown by Table1 and the above analysis, the selected tasks in grade 10 were of higher cognitive demand. In the next section I will show that the teacher selected mostly lower level tasks in grade 11.

4.2.2 GRADE 11 TASKS

The second activity in grade 11 was based on the quadratic function $y = ax^2 + bx + c$, $y = a(x - p)^2 + q$. The activity was divided into eleven tasks of which the first five expected learners to answer questions based on two intersecting graphs. The first task required learners to find the coordinates of A, B, C and D. In finding the coordinates of the graph learners could just factorise the given equation of the parabola and write down the coordinates. Learners used a well known procedure of factorization to solve the task, hence the task is of a lower level. The second task required learners to find the equation on the line EB which they could find by calculating the gradient after solving the equation of $y = 2x^2 - 3x - 2$ and $y + x = 0$ simultaneously. Learners could use previously taught procedures to solve the task. The third task required learners to find the coordinates of E which is the point of intersection of the graph of $y = 2x - 3x - 2$ and $y + x = 0$. The task focused learners on how to use procedures of solving the two equations simultaneously, which did not need much cognitive effort to simplify. The first three tasks required learners to use procedures without connection to meaning; they are of lower cognitive demands. The fourth task required learners to find the length of FG if the x-coordinate is given as positive one. The task required some degree of cognitive effort from learners to successfully complete. Procedures could be used to solve the task, but they cannot be followed mindlessly. The fifth task required learners to find the value of k if the point (k; 3) lies on the parabola. The task requires learners to use mathematical representations in multiple ways. In Stein et al's a framework "making connections among multiple representations helps to develop meaning". The fourth and fifth tasks certainly require higher level of thinking

from learners, and thus falls under procedures with connection to meaning, they are therefore of higher cognitive demand.

The sixth and seventh tasks required learners to sketch graphs using known procedures. (Sketch the graph of $y = x^2 – 2x – 3$, 5 - y/ = x + 4 by finding the axis of symmetry, turning point, range and the intercepts on the axes). The activity is of a low cognitive demand. According to Stein's categories and criteria, they are procedures without connections to meaning. The eighth task required learners to answer questions based on a given sketch having the equation $y = x^2$ - 4x - 5. The learners had to find the lengths of the given lines (OA, OB, OC, OE, and ED) using the equation. Factorizing the equation and linking the factors to the lines could answer the question, which is a well known procedure. It involves previously learned rules of factorization and requires limited cognitive demand for successful completion. In terms of Stein et al's category the question falls under procedures without connection to meaning. Learners can solve the problem by just referring to what they had seen before. The ninth task required learners to write down the equation of the dotted line, which is the axis of symmetry. No cognitive effort is needed to answer the question. The tenth task required learners to find the length of BC that can be found by using the theorem of Pythagoras. The task required learners to know a certain procedure in order to solve it. It required procedures without any connections to meaning to successfully complete. The eleventh task required learners to find the equation of g which is the straight line passing through point B and C. The task focused learners to use certain procedures such as calculating the gradient of BC in order to find the equation of g. Thus, as the Table1 and the above analysis show, the grade 11 tasks were mostly procedures without connections to meaning.

As I indicated before, in the grade 10 lessons the teacher selected tasks that were in accordance with the new curriculum. The new curriculum encourages tasks that will enable learners to investigate, explore and explain their solutions. Such tasks usually require the use of procedures with connection to meaning, which is why the selected tasks were of higher cognitive demand. In the grade 11 lessons the teacher selected tasks from the textbook in order to satisfy the requirements of the curriculum, which is more concerned with obtaining the correct solutions than on how learners arrived at the solutions. Such tasks usually require learners to use previously taught concepts,

and they are of low cognitive demand. In the next section I show that although the teacher selected higher-level tasks in Grade 10, at implementation the cognitive demands of the tasks declined.

4.3 TASK DECLINE

In this section I will analyze the tasks at implementation according to Stein's et al categorization. In the previous section I showed that the selected tasks were either procedures with or without connections to meaning. Stein et al (1996) identified various types of factors that could potentially influence the way in which tasks are actually implemented in the classroom. These include classroom norms, task conditions, and the teachers' and students' habits and dispositions (Stein et al, 1996, p. 461). Examples include the extent to which the teacher is willing to let learners struggle to work with difficult tasks, and the kind of assistance that he provides learners who are having difficulties. The amount of time given to the learners to solve the tasks also influences the way tasks are implemented. The above mentioned factors and other reasons will be used as evidence to show how the cognitive demands of the tasks declined. Table 2A below shows the tasks decline from selection to implementation phase in grade 10. I will further analyze the decline of tasks in grade 10 using three tasks features: solution strategies, representations, and communication.

ACTIVITY 1	SELECTION	IMPLEMENTATION
Task1.1	P\C	P\C
1.2	P\C	P\O
1.3	P\C	P\O
1.4	P\C	P\O
2.1.1	P\O	N\D
2.1.2	P\C	N\D
2.1.3	P\C	N\D
2.1.4	P\C	N\D
ACTIVITY 2		
Task 1.1	P\C	P\O
1.2	P\C	P\O
1.3	P\C	P\O
1.4	P\C	P\O
1.5	P\C	P\O
1.6	P\C	P\O
1.7	P\C	P\O
1.8	P\O	P\O
APPLICATION		
Task1	P\C	P\O
2	P\C	P\O
3	P\C	P\O
4	P\C	P\O
5	P\C	P\O
ACTIVITY 3		
Task1	P\O	P\O
2	P\O	P\O
3	P\O	P\O
APPLICATION		
Task (a)	P\C	N\D
(b)	P\C	N\D
(c)	P\C	N\D
(d)	P\C	N\D
(e)	P\C	N\D

TABLE 2A: Categories of tasks at selection and implementation (Grade 10)
Codes used: Procedures with connections=P\C, Procedures without connections=P\O, Not done in class=N\D

Table 2A shows that out of the 29 tasks selected, 20 were implemented during the lessons and 9 were not implemented. Out of the 20 implemented tasks, 4 were categorized as procedures without connection to meaning at selection and 16 were

categorized as procedures with connection to meaning. The table shows out of the 16 tasks that required learners to use procedures with connections to meaning, 15 declined to procedures without connections to meaning at implementation. According to Table 2A only task 1.1 remained the same at both selection and implementation. The following table summarizes the results:

Selection phase		**Implementation phase**			
Categories	**Number**	**Memoriza-tion**	**Procedures without connections**	**Procedures with connections**	**Doing mathematics**
Memorization	0	0	0	0	0
Procedures without connections	4	0	4	0	0
Procedures with connections	16	0	15	1	0
Doing mathematics	0	0	0	0	0
Total	**20**	**0**	**19**	**1**	**0**

TABLE 2B: Categories of tasks at implementation in grade10

Table 2B shows that out of the 16 tasks which were selected as procedures with connection to meaning, 15 of them declined to procedures without connection to meaning. The 4 tasks that were categorized as procedures without connection to meaning remained unchanged at implementation. The results show that although the selected tasks were to be solved according to the learning outcomes of the new curriculum, at implementation phase they were solved as if they were from the old curriculum. In analyzing the decline I will first give the teacher's view on how he expected learners to implement the tasks. During the interview the teacher clearly said that he liked his learners to work in groups so that they can give him feedback and justify their solutions. This is evident from the following extract:

> Researcher: How did you expect the learners to solve the tasks?
>
> Teacher: I expected them to work in groups to be able to assist one another and also to give me feedback in terms of their understanding and my whole aim was to guide them towards the expectation of this particular exercise and the expectation was for them to work on their own and see if they can make sense of this type of problems.
>
> Researcher: Do you expect the learners to justify their solutions?
>
> Teacher: Yes, it is very important as a teacher you learn best when you are engaging these learners. There are approaches that you may not be aware of and there are learners who are very intelligent in class so you should not undermine those learners. Let them tell you how

> they got the solutions if you suspect that their solution is correct because it may not be the same as how the teacher would get that particular solution.

The above extract shows the teacher's intention about the tasks; he expected learners to work on their own and make sense of the tasks. He also expected them to give him feedback on what they had learned from them. This is evident in task 1.3 where learners had to mention what they noticed. Such questions usually require learners to give an explanation that in turn gives the teacher feedback on the learners' thinking. Such questions are of high cognitive demand, and the teacher selecting such tasks shows his intention of giving learners an opportunity to explain their solutions. The teacher also expected his learners to justify their solutions so that he could understand their different approaches to the tasks. The interview extract shows that the teacher's intention was to select tasks that would require learners to explain their solutions, to make sense of the mathematics they are working with and also to justify their solutions. The tasks that he selected required learners to use procedures with connections to meaning. This is what happened during the lesson:

4.3.1 EXAMPLE 1 GRADE 10: DECLINE

Learners in groups were given enough time to fill in the given table and to sketch the required graphs. The teacher went around the class looking at their work and asked those that had finished to fill the table to sketch the graph of y = sinx. Most of the learners did manage to fill in the table as well as sketch the graph correctly. The teacher went to the board and drew the Cartesian plane while learners were still working. The teacher then asked one learner to sketch the graph of y = sinx which he did sketch correctly. The teacher then asked learners to have a look at the graph on the board and commented by saying:

> "Alright the first graph of y = sinx, the graph starts at zero turns at 90 and 270 degrees and ends up at 360. Is there anyone of you who did not get the graph"?

Learners did not respond to his question or comment but they instead continued with sketching the graph of y = 2sinx. The teacher continued going around the class checking their work and realizing that most of them had successfully sketched the

graph of y = 2sinx asked one learner to sketch the graph on the board. After the learner had sketched the graph the teacher said:

> "You are now at the last graph of y = 2sinx + 1"

Learners, after the teacher's comment continued to work on sketching the graph of y= 2sinx + 1 and one learner was asked to sketch the graph on the board. After the learner had sketched the graph most of the learners disagreed with his sketch (the learner's y- value at the turning point was at –2 instead of –1). At this point the whole class was complaining about the graph; and the teacher, after finding out why learners were complaining, picked up a learner's book, went to the board, wiped off the mistake from the graph and wrote the correct solution. This is how the learners' dissatisfaction was resolved:

> Teacher: Is it like that? (Pointing on the correct graph)
> Learners: Yes sir (chorus)
> Teacher: Is that how the graph should be?
> Learners: Yes sir

After learners were satisfied with the sketch of y = 2sinx + 1, the teacher then went to the board and asked learners questions based on the three graphs which were drawn on the board. The following conversation took place:

> Teacher: All right then lets look at the first one, its starts from zero up to 180 degrees that's half of the circle and then your other circle ends up at 360 degrees. So it completes one revolution.
> Learners: Yes sir
> Teacher: Your second graph if you multiply the first by two what happens to it? Now lets compare the two graphs.
> Learners: inaudible answer
> Teacher: Okay, what about here? (pointing at the graph of y = 2sinx)
> Learners: Inaudible
> Teacher: By how many units?
> Learners: Two
> Teacher: 2 units, okay, now lets look at the last graph, you now adding one what happens?
> Learners: Decrease by one
> Teacher: How? How does it decrease by one?

Learners: Inaudible

Teacher: What is the effect of q what does q does to the graph?

Learners: Cuts y axis at 1

Teacher: Cuts the y-axis at one, partially correct but something is missing .We are now making a general statement. What is the effect of this q? What does q do to the graph when you sketch the graph?

Learners: NO answer

The above extract show that the learners did not engage with the task as was intended at selection. During the interview it sounded like the teacher wanted learners to justify their solutions but this was not the case during implementation, there was a mismatch between choosing the tasks and implementing them. The teacher was trying to let learners explain their solutions but was not able to. Learners did manage to sketch the three graphs correctly. However this was not the main focus of the activity. Sketching the graphs correctly without investigating the effect of a and q belongs to the old curriculum. If learners are given tasks in which they are to explain their solutions and they end up only giving the correct sketches, the cognitive demands of the tasks decline to procedures without connection to meaning.

After the first learner had sketched the graph of y = sinx the teacher focused the whole class on the graph and explained to them where the graph starts, turns and ends. In this instance he was emphasizing the important features of the graph that learners had to be aware of in the graph. He took the most important aspects of the graph and explained them to the learners. They did not respond to his question on whether they managed to sketch the graph y = sinx correctly instead they were allowed to continue with the graph of y = 2sinx. In this case it seems the teacher was satisfied with the procedure of sketching the graph rather than the underlying features of the graph. As I have shown in Table 2A, tasks 1.2, 1.3, and 1.4 were selected as procedures with connections to meaning at selection but at implementation phase they are categorized as procedures without connections to meaning. The decline was caused by the way he handled them during implementation. The teacher did not give the learners opportunities to explain their solutions, instead the correct sketches seemed to be the main focus of the tasks. In the lesson discussed above the teacher selected higher level tasks which were in accordance with the new curriculum but he used the principles of the old curriculum to implement them. Being the presenter of solutions to the learners,

as well as not giving learners enough time to explain their solutions belongs within the old curriculum.

After the second learner had sketched the graph of y = 2sinx the teacher gave the class the go ahead to sketch the last graph of y = 2sinx + 1. Learners were not given the opportunity to explain what they noticed. Instead they were allowed to continue with the next graph. The procedure of sketching the graphs at this stage was more dominant than understanding the effect of +1 and +2 on the graphs of y = sinx and = 2sinx respectively. Stein et al (1996) mentioned that one possible factor bringing about task decline is the lack of sufficient time for students to wrestle with the demanding aspects of the tasks (p.467). Learners in this instance were not given any time to work on the demanding part of the task i.e. to say what did they noticed about the effect of a and q.

There was disagreement amongst the learners when the third learner sketched the graph of y = 2six + 1. After consulting one of the learners who was not satisfied with the graph the teacher went to the board and wiped out the incorrect section of the graph and corrected it. The learners had been showing signs that they understood how to sketch the graphs. Their dissatisfaction shows that they were making meaning from the graphs that they had sketched. The teacher asked the whole class if they were satisfied with the graph that he had rectified and in a chorus they responded by saying "yes". In this case the teacher was more interested in the correct shape of the graph rather than in learners' explaining their dissatisfaction. The attention that he paid was to the correct shape rather than any other thing. This is evident in that after the learners were in agreement with his new graph he went on to summarise the effect of a and q without asking further questions based on the graph. Stein et al (1996) mentioned that there is a tendency for teachers to shift emphasis from meaning, concepts, or understanding to the accuracy and completeness of answers. Such a tendency usually allows the cognitive demands of the task to decline, as they did in this instance.

After all the three graphs were on the board the teacher went to the board and summarized the effects of a and q by asking learners questions based on the three graphs as in the last extract of this section. First, he told the learners where the graph

of y = sinx starts, its middle and its last value. Secondly he went to the second graph and asked learners what would happen to the second graph if it is multiplied by two, and the learners did not respond. He further probed by pointing at the graph and asking them what happened at a particular point. Learners responded by saying “two” and finally he moved to the graph of y = 2sinx + 1 and asked them what adding +1 does to the graph. In the three instances the teacher was funneling the learners towards the correct solutions (Bauersveld, 1988, Brodie, 2002). In the first two cases he was funneling learners towards the meaning of a and in the last case towards the meaning of q. After the learners had responded by saying “two” the teacher went on to ask questions based on the third graph. The word “two” seemed to have satisfied the teacher that the learners had understood the question, and from there he said, “two units, okay, now lets look at the third graph”. “Just one expected word from the student then can bring the teacher to a presentation of the complete solution by himself” (Bauersfeld, 1988, p.36). The teacher, by explaining what the learners were saying and leading them to the answer allowed the cognitive demand of the tasks to decline from procedures with connection to meaning to procedures without connection to meaning. The teacher altered the cognitive demand of the task by asking questions that led learners to the solutions.

Although the teacher did not allow learners to explain their thinking in his interview, he said that he did, for example:

> Researcher: If learners give correct solutions do you ask them to explain how they arrived at the solutions?
> Teacher: Yes it is very very important because I don’t really believe the learners can coincidentally give solutions which is correct and some of these learners are finding it difficult in this solutions so it is better that the learners must explain how he or she has arrived at the solution because they may not be understanding the teacher. The learner when explaining their solution may come up with different way of showing how the problem must be solved.

The above extract shows that there was a mismatch between what happened in class and what the teacher said during the interview. The interview extract revealed that the teacher wanted learners to justify their solutions even if they are correct, but during the lesson this was not the case. Learners responded correctly and the teacher continued asking them questions without letting them justify their solutions. Jina

(2007) who observed the same lessons but with a focus on the teacher's questions and interaction patterns provides more detailed analysis to substantiate this claim.

Stein et al (1996, in analyzing whether the tasks changed or remained the same from set up to implementation, used three task features, namely solution strategies, representations, and communication to organize information related to set up and implementation versions of the questions about cognitive demands. I will also use each of the features to show how the cognitive demands of the tasks discussed in the above lesson declined during implementation.

Solution strategies. This refers to the relationship between the number of solution strategies of tasks as they were selected and the number of solution strategies actualised during implementation. Out of the four tasks discussed above three (1.1, 1.2, and 1.4) needed a single strategy at selection and implementation. Filling in the table and sketching the graphs usually requires single strategies at implementation. Explaining what you notice (1.3) required more than one strategy at selection. During implementation the word "two" was the only notable solution of the task. This means that tasks that were selected as requiring single strategies led to learners' use of a single solution strategy during implementation phase. Task 1.3 which was selected to encourage the use of multiple solutions had a somewhat less consistent relationship to implementation. Even if tasks 1.1, 1.2 and 1.4 required a single strategy at implementation, the strategy had to be linked to task 1.3, which was not the case during the lesson. The learners implemented the four tasks as if there were no relationships amongst them; hence the decline of the cognitive demands of the tasks.

Representation. This refers to the number and kinds of representations encouraged by the tasks at selection and the number and kinds of representation that were used during task implementation. The four tasks discussed in the lesson required double representation (symbolic and graphic) and were implemented using only a single representation. Thus there was no decline in the number of representations used from selection to implementation phase. Stein et al (1996) argued that more representations do not necessarily translate into deeper understanding. The crucial factor is how representations become connected to one another (p.475). Although the four tasks had double representations, they were connected to one another. Filling in the table,

sketching the graphs of y = sinx, y = 2sinx, y = 2sinx + 1 and explaining their relationships do have meaningful connections. This means that even if their representations remained the same at selection and implementation phase, at implementation learners were to find solutions far beyond using total reliance on symbolic manipulations. During the lesson, symbolic and graphical representations without being connected to each other dominated the learners' solutions: hence the task decline.

Communication. This refers to those tasks whereby learners had to explain and justify their solutions. Tasks 1.1, 1.2, and 1.4 appeared not to require any explanation at selection but at implementation in order to give the solution of 1.3 learners had to use the solutions found in 1.1 and 1.2 to explain the solution of 1.3. Also, in order to sketch y = 2sinx + 1 learners had to use their justification obtained in the previous tasks. Generally all four tasks required some form of explanation during implementation phase and from the evidence discussed from the classroom proceedings, there was no explanation from the learners. There was a change from selection to implementation, from explanation at selection to non- explanation at implementation phase: hence task decline

In terms of Stein's framework the tasks required learners to focus on the use of procedures for the purpose of developing deeper levels of understanding of mathematical concepts and ideas. This did not happen during the lessons. Instead learners were given enough time to sketch the three graphs but not enough time to explain their solutions, nor appropriate guidance to focus on deeper understanding of the task. The teacher took over the challenging aspects of the tasks and either did them for the learners, or told them how to do them (e.g. learners were told that the graph of y = sinx starts at zero and turns at 270 degrees, and also the teacher did showed learners how to draw the correct graph after a class argument). As I have mentioned in chapter 2 from the constructivist perspectives learners need time to reason, to try ideas, and to struggle for ways to describe or communicate ideas. If they are given time to make sense of the mathematics that they are solving they are likely to construct new knowledge rather than be presented with the knowledge by the teacher.

Although the teacher gave learners solutions in the above analysis, he did try in some instances to encourage learners to move from initial understandings of sketching the graph towards broader understanding of the effects of the parameters. This is evident from the following extracts in different lessons:

Teacher: I want you to tell me what you notice about this graph (Lesson 1)
Teacher: Now if you compare your first to your second graph, what is the effect of two? Is your graph widening up or? (Lesson 2).
Teacher: What happens to the graph as the values continue to increase?(Lesson 3)
Teacher: What is the difference between $y = x^2$ and $y = 2x^2$? (Lesson4)

The above extracts show that in the first lesson the teacher wanted learners to tell him what they noticed about the graph of y = 2sinx. He wanted them to see its relationship with that of y = sinx which they had sketched in the previous question. The question that he asked was to focus learners to discover the effect of +2 on the graph. In the second lesson he asked learners to compare the graphs of $y = x^2$ and $y = 2x^2 - 8$ and asked them how +2 affects the graph. By asking the same question for two different kinds of graphs shows the teacher's intention to encourage learners to see the effect of a in any given graph. He was trying to enable learners to make connections amongst multiple representation and tasks and to help them to develop meaning. In the same lesson he asked whether the graph of $y = 2x^2 - 8$ widens up or not. Since learners had already sketched the graph of y = 2sinx in the previous lesson he expected learners to relate what they learned in the first lesson to the second lesson. The teacher was encouraging learners to relate the two lessons. This shows that he wanted them to link the knowledge of what they had learned before to the present concept. In the fourth lesson he also required learners to find the difference between the graph of $y = x^2$ and $y = 2x^2$. The extracts from the four lessons show that the teacher tried in almost every lesson to focus learners onto particular mathematical ideas by asking them questions, but he was unsuccessful since learners did not respond to his questions, and he ended up giving them the solutions that led to the decline of the cognitive demands of the tasks.

4.3.2 EXAMPLE 2 GRADE 10 :NON-DECLINE

As indicated in Table 2A task 1, 2 and 3 of activity 3 were of a lower cognitive demand at selection and implementation. At the beginning of the lesson the teacher did showed the learners how to sketch the graph of $y = x^2 - 8$ using well-known procedures of finding the x and y intercepts as well as finding the turning point. He told the class that this was an alternative to the use of a table that they had used before to sketch a graph. Learners were given a worksheet and they had to sketch the graphs of $y = x^2 - 9$, $y = -x^2 + 4$ and $y = 3x^2 - 12$ showing all necessary details. The teacher instructed the learners to work individually in sketching the graphs. Learners worked individually and quietly until the end of the lesson. The teacher went around the class looking at their work and he did not interfere whilst they were busy. The instruction shows that the teacher wanted learners to use certain procedures to sketch the graphs. The task involved exact reproduction of what the teacher had shown in class. What was to be reproduced is clearly and directly stated. The task required learners to produce correct solutions, it did not require them to explain or investigate the impacts of the parameters on the graphs. The tasks remained at the same cognitive levels at selection and implementation because what was needed in implementation was specifically called for by the teacher by first showing learners the exact procedures of graph at the beginning of the lesson and then requiring them to use the same procedures during implementation. The task required limited cognitive demand for successful completion at both selection and implementation phases, hence remained at the same cognitive level. It is for the above reasons that Table 2A categorized the task as procedures without connection to meaning at selection and also at implementation.

In this section I have shown first how a task declined from a higher to a lower level and secondly how a task at lower level remained at that level. In the next section I will discuss the relationship between the selection and implementation of tasks in grade 11.

4.4 TASK NON-DECLINE

As indicated in Table 1 most of the selected tasks in grade 11 were of lower level. Table 3A below shows that the tasks remained the same at selection and implementation.

QUESTION 1	SELECTION	IMPLEMENTATION
Task 1.1	P\O	P\O
1.1.1	P\O	P\O
1.1.2	P\O	P\O
1.1.3	P\O	P\O
1.1.4	P\O	P\O
1.1.5	P\O	P\O
QUESTION 2.1	P\O	P\O
ACTIVITY 2		
Task 1(a)	P\O	P\O
(b)	P\O	P\O
©	P\O	P\O
(d)	P\C	P\O
(e)	P\C	P\O
2(a)	P\O	P\O
(b)	P\O	P\O
3(a)	P\O	P\O
(b)	P\O	P\O
(c)	P\O	P\O
(d)	P\O	P\O

TABLE 3A: Categories of tasks at selection and implementation (Grade 11)
Codes used: Codes used: Procedures with connections=P\C, Procedures without connections=P\O

Table 3A shows that out of the 18 selected tasks, two were categorized as procedures with connections to meaning and 16 as procedures without connections to meaning at selection. All the 16 tasks categorized as procedures without connections to meaning

remained the same at implementation phase. The cognitive demands of 2 tasks that were selected as procedures with connections to meaning changed to procedures without connections at implementation phase. This is a very minimal percentage that shows that the majority of the selected tasks remained the same at implementation in grade 11. The following table summarizes the results:

Selection phase		**Implementation phase**			
Categories	**Number**	**Memoriza-tion**	**Procedures without connections**	**Procedures with connections**	**Doing mathematics**
Memorization	0	0	0	0	0
Procedures without connections	16	0	16	0	0
Procedures with connections	2	0	2	0	0
Doing mathematics	0	0	0	0	0
Total	**18**	**0**	**18**	**0**	**0**

TABLE 3B: Categories of tasks at implementation in grade11

In the Grade 11 lessons there was no task decline, since the teacher originally selected lower level tasks. I will show that the cognitive demands of the tasks in Grade 11 remained the same at selection and implementation. As I have stated mentioned before, at both selection and implementation the teacher solved the tasks that he gave to the learners. The learners were not given opportunities during the lessons to show how to solve the tasks. During the fourth lesson the teacher gave the class a worksheet with the graphs of $y = 2x^2 - 3x - 2$ and $y + x = 0$ on the same set of axes. The following extract shows the teacher's intention to give learners information based on the graphs:

Teacher: Which equation represents a parabola?

Learners: No answer

Teacher: You have two equations

Teacher: Which equation? Which equation?

Learners: Y= two x squared minus three x minus two

Teacher: (Teacher explains that A and B are the x-intercepts on the graph) So which equation are you going to use to find the intercepts at A?

Learners: No answer

Teacher: Which graph passes through A? Which graph passes through A?

Learners: No answer

Teacher: Do you see point A?

Learners: Yes sir

Teacher: So which graph passes through point A?

Learners: Parabola

Teacher: (works through the procedure of factorizing two x squared minus three x minus two, points at A on the graph). What do you think is your x-value here?

Learners: Half

Teacher: And at B?

Learners: Two

Teacher: So what are the co-ordinates at point A?

Learner: Half and two

Teacher: negative half and zero, what are the co-ordinates at point B?

The above interaction shows that the teacher was predominantly interested in getting the learners to provide the correct solutions, rather than understanding the important features of the graphs. After the learners had identified the equation of the parabola he continued to ask them which graph passes through point A and went on to factorise the equation of the parabola. The emphasis here was to identify the parabola and use a well known procedure of factorizing to find the x-value at point A. By pointing at A after he had obtained the x-values he was channeling the learners towards the correct solution. It came as no surprise that learners gave the correct solution straight away. Immediately after learners had given the correct solution the teacher continued with his lesson without giving learners an opportunity to explain their solutions. During the interview he mentioned that it is important to give learners opportunities to explain their thinking, which did not actually happen in the above scenario. He then asked learners to provide the co-ordinates of A, and after one learner gave an incorrect solution the teacher gave the correct solution and continued with the next question. In this instance he took over the challenging aspect of the task and simplified it for the learners by giving them the correct solution. The learner who responded was not given an opportunity to explain her solution. Although the task in the above extract was categorized as procedures without connection to meaning at implementation there was room for the cognitive demands of the task to be raised through the learners' responses. This did not happen because the learners' responses were not followed-up.

It is for this reason that even the two tasks that were initially categorized as procedures with connection to meaning on selection ended up as procedures without connections at implementation.

4.5 DISCUSSION

During the interview the teacher made his intentions clear concerning his selection and implementation criteria in both grades:

> Researcher: I have realized that in your grade 11 lessons you only gave learners work at the end of the lessons. Is there any reason for doing that and maybe why?
> Teacher: The reason is that if you look at my teaching of the grade 11's it was mostly teacher centred because I have to make sure that learners understand the concepts that I was teaching them and the only way of checking whether if learners understand was to give the work at the end of the day so that are able to interact with that work. But if you look at the grade 10 you engage the learners throughout the lesson because you want them to be too involved in the lesson but in the grade 11 is only the teacher who gives them information, only give learners minimal participation during the lesson. That is the reason why at the end I give them work to do at home at their own time.
> Researcher: How did you expect the learners to solve the tasks?
> Teacher: I expected them to work individually to draw their own conclusions because it is very difficult to engage them in groups for particularly this type of activity in grade 11 because they have done this in grade 10 so you expect each one of them to be able to do this activity on their own.

The above extract clearly shows that the teacher used different criteria in selecting and implementing the tasks in the two grades. The teacher's approach in grade 11 was totally different from that in grade 10. In grade 11 he took examples from the textbook and explained to the learners step by step how to solve the example. In almost all grade 11 lessons he explained through the examples until the end of the lesson and then gave the learners homework from a worksheet. Learners were given tasks as homework since the teacher spent the whole lesson working through the examples. Hence there was no time to engage with the tasks during the lessons. In all five lessons I observed the teacher did not let the learners work in groups, even though there were only nine of them in the classroom. It shows from the above extract that in the grade 10 classes the teacher expected learners to work in groups and to be

fully engaged in the lessons, while in the grade 11 classes learners had to solve the tasks individually and to make their own conclusions. In the grade 11 classes the teacher did not ask questions that would enable learners to explain their solutions as he did in the grade 10 lessons. In grade 10 the learners were given worksheets to work on during the lessons and were given time to solve the tasks together in class. The teacher made it clear from the interview about his view of the tasks in the new and old curriculum:

> Researcher: What do you think about the tasks in the new and old curriculum, should they be similar or different?
>
> Teacher: I think they should be similar but the difference should be in terms of the approach. The tasks in this case were similar in both grade 10 and 11 but if you look at how I taught the grade 10 and 11's there was the difference. Grade 11 was more of teacher centred and learners were participating very less in the lesson but with the grade 10 the lesson was more learner centred to enable self-discovery amongst the functions so I will use the same but teach them differently.
>
> Researcher: Okay fine, in your opinion do you think is necessary to teach the grade 10 and 11 differently given the same tasks? And why, is it the curriculum or the tasks that are given by the textbooks or what?
>
> Teacher: The reason is the curriculum because it encourages the teacher to engage learners effectively and the only way learners can be engaged effectively is how you teach them by giving lots and lots of these activities so that they can try and assist each other. The teacher is only there to facilitates the lesson, the teacher directs how the lesson to be. If you look at the old curriculum the teacher gives a lot of information and these learners sometimes are not able to cope and the teacher only realizes this at a very late stage when assessment is given.

The above interview is the opposite of what happened during the lessons. In both grade 10 and 11 lessons the main difference was in selection of the tasks. The tasks selected in the grade 10 classes required learners to use procedures with connection to meaning, for example the learners were asked to say what happened to the graph of $y = x^2$ as the x-values increases. Such tasks are of a higher cognitive level. The tasks selected by the teacher in the grade 11 classes required learners to use certain procedures to solve them. For example learners, were asked to sketch the graphs of $y = 3\cos x$ and $y = \tan 1/2x$ and clearly show the intercepts with the axes and all turning points. Such tasks are usually of low cognitive demand. However, contrary to the teacher's claim there was little difference between the two approaches, except perhaps that in grade 10 there was mainly groupwork and in grade 11, whole class discussion

(Jina, 2007). However, as I have shown here, during implementation the cognitive demands in both classes were the same.

4.6 SUMMARY

In this chapter I have analysed tasks from grade 10, those that required learners to use procedures with connections to meaning and the others without connections to meaning. The analysis of the grade 10 tasks shows that those that were selected as requiring procedures with connection to meaning declined to procedures without connections at implementation. In the grade 11 classes the teacher selected lower level tasks and they remained the same at implementation. I have also shown that there was a mismatch between what the teacher said during the interview and what actually happened during the lessons. The analysis shows that the teacher thought that he was teaching the new and the old curriculum differently, but according to my analysis, there was very little difference.

CHAPTER 5

CONCLUSIONS, IMPLICATIONS AND RECOMMENDATIONS

5.1 Findings

This research study was designed to investigate how the teacher worked with mathematical tasks in the new and old curriculum. There was evidence from my data that the teacher did select tasks that involved higher-level cognitive demands from the new curriculum, and in the old curriculum he selected tasks of lower-level cognitive demands. However at implementation the cognitive demands of the tasks in the new curriculum declined from procedures with connection to meaning to procedures without connection to meaning. In the old curriculum the cognitive demands of the tasks at implementation remained at the lower level. The classroom observations and the teacher interviews show that there was a mismatch between practice and theory at implementation in the grade 10 lessons, and in the teachers' understanding of what he was doing.

This chapter will draw on the results obtained from the analysis to find possible solutions, implications and recommendations for future classroom practice. First, I answer each of the research questions.

5.1.1 Criteria for selecting tasks

My analysis shows that the teacher used different criteria in selecting the tasks from the new and old curriculum. In the old curriculum the teacher selected tasks from the textbook that were written according to the requirements of the curriculum in order to prepare them for the exam paper. In the new curriculum he did not rely on the textbook. It is evident from the following interview:

> Researcher: I have seen that you are using tasks from the textbook in grade 11, is there any particular reason for using the textbook and why?
> Teacher: If you look at the grade 11 setup most of the problems particularly those from textbook, they somehow direct the learners in terms of the basic requirement for particular topics, and as such it becomes important for me to rely on those from the textbook as a

formulation because I cannot formulate problems myself because the rules require other aspects from different topics which I may have taught but is always better to use problems which are from the textbook.

Researcher: So if it was maybe in grade 10 and you have a textbook and another source of information, will you use the other source and the textbook?

Teacher: Definitely yes, if you look at the grade 10 one has to be very innovative, because it does not necessary say that you must only rely on textbooks. I think you also can also use newspapers cuttings; you can also use your own ideas on how a topic must be approached so grade 10 requires a very innovative teacher but if you look at grade 11 the setup there is very rigid. As a teacher you only have to complete the syllabus and the only way of completing the syllabus is by doing the problem form the textbooks. So that is basically the difference.

The above interview and the previous analysis has shown that the teacher used different criteria for task selection from the new and old curriculum. The teacher relied on the textbook for selecting tasks from the old curriculum and in the new curriculum he used worksheets which were also from the textbook. The main difference was that in the new curriculum he chose tasks that could have engaged the learners during the lessons. In the old curriculum tasks were of lower level which did not require much cognitive effort.

5.1.2 Task implementation

There is evidence from chapter 4 that the teacher did implement tasks differently in the two curricula. In the new curriculum the teacher gave learners worksheets to work from. He also gave learners enough time to work on the tasks in groups. He also gave learners opportunities to sketch the graphs on the board but he did not give them enough chance to explain their solutions. The study found that instead of encouraging learners to justify their solutions he asked them leading questions. This was contrary to what he said in the interviews, where he mentioned that it was very important to let the grade 10 learners explain and justify their solutions. The teacher did try to ask learners questions to justify their solutions but he did not manage to support them to do this. He instead gave learners the solutions when they did not answer his questions. As I argued in chapter 4, the cognitive demands of the tasks declined from procedures with connection to meaning at selection to procedures without connection to meaning at implementation. The teacher had a clear intention on how to implement the tasks as evident from the interviews but during practice, he was unable to

implement them as he intended. The teacher thought that he was choosing the same tasks in both grades and teaching them differently, but he was actually choosing different tasks and implementing them in similar ways.

Although there were only nine learners in the grade 11 lessons, he did not let them work in groups nor did he ask them to explain or justify their solutions. Table 2A and Table 3B show that the teacher selected tasks that could promote mathematical reasoning in grade 10 and those that do not promote mathematical reasoning in grade 11. The main finding of this study is that although tasks that promote mathematical reasoning were selected in grade 10, at implementation phase they did not promote mathematical reasoning. This means that there was no difference between promoting mathematical reasoning in the old and new curriculum.

5.2 Implications

The purpose of this study was to investigate a teacher working with mathematical tasks in the new and old curriculum. As I argued in chapter 2, from a constructive perspective learners need to be given enough time to work on higher-level mathematical tasks in order to make sense of the problems that they are working with. It is important for teachers to give learners enough opportunities to make sense of the tasks that they are working with. Learners need to be given time to justify and explain their solutions and in this way they will be able to connect the previously learned concepts with the new tasks. The new curriculum encourages learners to work collaboratively in teams and groups to enhance mathematical understanding and be able to communicate their ideas critically and creatively. One way of enabling learners to be critical and creative thinkers is to give them higher-level tasks that will enable them to make connections among multiple representations and to help them develop meaning.

The teacher also plays an important role in enabling learners to be critical and creative thinkers. It is the role of the teacher to be the facilitator between what has been learned before with what is been learned; that is, to close the gap between what he knows and what the learner does not know. If the teacher gives learners solutions to what they were supposed to construct on their own, his/her role changes from being a

facilitator to the bearer of information for learners. The concept of ZPD plays an important role in the learning process of the learners. The way the teacher interacts with the task will enable learners to see the shift from working with lower level tasks to higher-level tasks. It is the role of the teacher to promote changes that are necessary for learners to learn mathematics successfully.

5.3 Recommendations

In this section I make recommendations at two levels: Understanding the pedagogical theories that underlie the new curriculum in mathematics and understanding learners' mathematical thinking. Recommendations are drawn from the analysis of this study, literature related to this study, and my own experience.

5.3.1 Understanding the pedagogical theories that underlie school mathematics changes

Taylor and Vinjevold (1999), in their findings on investigating Curriculum 2005, reported that "many teachers model the surface forms of learner-centred activities, without apparently understanding the learning theories underlying them, and certainly without using them as a medium for enabling learners to engage with substantive knowledge and skills" (p.230). During the interview in this study the teacher clearly emphasized the concept of learner-centred teaching but his approach to his lessons was not according to the underlying theory. It is not easy to link theory and practice, sometimes a teacher might think that he/she is teaching according to the theoretical pedagogy that underlies the new changes, but in reality he/she is doing the opposite. To understand the theories of teaching and learning that inform the new curriculum, teachers need to be given the opportunity to study further. Through studying teachers could read articles that explains and critically examine such theories. It has been my experience that through studying these issues in depth, I have been able to come to a better understanding.

5.3.2 Understanding learners' mathematical thinking

If teachers can be given opportunities to read research on learners' thinking about specific mathematical topics it may assist them in making sense of their learners' work. Readings are most effective if they are connected to other professional developments such as analyzing learner work around the same mathematics topic addressed in the readings. During training on the new curriculum it will be beneficial for teachers to be shown videos of colleagues trying to understand learners' thinking. In this way teachers will be able to develop their skills in listening to learners and interpreting their work.

Teaching according to the new curriculum changes is not as easy as it is stated in the curriculum documents. The curriculum documents do not give teachers alternative ways of tackling situations that might come up during the lessons. However, watching video excerpts of other teachers modeling new ways of teaching can be powerful in helping teachers understand what they need to do. Stories of other teachers engaged in reform may also help teachers to recognize in advance challenges they are also likely to experience. Such information can enable teachers to expect challenges during their teaching and in turn prepare themselves in advance to work with the challenges. Action research in which teachers monitor and evaluate their own practice can also help teachers as they begin to try out new teaching practices in their classrooms. I had a similar experience when I was studying for my Bsc Honours degree. Watching myself teaching enabled me to change some of my teaching approaches that all along I thought were the best way of teaching a particular topic.

5.4 Limitations

The study was conducted when the new curriculum was in its first year of implementation and many teachers were still in the learning process of grade 10 curriculum implementation. The results of this study cannot therefore be generalized across all teachers implementing the new curriculum. Since I had worked with only one teacher teaching the two curricula, it may have been the case that working with more than one teacher would have given different results from those captured in this

study. In chapter 3, I did however elaborate on why I worked with only one teacher. Even though there were some limitations of this approach, there was fruitful data that can assist future teacher trainers as well as teachers who are teaching the new curriculum.

5.5 Conclusions

This study has investigated how a teacher selected and implemented mathematics tasks in the new and old curriculum. In order to investigate the teacher working with the two curricula I took into consideration constructivist and socio-cultural theories of learning. I used the two theories since they were both consistent with my analytical framework. Constructivism argues that learners are active in constructing their own knowledge. Socio-cultural perspectives argue that children construct scientific knowledge with the assistance of adults. A socio- cultural perspective argues that the teacher plays an important role in assisting learners to construct scientific knowledge in mathematics classrooms. Data was collected from a teacher teaching the new and the old curriculum and Stein et al's (1996) framework was used to interpret and analyse this data. In this study it was argued that higher-level tasks are important to enable learners to construct their own knowledge. The findings were that even though learners in the new curriculum were given higher-level tasks, the cognitive demands of the tasks declined during classroom interaction. In this study the teacher did play a role in assisting learners but his assistance interfered with learners making sense of the mathematics they were involved in. The results show that there is still much to be done in terms of what the teacher learned during new curriculum training and how his training knowledge could be implemented in practice.

REFERENCES

Almy, M. (1979). The impact of Piaget on Early Childhood Education. *The impact of Piagetian theory.* University Park Press Baltimore.

Bassey, M. (1999*). Case Study Research in Educational Settings*. Buckingham: Open University Press.

Bauersfeld, H. (1988). Interaction, Construction, and Knowledge: Alternative perspectives for mathematics education. In Grouws, D.A and Cooney, T.J(Eds). *Effective mathematics teaching.* Reston: NCTM.

Bennie, K. (2006). *Focus on Mathematics Grade 11*. Cape Town: Maskew Miller Longman.

Boaler, J. (1997). *Experiencing school mathematics: teaching styles, sex and setting*. Buckingham: Open University Press.

Brodie, K., Lelliot, A., & Davis, H. (2002). Developing learner-centred practices through the FDE programme. *Challenges of teacher development: an investigation of take –up in South Africa*. J. Adler and Y. Reed. Pretoria, Van Schaik.

Cornbleth, C. (1990). *Curriculum in Context*. Falmer Press. London.Chs 2, pp. 12-41

Chisholm Report, (2005). Curriculum 2005 Review Committee . *A South African Curriculum for the 21st Century*. Presented to National Education Minister, Pretoria, 31 May 2000. Pp. 1-4.

Daniels, H. (2001). *Vygotsky and Pedagogy*. RoutledgeFalmer Press. London.

Davydov,V.V. (1995). The influence of L.S. Vygotsky on Education: Theory, Research and Practice. *Educational Reseacher*, 24(3), 12-21.Department of Education, (2002). *National Curriculum Statement 10-12 (schools*). Pretoria: Department of Education.

Forman, G.E. (1883). *Theories of learning*: A comparative Appoach. F.E. Peacock, INC. Itasasca: Illinois.

Ginsburg, H.& Opper, S. (1979). *Piaget's Theory of Intellectual Development*. Precentice Hall, INC., Englewood Cliffs: New Jersey.

Guba, E.G. and Lincoln,Y.S. (1985). *Naturalistic Inquiry*. New York: Sage Publications.

Hatano,G. (1996). A conception of knowledge acquisition and its implementations for mathematics. In P.Steffe, P. Cobb, G. Goldin & B. Greer (Eds.), *Theories of mathematics learning* (pp. 197-217). New Jersey: Lawrence Erlbaum.

Hedegaard, M. (1990). The zone of proximal development as basis for instruction. In L. Moll (ED.), *Vygotsky and education*. (pp. 171-195). Cambridge: Cambridge University Press.

Jansen, J. (1999). Why Outcomes-based education will fail: An elaboration. In J. Jansen and P. Christie (Eds*). Changing Curriculum: Studies on Outcomes-based Education in South Africa*. Cape Town: Juta.

Jina, Z. (2007). *Teacher's questions and interaction patterns in the new and old curriculum*: a case study. Unpublished MED Thesis, Jonannesburg: Wits University,

Kilpatrick, J., Swafford, J., & Findell, B. (Eds.). (2001). *Adding it up*: *Helping children learn mathematics.* In J. Kilpatrick, J. Swafford, and B. Findell (Eds.) Mathematics Learning Study Committe*e*, Centre to Education, Division of Behavioral and Social Science and Education. Washington, DC: National Academy Press.

Kincheloe, J.L. (1991). *Teachers as Researchers: Qualitative Inquiry as a Path* to *Empowerment*. London: Falmer Press.

Laridon, P.J., Brink, M.E., Fynn, C.A., Jawurek, A.M., Kitto, A.L., Myburg, M.J., Pike, M.R., Rhodes-Houghton, H.R. & Van Rooyen, R.P. (1995). *Classroom Mathematics,* Sandton: Heinemann Publishers.

Miles, B. Huberman , A. (1994). Qualitative Data Analysis. *An Expanded Source Book.* Sage Publication.

Minick, N. (1999). The Development of Vygotsky thought: an introduction. In Lev Vygotsky: Critical Assessment. Volume 1. Routledge: London.

Moll, I. (1999). Reclaiming the nature line in Vygotsky theory of cognitive development. In Vygotsky*: Critical assessment volume 1v*. Routledge: London.

Opie, C. (2004). *Doing Educational Research*-A Guide to first time Researchers. London. Sage Publications

Piaget, J. (1995). *Sociological Studies*.(L. Smith et al., trans.). London: Routledge.

Piaget, J. (1945,1977). *Plays, dreams and imitation in childhood*. Newchatel, Switzerland: Delachaux et Niestle.

Piaget, J. Inhelder, B. (1958). *The early growth of logic in the child*. Neuchatel, Switzerland: Delachaux et Niestle.

Remillard, J.T. (2005). Examining key concepts in research on teachers' use of mathematics curricula: *Review of Educational Research*. Summer 2005, Vol 75, No. 2. pp. 211-246.

Stein , M.K., Grover, B.W. , & Henningsen, M. (1996). Building students capacity for mathematical thinking and reasoning *: An Analysis of Mathematical Tasks used in*

Reform Classrooms. American Educational Research Journal. Summer 1996, Vol. 33, No.2 pp455-488.

Stein, M.K., Smith, M.S., & Silver, E.A. (2000). Implementation Standards-based Mathematics Instruction. *A casebook for professional Development*: New York Teaching College Press. Government Gazette, June,6, 1997:p.135.

Taylor, N. & Vinjevold, P.(Eds)(1999). Getting Learning Right. Joint Education Trust/Department of National Education. JET.

Tudge, J.R.H., Winterhoff, P.A. (1999). Vygotsky, Piaget, and Bandura: perspectives on the relations between the social world and cognitive development. . *In Lev Vygotsky: Revolutionary Scientist.* Routledge, New York.

Vygotsky, L.S. (1993). Lev Vygotsky. *In Lev Vygotsky: Revolutionary Scientist*. Routledge, New York.

Vygotsky, L.S. (1994). *The Vygotsky Reader*. Oxford Blackwell.

Vygotsky, L.S. (1978). Mind in society: *The development of higher psychological processes*. Cambridge, M.A.:Harvard University Press.

Zweers, L. (2005). *Mathematical Reasoning*. Unpublished Bsc Honours project, Johannesburg: Wits University:

APPENDICES

APPENDIX 1

INTERVIEW SCHEDULE

Date: ……. Grade: ……

Time: ……. Teacher: ……..

School: ……

The purpose of this interview is to get a better understanding on the mathematics teaching practices that you apply in your mathematics classroom. As I have asked you earlier the interview will be tape-recorded and if there is any question that you do not understand please feel free to ask me.

You are using different/same textbooks to select the task, are there any particular reasons
to do so and why?

If learners do not implement the tasks in the correct way, what will you do, and why?

What influenced you to implement the tasks in that particular way?

What influenced you to select that task instead of the others?

How did you expect the learners to solve the tasks?

What do you think the task required the learners to do?

How many of such tasks would you prefer to give to the learners at this grade and why?

Was the task successful? Why/why not?

Will you give the same task next year? Why/why not?

If the learners gives correct solutions do you ask them to explain how did they arrived at the solutions?
Do you expect the learners to justify their solutions? Why/not?

You told me how you did select and implement tasks, is there anything else that you would want to tell me about the tasks that we did not discuss?

Do you select and implement tasks according to the needs of the curriculum?
Why/why not.

If the tasks where not in this curriculum, will you still give them to learners?

APPENDIX 2

GRADE 10 AND 11 INTERVIEWS

TEACHER INTERVIEW TRANSCRIPT (GRADE 10)

Researcher: I have realized that you are using worksheets to complete when you started the Grade 10 lessons. Is the any particular reason for that?

Teacher: Mr. Modau yes there is a particular reason why one has to use worksheets, I think one is surely because time allocated to our periods we cannot write every thing on the board for learners. Some of them will not see what is really happening. Secondly the worksheets enable me to group learners so that they are able to assist one another when they are working. Number three the worksheets also enable me to remind the learners were we are from and what is that we are trying to in order to complete so that at the end of the section they must be able to relate all other activities that we have done in the past because some of them do not have exercise books so that they cannot copy this things in their books as well.

Researcher: What influenced you to implement the tasks in that particular way? Is there any reason for that?

Teacher: If you look at the topics that is, the effect of a and q, the importance of this particular section was for learners to be able to see how this a and q vary in each graph and hoe does it affect the graph. So I think there was a reason for the implementation of this activity by the learners so that they relate this to their day to day activities as well.

Researcher: What is the main reason for you letting them complete the table? Was there any reason for that?

Teacher: Yes, I think for learners particularly those with barriers in learning, it could be lack of understanding or lack of reading or writing. The table is a very simple way of sketching the graph so I was trying to bring any learner on board in terms of how this graphs can be sketched, of course latter on which was not part of this lesson. I also showed them another way how to sketch the graph without using the table by taking the very simple ways of sketching the graphs.

Researcher: What influenced you to select these particular tasks?

Teacher: I think the reason was I do not want to teach graphs in isolation because we have trig graphs which usually comes from the second paper, we have the quadratic functions which comes in the first paper and all this graphs, they actually behaves the same way so I think it was the reason to select this particular task was to bring all other aspects of mathematics together so that the learners are able to see the relationship and the close relationship between them.

Researcher: If there were similar tasks in other textbooks but which does not start with completing the table and so on, will you still use them or will you prefer this one, and why do you prefer this one to the other ones?

Teacher: I really don't think I will start with those tasks because this year has been a very tough year for the learners particularly in terms of the content itself they find it very difficult to cope and as I have said I think is more easier for them to understand because I know the difficulties that they experienced so I wouldn't start with other sections from any other textbooks but I will do those sections at a latter stage when they have developed an understanding.

Researcher: How did you expect the learners to solve the tasks?

Teacher: I expected them to work in groups to be able to assist one another and also to give me feedback in terms of their understanding and my whole

aim was to guide them towards the expectation of this particular exercise and the expectation was for them to work on their own and see if they can make sense of this type of problems.

Researcher: What do you think the tasks required learners to do?

Teacher: I think the most important aim of the task was one, cooperative learning were learners are able to interact with one another. Number two, they must be able to see how this graphs are implemented on everyday life, also how do they affect them. Number three to check in terms of the content, the effect of a and q on this graphs.

Researcher: How many of such tasks would you prefer to give to the learners in grade 10 and why?

Teacher: I think roughly just enough to consolidate their understanding, just enough maybe three or four or something.

Researcher: Why?

Teacher: I think if you give them three or four tasks their understanding becomes more clearer, they have a clearer picture of what is happening particular those tasks learners who has barriers to learning, the slow learners because this are the learning one has to identify so that we move up together with the whole class.

Researcher: Do you think that the tasks were successful?

Teacher: Yes I think they were successful because when I did assessment I could see the feedback that the learners were giving me in terms of all the three graphs that we have done. I think it was successful in terms of their understanding.

Researcher: Would you give the same tasks next year? Why or why not?.

Teacher: I don't even think I will give the same tasks next year because of the current grade 9. I think we have uplifted the standard there, what I will do is to change my teaching methods as a teacher and I will rather start with a different approach and see if it works and if it really works I will then have to revert to this particular method or approach.

Researcher: If the learners gives correct solutions do you ask them to explain how did they arrived at the solutions?

Teacher: Yes, it is very important because I don't really believe that learners can coincidentally give the solution which is correct and some of the learners are finding it difficult in this solutions, so it is better that the learners must explain how he or she has arrived at the solutions because they may not be understanding the teacher. If the learners when explaining their solutions may come up with different ways of showing how the problem must be solved, they must be given a chance to explain their solutions.

Researcher: Okay, so do you expect the learners to justify their solutions?

Teacher: Yes, it is very important as a teacher you learn best when you are engaging these learners. There are approaches that you may not be aware of and there are learners who are very intelligent in class so you should not undermine those learners. Let them tell you how they got the solutions if you suspect that their solution is correct because it may not be the same as how the teacher would get that particular solution.

Researcher: So if you suspect that their solutions are not correct would you still like them to justify their wrong solutions?

Teacher: Yes, I would also like them to explain to me how they got that solution because you see what is important is that a learner must be able to see how the problem must be solved. If the teacher is not being

satisfied in terms of how the problem was solved, the teacher must also be clarified on how the problem was obtained, so it is important to check how the learners are working when they arrived at the solution.

Researcher: You told mw how you did select and implement tasks, is there anything else that you would want to tell me about the tasks that we did not discuss?

Teacher: I think what is important is that I also find it very interesting to teach this particular section and I think it is one area that enhances learning within the learners because some learners like to draw the graphs, some learners want to give you theory, some learners want to solve problems but I have observed that most of them like this shapes, this patterns of graphs and this particular section because I wanted them to participate fully in our activities.

Researcher: Do you select and implement tasks according to the needs of the curriculum?

Teacher: Yes that is very important in terms of the curriculum there are those sections that you cannot do away with them, you have at least to teach the basic concepts of mathematics because they need those things when they proceed to the next so when one design learning activities I also check whether they are entailed in the grade 10 curriculum. I do consult with the curriculum and check if certain sections maybe omitted or must be part my day to day teaching.

Researcher: If the tasks were not in the grade 10 syllabus, will you still give them to learners?

Teacher: In terms of the NCS I really don't think I will give them because my observation is that grade 10 work is just too many, it is just too much for the teacher to cover all, maybe if I have covered about ninety ten percent of the required sections I may do them as optional topics just

for them to see and learn about them but it will not be compulsory for all learners.

Researcher: If the tasks that you selected were from the old curriculum, will you still implement them in similar ways?

Teacher: I would implement them in similar ways and is all because of the training that I have received as an educator to say the grade 10 must be taught differently from the previous, you must involve them in most sections as an educator and one way of involving them effectively is to always make your activities more and simpler so that they develop understanding and once that understanding has been developed then the educator can proceed from that particular level, so of course I will change that section and teach it in a new way which is the requirements of teaching NCS.

Researcher: What do you think about the tasks in the old and new curriculum, should they be similar/different?

Teacher: I really don't think that the old curriculum really helps us to bring understanding in the learners because most solve problems without really understanding how the problems affect them and I think they must apply the problems in their daily lives. If you look at the activities that I have developed in grade 10 for every task there is also an application on that particular aspect in reality so I think I am not very comfortable teaching the old curriculum because I did a lot of talking and the learners are not able to pick or understand the simple things that I do during the lessons.

Researcher: So in other words you are saying it is possible for you to teach the old curriculum in the new curriculum because of the difficulties that you are mentioning now?

Teacher: Yes I would teach the old curriculum in the new curriculum but one of my challenges will be the time constraints because I think if you look at the old curriculum I usually prepare most of the topics and learners takes time to learn the basic things that are required but I would of course teach the old curriculum in new the way just to enhance learning.

TEACHER INTERVIEW TRANSCRIPT (GRADE 11)

Researcher: I have seen that you are using tasks from the textbook in grade 11, is there any particular reason for using the textbook and why?

Teacher: If you look at the grade 11 setup most of the problems particularly those from textbook, they somehow direct the learners in terms of the basic requirement for particular topics, and as such it becomes important for me to rely on those from the textbook as a formulation because I cannot formulate problems myself because the rules require other aspects from different topics which I may have taught but is always better to use problems which are form the textbook.

Researcher: So if it was maybe in grade 10 and you have a textbook and another source of information, will you use the other source and the textbook?

Teacher: Definitely yes, if you look at the grade 10 one has to be very innovative, because it does not necessary say that you must only rely on textbooks. I think you also can also use newspapers cuttings; you can also use your own ideas on how a topic must be approached so grade 10 requires a very innovative teacher but if you look at grade 11 the setup there is very rigid. As a teacher you only have to complete the syllabus and the only way of completing the syllabus is by doing the problem form the textbooks. So that is basically the different.

Researcher: I have realized that in your grade 11 lessons you only gave learners work at the end of the lessons. Is there any reason for doing that and maybe why?

Teacher: The reason is that if you look at my teaching of the grade 11's It was mostly teacher centred because I have to make sure that this learners understand the concepts that I was teaching them and the only way of checking whether if this learners understand was to give the work at

the end of the day so that are able to interact with that work. But if you look at the grade 10 you engage the learners throughout the lesson because you want them to be too involved in the lesson but in the grade 11 is only the teacher who gives them information, only give learners minimal participation during the lesson. That is the reasons why at the end I give them work to do at home at their own time

Researcher: When you were dealing with the graph of trigonometry you have selected a question whereby learners had to sketch the two graphs. Why did you specifically wanted them to sketch the two graphs?

Teacher: If you look at the graphs, particularly the trig graphs learners must be able to identify this graphs, the only reason for them to identify this graphs is for them to compare and work out the differences and I think it was the reason why they were given the two graphs to draw so that they are able to check what makes them different and interact on those principles. If you look at the value of a and how those a changes the graph, and if you look at b, how does b changes the graph so they had to compare those two graphs to see if they are not the same.

Researcher: How did you expect the learners to solve the tasks?

Teacher: I expected them to work individually to draw their own conclusions because it is very difficult to engage them in groups for particularly this type of activity in grade 11 because they have done this in grade 10 so you expect each one of them to be able to do this activity on their own.

Researcher: How many of such tasks do you prefer to give to the learners in grade 11? and why?

Teacher: For standard grade learners I will prefer to give more of it, more of this type of activities because of the selection of the grading and the other reason is the learners are very lazy and sometimes when you

teach them you may think that they understand and only to find out that you are just talking to yourself, so I will prefer to give them more activities of this nature.

Researcher: Was the task successful?

Teacher: I think it was successful because I could also assess this at a latter stage and I could see the positive responses that they were coming from the learners. I think it was successful although it was not easy to check at that stage to know if the learners understand but I think it was very successful.

Researcher: Will you give the same tasks next year? Why, why not?

Teacher: No, next year I wouldn't because of the current grade 10's and I think it is only because of the changes circumstances in the curriculum. I will use a different approach but not the activities.

Researcher: If the learners gives correct solutions in grade 11 do you ask them to explain how did they arrived at the solutions?

Teacher: Well I think it depends on the problem and also if we have time but generally I will ask them to explain to me at how did they arrive at the solutions because it is very important to check how learners think particularly when dealing with problem solving.

Researcher: Do you expect the learners to justify their solutions?

Teacher: I think in mathematics it is very healthy to engage in such discussions because what is important is how a problem must be solved, not necessary the solution and if the problem is solved correctly, the solutions must be the same. So I think it is important that learners be able to challenge my solutions as well as so that we are able to agree

on one thing and this also helps me as a teacher to see how the learners think as far as mathematics is concerned.

Researcher: You told me how you did select and implement tasks, is there anything else that you would like to tell me about the tasks that we did not discuss?

Teacher: Maybe is the line of mathematics with this types of graphs, you know I think as a teacher I have felt in love with this whilst in high school and I expect the learners also to have a relationship with these type of functions and I think it also helps in my teaching that always want to make it as easy as possible so that the learners can really understand what is happening.

Researcher: Do you select and implement tasks according to the needs of the curriculum? Why, why not?

Teacher: Yes definitely, the intension as I had said before is that learners must be able to cope with the paper at the end of the year, and for them to cope with the paper it means the syllabus must be completed fully and proper revision must be done so the selection is according to the needs of the curriculum.

Researcher: If the tasks were not in the grade 11 curriculum, will you still give them to the learners?

Teacher: No, I don't really think I will give them of course I will maybe give them at a latter stage just to stimulate their thinking but I don't really think I will waste time and give them something like that.

Researcher: If these tasks were from the new curriculum will you still implement them in similar ways?

Teacher: No, I wouldn't because one is to encourage this learners to think innovatively, you need to encourage the learners to think critically now if you have observed how I taught the grade 11's I think I was pumping them with a lot of information and this information was not self discovery for them so with the grade 10 I will teach in such a way that the learners are able to this as their own way of thinking and also how to interact with so that it becomes something they own.

Researcher: You have mentioned that you were talking too much in the grade 11 classroom. Do you think doing that might assist them in looking for the relationships between the graphs?

Teacher: It doesn't really assist them in seeing the relationships between the functions because at that stage you are giving them information which is new to them and because of the duration of the period again it is really difficult for the learners to check if there is any relationship. Of course, maybe at a latter stage when they do revision they cam assimilate this and put it in such a way that it makes sense to them at that stage and even now I don't even see if there is any sense in doing this graphs.

Researcher: What do you think about the tasks in the new and old curriculum, should they be similar/different?

Teacher: I think they should be similar but the difference should be it terms of the approach. The task in this case were similar in both grade 10 and 11 but if you look at how I taught the grade 11 was more teacher-centred and learners were less participating in the lessons, but with the grade 10 the lessons were more learner-centred to enable the learners for self discovery amongst the functions so I will use the same tasks but teach them differently.

Researcher: Do you think that the tasks in the new and old curriculum should be the same?

Teacher: I think they shouldn't necessarily be the same, I think the new curriculum should have more of the old stuff in it because we now have more of the old stuff in it. We now have to encourage critical attitudes and thinking within the learners and the old curriculum did not encourage that within our learners, it encouraged rote learning. In the new curriculum I think it should be more of the old stuff reinforced by other topics as well.

Researcher: In you opinion do you think it is necessary to teach the grade 10 and 11 differently given the same tasks and why? Is it the curriculum or the tasks that is given by the textbook or what?

Teacher: The reason is the curriculum because it encourages the teacher to engage learners effectively and the only way learners can be engaged effectively is how you teach the learners by giving them lots and lots of activities so that they can assist each other. The teacher is only there to facilitate the lesson, the teacher directs how the lesson has to be but if you look at the old curriculum the teacher gives a lot of information and the learners sometimes are not able to cope and the teacher only realizes this at a very late stage when assessment is given.

Researcher: This is the end of the interview; I would like to thank you for giving me the opportunity to talk to you about you views on the old and new curriculum.

Teacher: Thank you, I wish you well in your studies.

APPENDIX 3

ACTIVITIES PRESENTED TO LEARNERS

GRADE 10 MATHEMATICS

THE EFFECT OF THE PARAMETERS a AND q

$Y = ax^2 + q$

ACTIVITY 1

(work in groups of FOUR or FIVE)

$Y = x^2$

1.1 Copy and complete the following table by using the equation above .

X	- 4	-3	-2	-1	0	1	2	3	4
y									

1.2 Sketch the graph using the values you found in 1.1

1.3 What happens to your graph as the x-values continue to increase ?

1.4 Sketch the graph of $y = 2x^2 - 8$ on the same set of axes with the graph you sketched in 1.2

1.5 Compare the graph of $y = x^2$ with that of $y = 2x^2 - 8$. What do you notice ?

1.6 What is the minimum y – values of the two graphs ?

1.7 Now sketch the graph of $y = -x^2$. Does this graph have a minimum or maximum turning point ? Why is that ?

1.8 Sketch the graph of $y = -2x^2 + 8$

APPLICATION

Lundi's height h (in metres) above the water during a somersault dive is given by the equation $h = -6t^2 + 3t + 3$, where t is the time in seconds after he leaves the diving board. A graph showing the relationship between the height above the water and time is shown below. Study the graph and then answer the questions that follow.

THE EFFECT OF THE PARAMETERS a AND q

$y = a \sin(x) + q$
$y = a \cos(x) + q$
$y = a \tan(x) + q$

ACTIVITY 1

$y = \sin x$

1.1 Copy and complete the table below:

x	0	30	60	90	120	150	180	210	240	270	300	330	360
y													

1.2 Sketch a neat graph based on the information you found above .

1.3 Now sketch the graph of $y = 2 \sin x$. What do you notice?

1.4 Using a table of values draw a neat curve of $y = 2 \sin x + 1$

MODELLING

2.1 The following fractions have been converted into decimal form :

$\frac{1}{3}$ = 0,3333333333.....

$\frac{2}{11}$ = 0,1818181818.....

$\frac{1}{37}$ = 0,027027027.....

2.1.1 Why are these numbers called reccuring decimals ?
2.1.2 Study the decimal fraction of $\frac{1}{37}$. Describe the pattern for this number.
2.1.3 The decimal fraction for $\frac{1}{13}$ is 0,076923076.
This recurring decimal repeats after every 6 decimal places.
Write down the next 6 decimal places.
2.1.4 The table below shows rainfall as measured in Durban over a year

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
120	110	90	60	45	40	50	75	90	115	120	130

Sketch a graph of annual rainfall recorded for the months of the year .
NOTE: REAL LIFE EXAMPLES WILL NEVER FIT A TRIG GRAPH PERFECTLY , SOMETIMES WE MAY NEED TO MAKE ASSUMPTIONS

GRADE 10 MATHEMATICS

THE PARABOLA $Y= a x^2 + q$

GRAPH SKETCHING

It can be time consuming to plot every parabola using a table of points. In order to do this we must determine the key points necessary to allow us to make a sketch graph of the parabola.

SKETCH THE FOLLOWING GRAPHS

1. $y = x^2 - 9$
   (Show all the necessary details)
2. $y = -x^2 + 4$
3. $y = 3x^2 - 12$

APPLICATION

A stone is dropped from the top of a building . The stone's height (h) in metres , t in seconds after it has been dropped , is $h(t) = -5t^2 + 80$

(a) Draw a graph to represent this function.
(b) Find h (2) and explain what this value means.
(c) From what height is the stone dropped ?
(d) How long does it take the stone to hit the ground ?
(e) After how many seconds will the stone be approximately 35 m from the ground ?

GRADE 11 MATHEMATICS

TRIGONOMETRIC GRAPHS

LESSON 1

Question 1

1.1 On the same set of axes draw neat sketch graphs of of the function $y = 3 \cos x$ and $y = \tan \frac{1}{2} x$ for $[0^0; 360^0]$ Clearly show the intercepts with the axes and all turning points . Draw the asymptotes using a broken line.

USE THE GRAPHS IN 1.1 AND ANSWER THE FOLLOWING QUESTIONS.

1.1.1 What is the period of the function $y = \tan \frac{1}{2} x$?

1.1.2 What is the amplitude of the function $y = 3 \cos x$?

1.1.3 Write down the equation of the asymptote.

1.1.4 Show on the graph , using A , where the solution to $3 \cos x = \tan \frac{1}{2} x$ can be found.

1.1.5 What are the co- ordinates of the turning point?

LESSON 2

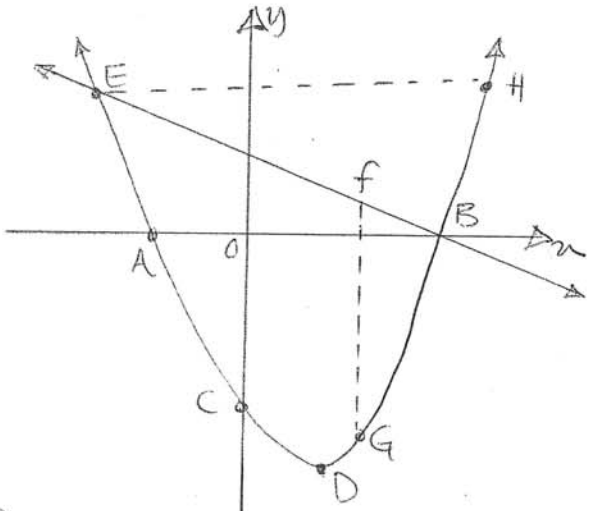
Question 2

2.1 On the same set of axes draw sketch graphs of $y = \tan 2x$ and $y = -2\cos x$ and indicate the intercepts with the axes and turning point

Gr 11 Mathematics SG Worksheet
05 Sept 2006

ACTIVITY 2

1. The straight line EB cuts the parabola $y = 2x^2 - 3x - 2$ at E and B and is parallel to $y + x = 0$.



a) Find the coordinates of A, B, C and D
b) Find the equation of the line EB
c) Find the coordinates of E
d) Find the length of fG if the x-coordinate of both F and G is 1
e) H is the point (k; 3). Find k

2. Sketch each function on a separate system of axes, by finding the axis of symmetry, turning point, Range and the intercepts on the axes.

a) $y = x^2 - 2x - 3$

b) $\frac{5-y}{x} = x + 4$

3. The sketch shows the graphs of $f: x \to x^2 - 4x - 5$ and a linear function g.

a) Find the lengths of OA ; OB ; OC ; OE and ED
b) What is the equation of the dotted line
c) What is the length of BC
d) Find the equation of g.

