CRITICAL REFLECTIVE TEACHING PRACTICE IN THREE MATHEMATICS TEACHERS

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Abstract

This qualitative study reports on critical reflective teaching by three mathematics teachers and how it shapes their classroom practice. The study was carried out in three secondary schools in Rundu in northern Namibia. The study employed a case study method. The selection of teachers was based on their rich practical professional knowledge and exemplary teaching practices. Data collection and analysis was done through an interpretive approach. Interviews and document analyses were the two research tools used, not only for the collection of data but for triangulation also. Interpretations of the findings were validated through member checking.

Critical reflective teaching involves thought and action, and it raises teachers' consciousness of what they do. Through critical reflective practice, teachers scrutinize their beliefs and knowledge of the subject and their practice. Furthermore critical reflective practice may get teachers into a disposition to find alternatives to improve their teaching.

In this study, the findings are that participants reflect extensively on their classroom practice. The teachers pointed out that reflection on practice enables them to analyse and evaluate their teaching in line with effective mathematics teaching. They emphasised that critical reflection leads to the identification of weaknesses in teachers' classroom practice. This culminates in better planning whereby alternative approaches to teaching are exercised.

Because of its potential to improve teaching and enhance professional development it is therefore recommended that mathematics teachers be exposed to skills that enhance critical reflective teaching practice. Teachers need to familiarise themselves with the concept of critical reflective teaching in mathematics to meet the demands of superior quality teaching.

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Finally, I thank God the Almighty for once more blessing me with the opportunity to gain experience as a researcher and eventually greatly expanding my knowledge base upon which my teaching practice is now founded.

DECLARATION OF ORIGINALITY

I, Luwango Luiya declare that this assignment is my own work written in my own words. Where I have drawn on the words or ideas of others, these have been acknowledged using complete references according to Departmental Guidelines.

> L. Luwango - 15 December 2008 (Signature and Date)

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CHAPTER 1 INTRODUCTION 1.1 INTRODUCTION

In this chapter I will introduce my research on the critical reflective teaching practices of three mathematics teachers. To locate my research in context, firstly I will discuss the background of the area I researched on. Secondly, I will provide the general background of the research and research site. Thirdly, my research goal will be presented. Lastly, I will outline an overview of my study where the contents of all five chapters will be highlighted.

1.2 CONTEXT OF STUDY

Prior to Independence in Namibia in 1990, segregated Education was exercised where blacks in general were subjected to low quality education or "Bantu Education". After independence, a reformed education policy in Namibia shifted from a teacher-centred to a learner-centred education system. In 1993 the Ministry of Education drafted a policy document 'Toward Education for all' which translated the Namibian philosophy on education into concrete and implemental government policies. Within this policy document, it is outlined that:

Perhaps the most important challenge in improving the quality of our education system is to ensure that our teachers are well prepared for the major responsibilities they carry. More than anything else, it is the teachers who structure the learning environment. It is they who can keep learning exciting and satisfying or alternatively who make schooling a pain to endure. It is essential therefore, that we help our teachers develop the expertise and skills that will enable them to stimulate learning (Towards Education for all, 1993:37)

As implied in the policy, teachers have the responsibility to carry out critical observations on their lessons and reflect on them to identify problems encountered. Through effective instructional strategies, weak as well as strong learners' academic performance may improve. Therefore, I find research on critical reflective practice, as exercised by teachers in schools, vital. This research thus aims to find out critical reflection as practiced by three mathematics teachers. My rationale to conduct research on critical reflective practice in mathematics education has also been enforced by a finding of Skovsmose (1994:123), who declared that "Reflective elements have been put outside the door of the mathematical classroom and forgotten, and mathematics education has concentrated on the development of a mathematical proficiency".

Discussing reflective practice, Hall as cited in Van Harmelen (2006), outlined that reflective practice includes a range of activities. Hall in Van Harmelen (2006), writing about reflection in teaching, summarised 3 levels of reflectiveness. These are: everyday reflection, deliberate reflection and systematic reflection. Everyday reflection refers to individual reflection about daily life occurrences, while deliberate and systematic reflections are reflections carried out to improve a teacher's teaching practice.

Donald Schon cited in Van Harmelen (2006) emphasised that critical reflective teaching is core to the understanding of what professionals do. He further asserts that critical reflection is important for teachers to think about how effective their teaching is and makes them conscious of what experience has taught them. In short, it is to enable teachers to think and act. Additionally, Taghilou (2007:99) claims, "reflective pedagogy can culminate in effective pedagogy and learning".

Brook Field, in Van Harmelen (2006), emphasised four processes central to developing as a critically reflective practitioner. Firstly, it is through analysing their own views that teachers become conscious of how their beliefs, values, cultural practices and social structures influence and affect their teaching practice. Teachers ought to make their notions of reality, which are taken for granted, explicit. Secondly, teachers need to be aware of their past experience, assumptions and cultural context. Thirdly, teachers ought to challenge the current ways of knowing and act by thinking of alternatives. For example, thinking of innovative ways to facilitate learning with understanding. Lastly, analysing things from different viewpoints is necessary for teachers to assimilate relevant ideas too. Additionally, Kincheloe (1991:18) argued that "...in the good work place of the democratic school [,] educational improvement occurs when the practitioner learns to think more precisely and conceptually."

According to Lloyd (2007) the implementation of a revised curriculum requires change in teachers' beliefs. Lloyd (2007) added that:

Reforms aim to revise the conventional view of mathematics learning as the mastering of a fixed set of facts and procedures to more centrally locate the processes of investigation, sense making, and communication in classroom activities. [He further emphasised that] when teachers' conceptions and practices are deeply tied to traditional mathematics pedagogy, innovative curricula can be very difficult to implement...(Lloyd, 2007:78).

Clarke as cited in Hart (2007:43) emphasised that "crucial to the success of any reform effort is the professional development...chosen to implement the...[reform ideals] ".

The broad curriculum guide suggests that, "Seen as a whole, the aims [described in the broad curriculum], give an outline for a balanced, relevant and coherent programme of learning and instruction" (Namibia. Ministry of Basic Education, Sport and Culture, 1996:5). In my view, this implies that the introduction of a new curriculum requires a new approach to classroom practice, particularly in mathematics teaching. Furthermore the curriculum guide for formal basic education (1996) indicates, "The emphasis in delivering the curriculum is on the quality and meaningfulness of learning" (Namibia. Ministry of Basic Education, Sport and Culture, 1996:23). As the approach to teaching and learning should be learner-centred, a teacher needs to be critically reflective to evaluate his/her teaching in line with learner-centred education. Thus the pamphlet on learner-centred education (1999) shows that "teacher reflection has a larger role to play in improving learner-centred education in Namibia. Reflection is believed by many experts to be a genuine way to foster positive change in teachers" (Namibia. National Institute for Educational Development, 1999:11). In the same vein, Liston (1996:6) asserted that:

Reflection as a slogan for educational reform also signifies a recognition that the process of learning to teach continues throughout a teacher's entire career, a recognition that no matter how good a teacher education program is, at best, it can

only prepare teachers to begin teaching. When embracing the concept of reflective teaching, there is often a commitment by teachers to internalise the disposition and skills to study their teaching and become better at teaching over time, a commitment to take responsibility for their own professional development.

Pertaining to the notion of critical reflective practice, Dewey cited in Rodgers (2002) amongst other authors, claims that:

What is critical is the ability to perceive and then weave meaning among the threads of experience...it is the meaning that one perceives in and then constructs from an experience that that experience value...The function of reflection is to make meaning: to formulate the "relationships and continuities" among the elements of an experience, between that experience and the knowledge that one carries and between that knowledge and the knowledge produced by thinkers other than oneself...Reflection is that process of "re-construction" and reorganization of experience which adds to the meaning of experience (Dewey cited in Rodgers, 2002:847-848).

Therefore, with emphasis on teachers, Dewey in Rodgers (2002:849) argues that:

A reflective teacher does not merely seek solutions, nor does he or she do things the same way... everyday without awareness of both the source and the impact of his or her actions. Rather, from his or her practice and the students' learning, the teacher seeks meaning and creates from this a theory to live by, a story that provides structure for the growth of the students and the teacher.

Johnston-wilder (1999:98) adds, "Reflection provides the basis for sound evaluation of your work and of your progress as a developing teacher".

In other words it is imperative that teachers function as reflective practitioners to be conscious of their teaching practice and the effects thereof as well as the mathematical content conveyed to learners. The aforementioned should be exercised with the intention to enhance continual professional development as opposed to static teaching practice.

Ball, Lubienski, & Mewborn (2001) discussed the examination of mathematical practice, whereby a recommendation for mathematical analysis on core activities of mathematics teaching is made. Ball et al. (2001) stated that:

Those activities include things such as figuring out what students know; choosing and managing representations of mathematical ideas; appraising, selecting, and modifying textbooks; deciding among alternative courses of action; and steering a productive discussion. (Ball et al., 2001:453)

According to Ball et al. (2001), the aforementioned activities' success is based upon looking inside classroom lessons and developing mathematical topics over time, eventually helping to unearth the mathematical entailments of practice. I thus conclude that through critical reflection teachers can look inside their classrooms to identify learners' needs or problems experienced in learning mathematics. Through problem identification processes, discovery of alternative approaches to mathematics teaching is possible. Thus, adoption of alternative instructional approaches may transform practice in terms of methods to teach mathematics effectively.

However, Liston (1996:12) affirms that:

Reflective teachers are fallible teachers. Reflective teachers are not some sort of special superwomen or supermen. Reflective teachers are simply and unabashedly committed to the education of all of their students and to their own education as teachers.

1.3 THE RESEARCH SITE

I am an experienced mathematics teacher qualified to teach grade 8, 9 and grade 10. I teach in a junior secondary school in Rundu. Rundu is a town located in Kavango region in the northeastern part of Namibia. On the map in figure 1.1 the Kavango region is marked number five. Research was conducted in two senior secondary schools and in a junior secondary school situated in Rundu. All three schools are large schools consisting of many learners. The ratio of teachers to learners is 1:40 with English being the medium of instruction in all three schools.



Figure 1.1 Regions of Namibia. (S. Abraham, 2006. Graphics Services Unit, Rhodes University, Grahamstown.)

1.4 GENERAL BACKGROUND TO THE RESEARCH.

The BEd (Hons) course I attended in 2006 instilled in me an interest in critical reflective practice. This prevailed when Ms. Van Harmelen conducted a lecture on reflective practice. During the aforementioned course, ideas on reflective practice were harnessed whereby my interest in pursuing research on critical reflective practice in mathematics education developed. The salient point was, "looking back on experience...to learn from it...[through] think[ing] [to] evaluate...experience [in finding out] what we learnt from it [so as to plan better and]...change our future behaviour in the light of our reflection"

(Van Harmelen, 2006:8). She defined reflective practice as an effort and commitment to improve practice. She emphasised that critical reflectiveness is practice-oriented whereby a teacher learns-by-doing, especially in the process of implementing the learnercentred education policy. She further stated that it is a co-ordination of practice that eventually leads to the development of learning support materials and the curriculum. Having exposure to the BEd (Hons) course I realised that the notion of critical reflective teaching posed challenges to teachers.

Being a classroom practitioner, I found critical reflective teaching practice vital in mathematics teaching. Therefore my intention in this study is not only to gain insight into the three teachers' critical reflective practices but also to expand my view on the notion of critical reflective teaching in mathematics education.

1.5 RESEARCH GOAL

My intention in this study is:

- To investigate three mathematics teachers' critical reflective practice and
- To find out the effect critical reflection has on their teaching.

1.6 OVERVIEW OF THE THESIS

My thesis consists of five chapters. Chapter 1 includes my research goal and highlights the context of my study.

In chapter 2, I present an overview of relevant literature where I discuss theories and principles of critical reflective teaching in mathematics education. The major themes I dealt with are:

- Learner-centred education policy
- Reflective practice within the education reform policy
- Critical reflection in mathematics teaching
- Principles of critical reflection

- Theories of critical reflection
- Strategies for becoming a critical reflective mathematics teacher
- Implications for teachers
- Research in Namibia and
- International views

In chapter 3, I present the research methodology I used in my study. I also justify the selection of the methodology employed.

In chapter 4, I present my research findings where I also analyse the findings in light of the literature I reviewed. Attention was given to main themes, which are the five arenas of reflection. These are reflection on:

- Received knowledge and training,
- Core values/beliefs,
- Experience as a learner,
- Teaching practice, and
- General view on what critical reflective teaching is in mathematics education.

In chapter 5, I present my conclusion: summarising the purpose of my research, a brief outline of the research process, an overview of research findings, the potential value of my research, limitations and recommendations for stakeholders in education and further research.

CHAPTER 2

LITERATURE REVIEW

"...Working with literature is an essential part of the research process. It inspires, informs, educates, and enlightens. It generates ideas; helps form significant questions, and is instrumental in the process of research design. ...A well-constructed literature review is an important criterion in establishing researcher credibility" (O' Leary, 2004:66)

2.1 INTRODUCTION

In this chapter I will critically analyse and review literature that informs the role of critical reflective teaching in mathematics teaching. My argument in this research is that, as teachers, we ought to think critically about what we do in order to improve our teaching. Since learning is ongoing process that begins before we teach, it should be a continuous process whereby teachers could learn from past teaching experience to shape their future practice. My focus will be to investigate the role of critical reflective teaching practices in mathematics teachers.

Briefly, critical reflection enables teachers to be conscious of what they do. It is a process of engaging in an in-depth thought directed towards organising interesting and relevant mathematics activities situated within the local and international context, eventually improving their teaching. At the same time, teachers may also focus on other pedagogical aspects such as time allocation, classroom organisation and management, authentic assessment and creating a culturally inclusive environment. An in-depth discussion on critical reflective practice is outlined in this chapter.

Firstly, I will initiate my discussion with an overview of Namibia's education reform policy. Secondly, I will discuss critical reflective teaching and its role in mathematics

teaching. Thirdly, I will discuss the principles of critical reflection, theories underpinning critical reflective teaching in mathematics and strategies to become a critical reflective teacher of mathematics. Then follows a discussion pertaining to what teachers ought to know about being a critical reflective practitioner. Finally, I will discuss research findings carried out in Namibia and internationally.

2.2 THE NAMIBIA EDUCATION REFORM POLICY

2.2.1 Learner centred Education policy

After independence in 1990, Namibia implemented a reform education policy that involved a shift from a teacher-centred to a learner-centred education system. In 1993 the Ministry of Education drafted a policy document 'Toward education for all' which translated the Namibian philosophy on Education into concrete government policies that could be implemented. This implied that learners should learn with understanding as opposed to memorising and regurgitation of facts. At the same time learners were to be considered constructors of knowledge other than empty vessels to be filled with knowledge. Similarly, the reform policy, recommended that learners "...must also learn to analyse and synthesise, to imagine and explore, to criticise and create, to understand and use. Students must also learn to relate what-is-now to what-can-be and how to get there" (Namibia. Ministry of Basic Education and Culture [MBEC], 1993:121). Therefore, within this context my argument is that mathematics teachers have a very important role to play in ensuring that a learner-centred approach is a reality in their teaching practice. Thus the challenge for them is to transform and function as critical reflective practitioners and transform their classrooms into communities of inquiry.

2.2.2 Reflective practice within the Education reform policy

The reform policy document (1993) stipulates that teacher reflection has a large role to play in improving learner-centred education in Namibia. It is further outlined that reflection is, believed by experts to be, an authentic way to enhance positive change in teachers. In other words, reflection is regarded as a process of looking back at one's

teaching experience, calling some aspect of teaching into question, analysing it, evaluating it, and making plans for improvement. The reform policy document (1993), mentions two tools of reflection. These are mostly, conversation with peers and secondly creating focus groups. In my view, sharing teaching experience with other teachers is also an effective way to reflect. With regard to focus groups, teachers with common interests ought to get together in small groups to address common problems. During group meetings, for example, videos of successful teachers doing something in class can be shown and analysed.

The Ministry of Education (1993) pointed out that:

Indeed, learning is more than memorising and repeating. Our children need to learn to think independently and critically. They must master strategies for identifying, analysing, and solving problems. Most important, they must develop self-confidence: their own sense that they have the ability to contribute productively to their society, to help it grow and to participate in governing it. One of the aims of basic education is to provide a balanced, relevant and coherent programme of instruction and learning to promote functional numeric and mathematical thinking to help learners understand and master the basic mathematical concepts and operation, and to help learners apply mathematics in everyday life. Emphasis should be on higher levels of thinking and anticipate identifying confusing elements. (Namibia. MBEC, 1993: 38 & 119)

It is for this reason that the ministry adopted a "learner-centred approach" to teaching as it serves a means to achieve the educational goals of the reformed system. The constructivist theory suggests that learners construct knowledge by attaching meaning to what they do (Fosnot, 1996).

The reform policy, 'Toward Education for all' (1993), also indicates that:

The teacher is a master learner. One of the teacher's major responsibilities is to help organise and structure the interactions among the students in the class. Students can and should help each other learn. But it is the teacher who must make it possible for that to happen and encourage it. It is for that reason that even with the most advanced equipment and materials, teachers will always have a critical role in education. Since teachers are essential to learning, they need to be well prepared. (Namibia. MBEC, 1993:139)

My argument is, in order for teachers to be master learners they have to analyse their own teaching and beliefs about mathematics pedagogy through critical reflection. The link between reflection in mathematics teaching and achieving excellence is fully discussed below.

2.3 CRITICAL REFLECTION IN MATHEMATICS TEACHING

While it might be more logical to cover the discussion of the general case for critical reflection by teachers and the general theory, I have decided to first discuss the case for critical reflection in mathematics teaching, which is briefer.

A number of learning theorists and writers on mathematics teaching advocate the reflective teacher as a key element of the effectiveness of mathematics teaching. Kilpatrick, Swafford, & Swindell (2001:385) who made his reputation on his now famous teaching model for proficiency felt that, "ongoing learning [is necessary to operate in line with] new curriculum frameworks, new materials, advances in technology, and advances in research on student thinking and teaching practice". Kilpatrick et al. (2001:385) states that "...engage[ment] in inquiry can provide the basis for teachers' learning to become generative so that their knowledge, conceptions and practice continue to grow and evolve". Kilpatrick et al. (2001) further suggested that teachers analyse mathematical ideas in school curriculum, from a learners' point of view. Again, teachers should also think of learners' problem-solving strategies and how the difficulties learners encounter in the classroom influence classroom practice. At the same time considering the impact mathematics teaching practice has on what learners learn. Kilpatrick et al. (2001) asserts further that teachers need to think of how to address the misconceptions identified and how to sustain learners' mathematical thinking through careful planning.

Anderson (1996:4) argued that learning occurs best with "a combination of abstract instruction and concrete illustrations". Here too, mathematics teachers would need to think of how to combine abstract instruction and concrete illustrations to situate

mathematics learning within the classroom and real-world context; and to enable the application of classroom gained knowledge to solve mathematical problems encountered in real life situations. I think another way to extend the situating of mathematics into real life situations is through the use of ethno-mathematics as a classroom tool. Arguing from Anderson's (1996) perspective ethno-mathematics would help to create an inclusive environment in which a variety of mathematics embedded in different cultural activities is brought into the classroom. In my view this could make mathematics more interesting and relevant to learners in a multicultural society.

Kilpatrick, Najee-ullah & Mitchem (1997: [2]) discussed a Reflective Teaching Model as a "teacher-change model". According to Kilpatrick et al. (1997: [2]) "the reflective teaching model provides a framework for teachers to systematically observe experience and reflect upon teaching and learning and thus learn to challenge and explore their own teaching practice". Kilpatrick et al. (1997) argues that through the sharing of authority learning situations appropriate for the creation of new knowledge about teaching and learning are created. According to Kilpatrick et al. (1997: [2]) it is important for teachers "...to relinquish intellectual authority and to learn to value various perspectives, to honour knowledge gained through experience and/or to respect the reasoning and thinking [of different learners]". Furthermore, it serves the purpose of collaboration between teachers and learners through effective communication as teachers attempting to execute appropriate ideas from learners and "stimulating... all [learners'] intellectual growth" (Kilpatrick et al. 1997: [3]).

A critical theorist, Freire cited in Stinson, Bid well, Powell, & Thurman (2007:691), call for the act of "learning to perceive social, political, and economic contradictions and to take action against the oppressive elements of reality (Freire, 1970/2000:35) through the foundation aspects of critical pedagogy". This implies that teachers could teach mathematics for social justice whereby learners could use mathematics explicitly as an analytical tool for examining social injustices and develop positive cultural and social ethics. Freire cited in Stinson et al. (2007:619), using a critical theorist approaches, advocated a very different perspective on the teaching of mathematics as:

... A different context where learners are no longer passive, empty depositories awaiting the teacher's deposits of knowledge – what Freire (1970/2000) coined, "the 'banking' concept of education"(p.72)- but are active co-creators of classrooms "where students of varied backgrounds and abilities work with expert teachers, learning important mathematical ideas with understanding, in environments that are equitable, challenging, supportive, and technologically equipped for the twenty-first century.

Considering the aforementioned view, in order for teachers to develop a different view on the teaching of mathematics, they need to function in line with the education reform ideals as reflective practitioners.

Kincheloe & Steinberg (1997) though not mathematicians, emphasised that problems occur when a teacher does not take a step-back out of his/her teaching practice to analyse it. This results in a mere acceptance of views from relevant authorities in education or curriculum planners without critically analysing them. In relation to mathematics, teachers need to think about their views on mathematics, the content being taught, values and attitudes they bring to the learning environment.

In addition, Prawat (1991) emphasised that the purpose of teacher empowerment is to prepare teachers to get involved in the process of bringing about adjustments in curriculum as opposed to a mere implementation of ideas. I believe this is possible only by reflecting critically on pedagogical aspects through what Prawat (1991) referred to as 'an agenda'. According to Prawat (1991), teachers ought to have conversations with the 'self' through analysing everything they do in the classroom as teachers; and with 'settings' focussing on the teaching /learning environment in terms of resources and support needed by the teacher. According to Prawat (1991), teachers ought to think about knowledge and value claims they regard valid; and think of what they have to contribute to the development of mathematics curriculum. It is also the teachers' responsibility to think of what to focus on in the teaching or learning environment. This is possible through a careful selection of resources and teaching approaches that enhance quality teaching and learning. Prawat (1991) emphasised that the aforementioned requires teachers to re-examine traditional views of learning in their subject and apply appropriate theories and techniques in the learning context.

In seeking to develop practice, Dewey as cited by Arthur, Miller, Thibado, Rule, Dunham, & Stoker (2007:43) suggested that reflective thinking frees us from "impulsive" and routine activity. He emphasized that it enabled the development of an increased awareness of individual teacher's own pedagogy, instructional decisions they make; at the same time realize that the choices that are made have an impact on the learning in the classroom. In addition, critical reflective practice promotes change and reflective thinking to clarify our thinking about what we do as mathematics teachers.

2.4 BECOMING A CRITICAL REFLECTIVE MATHEMATICS TEACHER 2.4.1 Principles of critical reflection

The proponents of critical reflection claim that critical reflective practitioners ought to exercise a democratic leadership style. The principle underpinning this argument is that a democratic leadership style requires teachers to have their lessons open for scrutiny by other teachers and learners. Dewey, as cited by Arthur et al. (2007) pointed out that reflective thinking is a process whereby teachers look back to experience to analyse it. This means that teaching practices are critically examined from a personal perspective and from the perspective of others. He further stated that it involved thinking carefully about preferred teaching approaches during and throughout the planning and teaching process. Furthermore, Taghilou (2007:90) indicates, "reflective pedagogy is an attempt to understand the learner, the teacher and the learning/teaching process as a whole; and help the pupils move toward ... perfect ...competency... [In addition,] Reflective teaching is a means of professional development that begins in the classroom... It is a cyclical process leading to the construction of meaning" Taghilou (2007:90). This occurs by:

- 1. Observing and gathering information,
- 2. Analysing the information to identify any implications,
- 3. Hypothesizing to explain the events and guide further action,
- 4. And implementing an action plan. (Richards & Lockhart as cited in Taghilou, 2007:91).

Stinson et al. (2007:619) pointed out that "critical mathematics pedagogy centres instruction specifically around issues of social and political justice and reform". Meaning, from the critical pedagogy perspective, knowledge and understanding of mathematics is "...understood as a means for learner and teacher self-empowerment; to organize and reorganize interpretations of social institutions and traditions; and to develop proposals for more just and equitable social and political reform" (Skovsmose as cited in Stinson, 2007:619). Likewise; Harrison, Lawson, & Wortley (2005:272) outlined, "Critical reflection is a more detailed personal record of what has been learnt (thought) and trying out what has been learnt (action)".

Loughran as cited in Harrison et al. (2005:275) defines reflection as "not simply 'learning in the raw' but also a method of attaching meaning to what we learn to gain more clarity." He described it as the "purposeful, deliberate act of inquiry into one's thoughts and actions through which a perceived problem is examined in order that a thoughtful reasoned response might be tested out" (Harrison et al., 2005:275). During this stage, previous practice is scrutinized using personal views to consider alternative instructional approaches. He added, "it involves 'retrospective reflection', with similarities to critical review process where one has to step back and look at one's own teaching with the purpose to improve it through reflection and action" (Loughran as cited in Harrison et al., 2005:276).

2.4.2 Theories of critical reflection

As outlined by Kilpatrick et al. (1997), the Reflective Teaching Model discussed earlier is grounded in two theories, constructivism and meta-cognition, and on a fundamental belief of sharing authority. According to the constructivist theory "learning is an active process of trying to make sense of new experiences" Kilpatrick et al. (1997: [2]). This occurs when learners "integrate new ideas and information into their existing knowledge structures [whereby] new knowledge becomes unique to [their own thinking resulting in accommodation of new knowledge]" Kilpatrick et al. (1997: [2]). Thus, understanding of mathematical concepts is no longer expected to emerge from a mere transmission of knowledge. Learning is expected to emerge through "discourse and opportunities to explain (teach) [personal] understandings to another person and the opportunity to understand (learn) [from other people's points of view]" (Kilpatrick et al. 1997: [2]).

Discussing meta-cognition from Kilpatrick's et al. (1997) perspective, this is a theory around thinking and experience. According to Kilpatrick et al. (1997: [2]) this includes "our ability to think about what we are doing and thinking while we are experiencing it". Kilpatrick et al. (1997: [2]) discussed further that it is about being able to think "on experiences and to learn from them". Meanwhile Schon cited in Liston (1996) refers to the aforementioned theory as 'reflection-on-action' that occurs when we think of our lesson before teaching and after teaching focusing thought on what happened during the teaching process. Another time frame is 'reflection-in-action' prevailing during the lesson as a teacher attempts to solve unexpected problems or to alter the way of explaining by rephrasing questions. Higgs (1995), Kilpatrick et al. (1997) and Schon as cited in Liston (1996) outline the idea of reflecting before the lesson, during the lesson and after the lesson. This shows the relevance of meta-cognition theory within the critical reflective teaching process as necessary. It enables teachers to think of the lesson process, identify problems to solve the ones that need immediate attention, being flexible and acting professionally throughout the lesson.

Similar to Dewey as cited in Arthur et al. (2007), Higgs (1995) classified the 'context of reflection' using different concepts. Though the meaning is the same, other theorists classify it as reflection before the lesson, during the lesson and after the lesson, Higgs (1995) terms it as anticipatory reflection, contemporaneous reflection and retrospective reflection. Higgs (1995:152) affirms that:

Anticipatory reflection is the first and most common form of reflection and embraces the question 'how might I approach teaching "this" particular content/lesson? [The claim is that] If this question is the entrée to anticipatory reflection then it should be a guide to how one reasons through and develops a pedagogical approach that might be tested in practice...[besides] the reflective cycle offers opportunities to make purposeful pedagogical decisions about a course of action to be embarked upon. Pertaining to contemporaneous reflection, Higgs (1995:152) stressed that:

Contemporaneous reflection is whereby the 'action-present' is the impetus for reflection. It is reflection that is immediately responsive to the learning environment and may be seen as shifts in pedagogical approaches and behaviours which may be either anticipated or unexpected...therefore, contemporaneous reflection is a most demanding and highly context dependent action... [It is pronounced that this] leads to learning from testing during a teaching episode and requires a personal acceptance of the risks involved.

Again, Higgs (1995:152) argued that:

Retrospective reflection is initiated by questioning what happened and why [?] in [the] teaching episode...[and this occurs] after the teaching episode. [It is]...initiated in response to the actions embarked upon as a result of testing hypotheses and teaching approaches devised through anticipatory reflection.

With regard to meta-cognition theory and thinking, Kilpatrick et al. (1997: [2]) emphasized "the theory refers to an ability to think about what we are doing and thinking while we are experiencing it". It also cultivates the ability to reflect on experiences and to learn from them. This further enables teachers to be conscious of the progress of the lesson, identify the setbacks and plan on how to regulate learners' behaviour while teaching.

Deliberating on sharing authority, a teacher may reflect on how to incorporate cooperative learning in the teaching process. I think a way of sharing authority could be asking fast learners to assist slow learners, especially in classrooms with a large number of learners. Here the sharing of authority prevails in the process of assisting slow learners.

In addition, I noted that critical reflective teaching is also underpinned by critical thinking theory. According to Splitter (1991:95) "thinkers become critical thinkers when they learn to think in ways that are reflective, rule-governed and directed toward making objective claims (judgements) about the world... critical thinking is basic to any thinking

if that thinking is to make sense". Furthermore, Splitter (1991) cited Siegel who outlined that teachers must value all learners and approach them respectfully. Siegel in Splitter (1991) pointed out that teaching 'in a critical manner' means acknowledging each learner's right to question, challenge and to demand reasons. Generally, it means preparing learners to take charge of their own lives as adults, to be equipped with appropriate skills to make sound and independent judgements.

Stinson et al. (2007) indicate that critical reflective teaching practice may bring about change in terms of teaching mathematics for social justice and empowerment. According to Stinson et al. (2007:620):

Critical theory maintains socio-political critiques on social practices and ideology that mask "systematically distorted accounts of reality which attempt to conceal and legitimate asymmetrical power relations" (Bottomore, 1983/2001:209). Included in these critiques is an examination of how social interests, conflicts, and contradictions are expressed in thought and produced in systems of domination (Bottomore, 1983/2001). Critical theorists contend that an examination of these systems of domination will bring about an awakening of consciousness and awareness of social injustices, motivating self-empowerment and social transformation.

2.4.3 Strategies for becoming a critical reflective mathematics teacher

On the one hand, Dewey as cited by Arthur et al. (2007:44) "emphasised that teachers' attitudes, qualities and character traits (such as open-mindedness, sincerity/wholeheartedness, and responsibility) [are] important...towards becoming a critical reflective practitioner". Taghilou (2007:90) also outlined "reflective pedagogy necessitates multi-dimensionality, a consideration of "the whole" from all its possible angles". The aforementioned is vital because, "preparation for working with diverse populations in an ever-changing cultural and global context requires teachers who are knowledgeable, caring, and responsive" Taghilou (2007:90).

On the other hand, Liston et al. (1996) argued that, for teachers to reflect critically on their mathematics teaching practice; it is imperative that they analyse their teaching in

terms of the four arenas/levels of reflection including the fifth arena created with my supervisor's assistance. These are:

- Reflection on own knowledge,
- ✤ Core values/beliefs,
- ✤ Own experience,
- Own pedagogy/teaching practice, and
- Critical reflective teaching

In line with Liston et al. (1996), Brook Field in Van Harmelen (2006) discussed four processes central to the act of being critically reflective. Firstly, it is through analysing their own views that teachers become conscious of how their beliefs, values, cultural practices and social structures influence and affect their teaching practice. They ought to make their notions of reality, which are taken for granted, explicit. Secondly, teachers need to be aware of their past experiences, assumptions and cultural context. Thirdly, teachers ought to challenge the current ways of knowing through thinking of alternatives in terms of innovative ways to facilitate learning. Lastly, it is important that teachers view things from a different perspective, focus on critical reflective practice to assimilate information acutely.

2.4.3.1 Reflection on own knowledge

A teacher should have mathematical understanding to teach mathematics for understanding. A teacher is more confident teaching mathematics when s/he understands mathematics in terms of the knowledge, *what*, *why* and *how* to teach mathematics. Drawing from my experiences as a teacher, in most cases learners value and respect teachers who themselves understand the content they are teaching and how best to teach. A teacher should reflect on their ability to create a learning environment that is conducive in terms of maintaining discipline. Reflection on classroom control is important because learning with understanding occurs within an environment that is inviting and conducive as opposed to a chaotic situation. It is for this reason I regard it important for a teacher to critically examine their understanding of mathematics content knowledge. Teachers' 'de facto' and 'de jure' authority according to Barrow & Woods (1982) enables them to teach mathematics successfully. Teachers should be authorities not only because they have the power over the learners but also because they are "... authorities in their field" (Barrow &Woods, 1982:99).

Within this arena, teachers are expected to be conscious of themselves as individuals, the classroom context, and mathematics content, how to evaluate the curriculum and how to teach for understanding. Elbaz as cited in Liston (1996:35) emphasised that the "practical knowledge (or theories) of teachers is concerned with knowledge of self as the teacher, of the milieu or context of teaching, of subject matter, curriculum development, and instruction". Furthermore Elbaz (1983) press that this knowledge ought to be classroombased and on the understanding of the situation in which teaching and learning occurs. Taghilou (2007:91) in conjunction with Elbaz (1983) broke up knowledge into five knowledge bases as indicated below. The recommendation is that teachers need to be aware of the five knowledge bases centred on:

- ✤ Knowledge of self,
- ✤ Knowledge of content,
- * Knowledge of teaching and learning, knowledge of pupils and
- Knowledge of context within schools and society.

2.4.3.2 Reflection on core values/beliefs

Arguing from Cornbleth's (1987) point of view, I think teachers need to analyse their beliefs about teaching mathematics because held beliefs may contradict educational democratic ideals such as equity and attempts to realize them. For example, if a teacher has the belief that every learner can succeed mathematically then the teacher admits that it is his/her responsibility to provide supportive conditions to make individual achievement possible. As a result, the teacher will value, view and expect all learners to make contributions to the lesson despite their varied abilities. With regard to learners' learning potential, Gates (2001:265) emphasised that "the teacher will not objectify, construct and apply fixed criteria or rules that perpetuate inequity or either maintaining learners in permanent groups". Meanwhile the teacher will employ possible strategies to enable learners to view mathematics as a subject that is interesting, inviting, engaging

and meaningful. This, in my opinion, may be achieved through resources that are stimulating in terms of thinking and allow learners to learn cooperatively.

Adler (1991:8) emphasised that "change, however, need not to be a break from the past". Therefore, my argument is that teachers should review their beliefs pertaining to traditional methods of teaching so as to jointly implement it with a learner centred approach. For instance, when discussing the multiplication table, memorisation of the table may be useful at the same time as enhancing understanding of the operations underpinning the multiplication tables. The aforementioned is important because what learners learn is not only influenced by teaching and learning approaches it is also influenced by influences from the broader society outside the classroom, such as by magazines, videos, radio stations and many more. In addition the National subject policy guide (2006) emphasises that:

A mathematics lesson, which does not actively involv[e] learners, will be regarded as a boring and unproductive lesson. Therefore, lecturing technique must be used together with other techniques such as discovery, group work, question and answer, etc to enable to apply the concept of learner centred pedagogy in mathematics. (Namibia. National Institute for Educational Development, 2006:21)

Lloyd (2007:78) outlined that:

In contrast with traditional classroom activities that emphasise repetition, practice, and routinely means to some focused endpoint, inquiry mathematics instruction emphasises student engagement in problem solving and [text missing] building about important mathematical situations and concepts.

Lloyd (2007) argued that the transformation of mathematics instruction could be a very difficult exercise for teachers. Lloyd (2007:78) points out that "perhaps the greatest obstacle for teachers is a lack of personal familiarity with mathematical problem-solving and sense-making-processes that [they] have never experienced themselves as students or teachers". It is important that teachers familiarise themselves and transform their beliefs in line with inquiry mathematics instruction, as this is one of the main aspects under critical reflective teaching. This is important as discussed in the arena pertaining to teachers' own knowledge of mathematics.

Taghilou (2007) also indicated that values/beliefs include character traits such as being caring and reflexive with regard to problems that may arise in the classroom. Taghilou (2007:90) further outlined "reflective pedagogy necessitates multi-dimensionality, a consideration of "the whole" from all its possible angles".

Culver (1990) emphasised that "a major barrier to changing the learning environment is our own preconceived notion of how students should learn and how we should teach" (Culver, as cited in Kilpatrick et al., 1997: [1]). Again on the area of core beliefs Funk (2000:15) asserts that:

Assuming that a worldview can be incorrect or at least inappropriate, if your worldview is erroneous, then your behaviour is misguided, even wrong. If you fail to examine, articulate and refine your world view, then your world view may in fact be wrong, with the above consequences, and you will always be ill-prepared to substantiate your beliefs and justify your acts, for you will have only proximate opinions and direct sensory evidence as justification.

Since teacher beliefs are a basis for their thought and actions, it is important that these beliefs are not irrelevant or wrong as Funk (2000) outlined above. For example, if a teacher believes that girls cannot do mathematics or only the gifted learners can succeed in mathematics, then this teacher will find it difficult to make an effort to assist girls or slow learners to succeed as well. Consequently, girls or slow learners' performance in mathematics will decline and they will also believe that mathematics is only meant for boys or gifted learners; and in the end possibly withdrawing them completely from learning mathematics. Therefore teachers ought to think critically about how their actions, guided by their beliefs, affect the learners and the learning process in the classroom.

Gates (2001) emphasised that it is also important that teachers change their beliefs about taking risks to open up new possibilities, new ideas and new ways of working. It is a process of changing teachers' ideas about teaching into various interesting teaching strategies. Gates (2001) further discussed trying out new approaches to teaching helps teachers not to cling only to habitual approaches ignoring other approaches that may be

innovative. Gates (2001:275) outlined some examples of conditions that might be considered a change to 'normal' ways of working. These are:

- o Seating arrangement.
- Using practical equipment,
- o Adopting an investigative approach,
- Group work and discussion,
- o A shift from practising and consolidation of specific skills,
- o Pupils writing on something other than their exercise book,
- Pupils writing about mathematics per se, and
- o Using a resource other than a textbook or a worksheet.

My argument here is that when reflecting, a teacher ought to consider even simple changes as basic as seating arrangements to practice opening up new possibilities of doing things.

Arguing from Gates' (2001) point of view, I feel that if a teacher believes that learning should promote interest, and then the teacher will strive to make learning interesting for the learners. With this belief the teacher will give learners the chance to improve gradually from simple mathematics tasks towards more challenging ones. Johnston-Wilder (1999:93) emphasised that:

Good tasks can be ones that help students to develop skills in the context of their usefulness, Tasks that require students to reason and to communicate mathematically...to promote their ability to solve problems and to make connections.

It may not be the whole story, but the evidence is compelling that our beliefs and values are powerful drivers of what we do and how we do it. Reflection can uncover these influences and open opportunities for innovation in teaching.

2.4.3.3 Reflection on own experience

According to Taghilou (2007:89) reflective teaching is "a stance, a state of mind, a healthy, questioning attitude toward the practice of our profession". I think it is necessary that teachers look back at their mathematical teaching experience and review it with the purpose to use past actions to improve future practice.

Liston & Zeicher (1996:25) indicated, "...Educational experiences [and other] life experiences form an 'experiential' basis for teachers' practical theories". According to Liston et al. (1996), some of these experiences are life experiences, educational experiences, experiences with other teachers, school rules and structures, administrators and extracurricular programs. These "...are frequently the 'stuff' to which we refer when we think about how we want to teach" (Liston et al., 1996:25). Liston et al. (1996:25) suggests that the extent to which teachers learn from experience and how they learn from experience varies, because "not all experience is necessarily beneficial in its impact on learners". He stressed that experience "... is Mis-educative when it has the effect of distorting the growth of further experience" (Dewey as cited in Liston et al., 1996:27). Liston et al. (1996:27) further pointed out that "...the degree to which we think about those experiences and the degree to which those experiences frame further events and enable us to grow as thoughtful teachers constitutes, in part, our reflective understanding". In my opinion, the aforementioned may enable teachers to continually advance as attentive practitioners.

In addition, Kolb's experiential learning cycle in Harrison et al. (2005:272) asserts, "...Knowledge is created through the transformation of an experience". According to Kolb (1984) learning can begin at any stage of the cycle, but the stages should be followed in sequence. Firstly, Kolb (1984) suggested that the teacher take note of the experience in writing. According to Kolb as cited in Harrison (2005:272), this record is then used to scrutinise the experience through interrogation, asking questions such as:

- What happened? And why?
- What was expected to happen?
- What does it mean?

Kolb (1984) emphasised that through the abovementioned cyclical process, meaning of the experience is created and it culminates into "a 'personal theory' or...a more detailed personal record of what has been learned (reflection)" (Harrison et al., 2005:272)

2.4.3.4 Reflection on own pedagogy/teaching practice

Lloyd as cited in Leder (2002:150) stressed that:

Because many teachers' beliefs and practices are deeply tied to school mathematics traditions, the success of current mathematics education initiatives depends on our identification of viable ways to encourage and enable teachers to make significant shifts in their beliefs.

My argument here is that, as teachers we need to be well informed about what it means to teach mathematics proficiently. This is important because it guides the teachers' thinking to focus on important mathematical aspects such as the 5 mathematical strands of teaching mathematics proficiently, as discussed by Kilpatrick et al. (2001). These components of mathematics proficiency as outlined by Kilpatrick et al. (2001:116) are:

- Conceptual understanding comprehension of mathematical concepts, operations, and relations
- Procedural fluency skill in carrying out procedure flexibly, accurately, efficiently, and appropriately
- Strategic competence ability to formulate, represent, and solve mathematical problems
- Adaptive reasoning capacity for logical thought, reflection, explanation, and justification
- Productive disposition habitual inclination to see mathematics as sensible, useful, and worthwhile, coupled with a belief in diligence and one's own efficacy.

Therefore, I think a teacher should think critically of appropriate approaches to ensure learners understand mathematical concepts, at the same time of how to guide learners to fluently apply appropriate and efficient problem solving procedures and strategies.

Moreover, during the process of reflection teachers ought to be critical about every aspect of the lesson, initiating with careful planning of the lesson, thinking and selecting quality learning resource materials. A teacher should also design activities of superior quality, select best teaching approaches and ways to expose learners to mathematics language. At the same time, they should also be thinking of ways to address misconceptions and on how to ensure cooperative learning in mathematics classroom. Furthermore, it is necessary for teachers to learn how to ask probing questions. Probing, as emphasised by Fosnot (1996), helps a learner to find words for their thinking and helps them get their ideas out. It also helps them recap what they have done at the same time clarifying a question and encouraging further exploration of the problem at hand. For example, working out the next two terms in the number pattern 28, 21, 14, _, _, _, a teacher can ask the learners to explain how they worked out the missing terms; and also explore to find two more terms. Through this learners will expand their knowledge concerning negative numbers and subtracting from 'zero'. In this case a teacher needs to be patient enough to listen to the learners' responses and to understand them from their viewpoints and to understand their thinking. It enables the teacher to find new ways to facilitate understanding whenever learners encounter problems when carrying out tasks.

In addition, Elliot and Bridges cited in Harrison et al. (2005:272) outlined the improvement of practice through action research described as " the study of a social situation with a view to improving the quality of action within it". Thus teachers can critically reflect through: "...accounts and incidents, transcripts and tapes, [using] the outcomes of tasks to highlight the noticing, ... [while conducting action research through] plan[ning], act[ing], observ[ing] and reflect[ing]" (Elliot and Bridges cited in Harrison et al. 2005: 272). As presented by Elliot and Bridges (1981), before taking action, the teacher identifies the problem when planning and a hypothesis is formulated about the situation and plan of action is drawn up. During the lesson, the teacher should observe to collect evidence. When reflecting the teacher should ask him/herself questions such as:

- What does the experience mean?
- What can be learnt from it/ how does the practice match the personal theory?
- Does the theory need re-adjusting?
- Will the teaching change next time?

[This is a continuous or cyclical sequence that evolves until the] personal theory matches the practice. (Elliot & Bridges cited in Harrison et al., 2005: 272).

Harrison et al. (2005:276) further outlined a process of "deconstructing and constructing practice". My perception here is that the construction of practice is attainable through exploring different teaching methods. It further involves not only planning but also to envision experiences that may happen as a result of planning and discussion of practice with a mentor. Furthermore, Harrison et al. (2005) cited Macintyre on the importance of reflecting on the technical aspects of teaching. This is important because teaching has a direct impact on the kind of learning taking place in the classroom. The kind of teaching, taking place in the classroom can either facilitate the acquisition of knowledge through construction or can impede the learning process. Thus Gates (2001:273) outlined the importance of the use of practical equipment and it is important for teachers to incorporate the use of this equipment to:

- Provide learners with concrete experiences, something to physically manipulate, to construct understanding of abstract concept;
- Offer pupils a focus of interest and provide a richness beyond verbal and written communication;
- Create an image which learners can at a later time revisit in order to reconstruct knowledge;
- Demonstrate that mathematics is a creative subject which exists beyond the pages of a textbook;
- Provide imaginative approaches to learning mathematics and create, for pupils, an investment in mathematics.

Since critical reflection involves giving careful thought to the instructional choices made throughout the process of planning and teaching, teachers should also think of time constraints to manage the learning materials in use. At the same time, they should reflect on what aspects to continue or change and the learning outcomes from the experience. They can then decide how this information should be used to make sound instructional decisions in the future.

2.5 IMPLICATIONS FOR TEACHERS

Drawing from the report compiled by Namibia, National Institute for Educational Development (2003), the main implication of critical reflective teaching practice for teachers is the reconsideration of the role of the teacher-learner relationship towards their
progress in mathematics learning. A key driver in shaping this relationship is the teacher's attitude towards the learners. If a teacher cares about the learners, he/she is then concerned about their performance and will strive for mathematical understanding among all learners. In other words, teachers will dedicate their time to thinking of ways to improve their teaching to achieve this end, viz. improved performance through understanding. This requires not only critical thinking about the teaching process but also efforts in shaping teaching practice through action.

Currently, with the Namibian educational reform policy in effect, a teacher is required to have a good understanding and knowledge of subject content, the relevant curriculum and syllabus; and the appropriate pedagogy to critically reflect on ways to enhance understanding in mathematics teaching. The challenge is that teachers need to analyse and reflect on how to locate mathematics within the classroom and real life context to enhance understanding. In the report compiled by Namibia, National Institute for Educational Development (2003), it is stated that:

The teacher must learn and be able to decide when it is best to convey content directly (in a conventional way); when it is best to let learners discover or explore information for themselves without any teacher intervention; when they need directed learning; when they need reinforcement of learning; when the focus should be on skills more than content...or when the learners can be allowed to find their own way through a topic or area of content. ...Developing reflective practice is one of the keys to increased awareness of learner-centred education and improved classroom practice. (Namibia, National Institute for Educational Development, 2003:29)

Arguing from Kilpatrick et al.'s (2001) point of view, teachers need to have a good knowledge base in terms of their understanding of mathematics concepts and be fluent in solving mathematical problems through efficient procedures; including other strands of mathematical proficiency discussed in section 2.3.3.4. They should also understand the value of mathematics outside the classroom and also appropriate strategies to teach mathematics considering learners' pace of learning.

In conclusion, the literature underpinning critical reflective teaching recommends that:

Although the path is long and complex, A frequent (and motivating) starting point for personal mathematical activity is the need to teach a topic for the first time or even to teach a topic that you have not previously studied. Sometimes the first stage is to find a textbook to develop your own understanding of the topic; at other times, finding a fruitful teaching approach to traditionally awkward topics is more pressing. (Johnston-wilder 1994: 225)

Bailey et al as cited in Taghilou (2007:90) emphasised that "reflection is the examination of the underlying assumptions and the understanding of the interaction of dispositions (being), practice (doing), and professional knowledge (knowing)". Teachers ought to understand critical reflective pedagogy as a conscious attempt to think before, during, and after the instruction to enhance the learners' academic achievement.

Larrivee (2000:295) holds that our identity, as teachers, is shaped by our beliefs therefore:

Shedding a dearly - held belief shakes our very existence. [The effect is that] if a teacher tries to shed the belief that the teacher must be in control to be effective, it means revealing uncertainty and vulnerability... [Therefore teachers need] to act with integrity, openness, and commitment rather than compromise, being defensive... or fearful. [Furthermore]...to become a critically reflective teacher involves negotiating feelings of frustration, insecurity, and rejection. [Thus] ...teachers [need] to accept that such feelings are a natural part of the change process.

With regard to uncertainty, Larrivee (2000:304) stressed "this sense of uncertainty is what opens the door to a personal deeper understanding, leading to a shift in ways of thinking and perceiving".

Furthermore, arguing from Larrivee's (2000:298) perspective teachers need to "slow down their thinking and reasoning process". This may raise awareness pertaining to the way teachers perceive and react to learners, eventually exposing their unconscious response to learners.

2.6 RESEARCH ON CRITICAL REFLECTIVE PRACTICE

2.6.1 Research in Namibia

In Namibia, little research has been conducted on critical reflective teaching focussing on in-service mathematics teachers. In compiling research findings conducted by the Namibia Institute for Educational Development, Van Graan reports Hamunyela's (2000) findings based on BETD graduates who emphasised the benefit of personal professional growth and empowerment through reflection. According Van Graan (2004), graduates sampled in this study improved their practice through critical reflection. For example, a teacher brought a tape recorder to the class for recording her teaching. After class she would engage in self-evaluation through listening to herself in reflecting on her classroom situation. She made changes in her teaching as a result. On the other hand Van Graan (2004) points out that in many settings in Namibia; teachers are not generally encouraged to make sound changes in their teaching to gain new understanding. This is because teachers still believe that new and improved knowledge is gained from external sources and from 'experts', rather than from personal experience, and by listening, rather than acting.

Finally, from the research discussed above, it was identified that 'being critical' and critical reflection does not occur automatically. Teachers need to be aware of the theoretical underpinnings of critical reflective teaching in mathematics education.

Mbango (2007) also carried out research on reflective teaching practice in Namibia. Her research focussed on the role of portfolios in developing reflective practice in the Basic Education Teacher Diploma (BETD) pre-service program. She found that the goal was to enhance reflective practice but limited understanding and inadequate preparation inhibited the realization of the goal. According to Mbango (2007:93 & 94):

... The findings revealed that the current state of portfolio development in the college is only part of the bigger picture. I came to realize that although we insist that the students develop a teaching portfolio and are expected to reflect on their practice, the students in fact have a limited understanding of reflective practice

and the role of the portfolio in providing evidence of this practice...This study suggests the college should also establish mechanisms to reinforce the portfolio development process. The students should be provided with the necessary opportunities to prepare them for portfolio development. The preparation must include the conceptual understanding of a portfolio and how to develop the required portfolios. If reflective practice is to be a reality then the way we prepare our students is crucial.

2.6.2 International views

Arthur et al. (2007) outlined that many researchers have investigated student teachers' use of reflection. Dobbins' research cited in Arthur et al. (2007) shows that student teachers that reflected on their experience displayed improved classroom practices with a better effect for learners. In addition, Arthur et al. (2007:45) concludes that the "foregoing studies show that reflection on experiences assists pre-service teachers in growing professionally and independently to make sense of their experiences".

Stinson et al. (2007) carried out research on a critical mathematics education course for teachers. According to Stinson et al. (2007:619):

The findings report that the teachers believed that the course provided not only a new language, but also a legitimisation to transform their pedagogical philosophies and practices (and research agendas) away from the "traditional" and toward a mathematics for social justice.

In addition, their classrooms transformed into democratic, inclusive places, with lessons being more of a "conversation between teacher and learners" (Lerman, in Stinson et al., 2007; 62).

However, Stinson et al. (2007) stated that there are still many teachers who are afraid to pursue new ideas because they lack the language and the legitimisation; forced, through lack of knowledge, to reproduce the same traditional mathematics instruction they themselves endured.

Rarieya's (2005:291) report on 'a Pakistan case', points out that:

Critical reflective practitioners who were involved in the research developed a visible reflective stance...they saw reflective practice as a tool of re-looking at their practice...they also thought it was an important way 'of maintaining mutual communication with learners'.

Rarieya (2005) further stated that the teachers' nature of classroom discussions also changed and improvement in their writing skills prevailed.

Rodgers (2002:842) outlined a list of American educational and teaching organizations that have called for reflective enquiry by teachers and students. The list as shown below indicates that:

In the past 10 to 15 years, numerous commissions, boards, and foundations, among them, the National Board for Professional Teaching Standards (NBPTS, 1987); the National Commission on Teaching and America's Future (NCTAF, 1996); the National Foundation for the Improvement of Education (NFIE, 1996); the National Staff Development Council (NSDC, 1995); and states and local school districts, have identified reflection/inquiry, what Thompson and Zeuli would call thinking to learn, as a standard toward which all teachers and students must strive.

Yoo (2001) reports a more personal story of graduate students and the value ongoing reflection brought them. Yoo (2001:81) stated that:

By committing themselves to ongoing reflection, my graduate students gained a more holistic view of teaching and learning, problem solving, and curriculum design. They improved their observation skills, which helped them avoiding drawing careless conclusions about their students on the basis of test scores and superficial observations. They avoided stereotyping their students as quiet, antisocial or offensive.

Different from the findings indicated above; Ball et al. (2001) discussed some weaknesses in staff development programmes and in-service training, such as workshops. Ball et al (2001) in discussing the situation in the United States of America points out that:

Although [much] money is spent on staff development and in-service training, workshops are often intellectually superficial from deep issues of curriculum and learning. [Furthermore], no infrastructure exists for professional development...[and] professional development lacks a curriculum for teachers' learning, a curriculum that considers the practices they are being asked to enact, the mathematical knowledge that such practice entails, and the attention to what they already know and believe...(Heaton as cited in Ball, 2001:437).

Therefore, Elliot cited in Altrichter (1993:200) suggested that:

This should be taken into account when presenting teachers with educational innovations: if change proposals are to stand a chance of getting implemented under normal conditions of decision-making in schools they should:

- 1 Specify concrete procedures for accomplishing change.
- 2 Provide examples of how these procedures might be implemented in typical classroom environments.
- 3 Specify ways in which procedures can be legitimately adapted and modified by teachers in the light of their own assessments of particular situations.
- 4 Provide examples the sort of benefits teachers can expect in return for the effort they are expected to put into the implementation process.

Drawing from Elliot as cited in Altrichter (1993), I think workshops or any other training programmes need to explicitly guide teachers to respond to the reform ideals as critical reflective practitioners.

2.7 CONCLUSION

In an effort to respond to the reform ideals, my argument is that more should be done with regard to the transformation of mathematics education through teachers' critical reflectivity on their conceptions of mathematics pedagogy and their own practice within the mathematics classroom. It is shown from outcomes of the research carried out both nationally and internationally, that critical reflective practice can have a positive impact on teaching and learning. However, many teachers have yet to become critical reflective practitioners.

In this chapter I explored:

- What the literature says about critical reflective teaching in mathematics education
- The education reform policy on the role of reflective practice in Namibian education and
- The implications for teachers.

In the next chapter I will discuss the research methodology I used to gather data and analyse the role of critical reflective teaching practice in three mathematics teachers.

CHAPTER 3 METHODOLOGY

3.1 INTRODUCTION

In this chapter I discuss and present the methods I used to conduct my research to achieve the research goal. My research focused on critical reflective teaching in three mathematics teachers' classroom practices. In order to generate data it was necessary for me to select appropriate research methods. The literature provided valuable guidance in my choice of design, especially in the area of analytical tools.

Briefly, my empirical research was conducted in 2008. The literature review prevailed from October 2007 to June 2008. I began approaching the three participant teachers in October 2007 but only managed to interview them early to mid 2008. Three experienced teachers, teaching secondary school mathematics, were involved. I learned much from the individual discussions with all three participants and was also exposed to their lesson plan formats where reflective notes were written. Discussions were tape-recorded and their names were changed in the report to maintain their anonymity. The names are Mrs. Mula, Mr. Patrick and Mr. Tadi. Analysis of the interviews commenced immediately after the interview.

3.2 RESEARCH GOAL

The research goals are:

- To investigate three mathematics teachers' critical reflective practice.
- To find out the effect critical reflection has on their teaching.

My intention was to find out how the three selected mathematics teachers use critical reflection in their classroom practice and how it shaped their teaching.

3.3 CHOICE OF APPROACH

3.3.1 The interpretive paradigm

Jackson (1995: 10) emphasised that the interpretive paradigm

...Relies mainly on field studies, on participant observation studies, in-depth interviews with people and on ethno methodology (a detailed examination of a single event or case)...communication of the results of such studies usually emphasises verbal descriptions rather than numerical analyses.

This research was carried out within the interpretive paradigm because Cohen, Manion, & Morrison (2000: 22) argue that:

...The central endeavour in the context of the interpretive paradigm is to understand the subjective world of human experience. To retain the integrity of the phenomena being investigated, efforts are made to get inside the person and to understand from within. The imposition of external form and structure is resisted, since this reflects the viewpoint of the observer as opposed to that of the actor directly involved.

Since the interpretive paradigm focuses on experiences of participants as outlined by Cohen et al. (2000), I found this paradigm suitable for my research because I intend to find out not only the teachers' understanding of reflective practice but also the actions they execute to improve their teaching practice. In addition, as outlined by Cohen et al. (2000) it also focuses on individuals and sets out to understand their interpretations of the world around them.

Initially, the three teachers experienced difficulties in articulating precisely how they teach mathematics reflectively because they were not familiar with the concept of 'critical reflective teaching practice'. As a result, I had to briefly outline the arena of critical reflective teaching as pertaining to all we do as mathematics teachers in terms of classroom practice and how we do it.

3.3.2 Qualitative research

Qualitative research, as incorporated by the interpretive paradigm, enables the collection of data through observations, interviews and document analysis. According to Anderson (2000), in qualitative research, the principal data collection instruments are interviews and/or observations. This is done with the intention to understand and interpret the social reality from two perspectives. Anderson (2000:125) pointed out that:

First, try and understand phenomena through the participants' eyes, [secondly] place that understanding within your theoretical and conceptual framework of the phenomena and reconsider the participants' perspective with the goal of trying to define, unravel, reveal or explain their world.

As my research focus is on individual teachers' practices, it is through interviews that teachers had to discuss their views for me to collect relevant data. Access to ways these teachers document their thoughts was also possible through document analysis.

3.4 METHODOLOGY

3.4.1 A case study

This research is a case study specifically bound by the practice of three mathematics teachers in their classroom situation. Maxwell (1996:6) emphasised that "the methods you use must enable you to answer your research questions and also to deal with plausible validity threats to these answers". I found a case study method appropriate to answer my research question, since it is "the study of an instance in action" (Adelman et al. cited in Cohen, 2002:181). According to Cohen et al. (2000:181):

A case study can penetrate situations in ways that are not always susceptible to numerical analysis. Case studies can establish cause and effect indeed one of their strengths is that they observe effects in real contexts, recognizing that context is a powerful determinant of both causes and effects.

Besides Cohen's et al (2000) interpretation of a case study, Anderson (2000:121) defined a case study as:

...An investigation defined by an interest in a specific phenomenon within its real-life context. It is a qualitative form of inquiry that relies on multiple sources of information. Its distinctive feature is the case that may be an event or process considered worthy of study.

Since the study pertained to teaching practice, I regarded individual teacher's teaching experience as their real-life experience to generate data from. A case study method enabled me to focus on a particular case in terms of individual teacher's ideas. I interviewed three teachers to gain insight to the use of critical reflective teaching in their approach to mathematics teaching. In addition, from each case I was enlightened on their understanding of what critical reflective teaching is.

This case study also offered me the opportunity to learn from the individuals interviewed. I had access to different ideas in terms of how they evaluate their teaching in light of their experiences. They discussed the extent to which they critically think of what they do, and attempts or actions they take to continually develop professionally.

3.5 SAMPLING

3.5.1 The sample

Cohen et al (2000:103) pointed out that "In purposive sampling, researchers handpick the cased to be included in the sample on the basis of their judgement of their typicality. In this way, they build up a sample that is satisfactory to their specific needs".

Prior to the purposeful selection of my sample, the following aspects were considered.

- My research goal
- Accessibility to research site
- The subject taught by these teachers
- The research method and approach

My three participants, one female and two male teachers, are full-time mathematics teachers who are in their mid thirties to forty. The sample includes an ordinary teacher, a mathematics head of department and a school principal, who is also a mathematics teacher. All of them are non-English speaking Namibians whereby English is spoken as a second language. All of them have more than 4 years of teaching experience. The ordinary teacher was involved in the pilot interviews as well as in the actual interview process.

3.5.2 Criteria and reasons for sample

Considering the nature of my research, I had to involve:

- * Teachers with rich practical professional knowledge
- Teachers teaching in Secondary School
- Teachers residing in Rundu
- Reflective practitioners (teachers who carry out instructions consciously).

I have chosen this level of schooling because it is the level in which I operate as a teacher and with which I am most familiar. I have conveniently selected schools that are easy to reach to facilitate my research process. I have a good working relationship with the participants. This is because I have worked with these teachers in cluster mathematics workshops held previously in Rundu where two of the three served as facilitators and the other teacher as an attendant. During these workshops I gained insight as to the possibility for these teachers to execute critical reflective teaching in their mathematics teaching practice. This is based on the fact that the ideas they shared with other teachers during the workshop sounded valid and convinced me that they do actually spend time thinking about their teaching.

The third participant was selected from the three pilot interviews that were carried out. The selection was based on valid data he produced during the interview process and positive attitude displayed when approached. Moreover, the selection of these teachers was based on the fact that they are currently mathematics educators and are thus directly involved with learners.

3.6 TECHNIQUES AND METHODS OF DATA COLLECTION 3.6.1 Interviews

According to Gillham (2000:62), "interviewing, even in its most unstructured, 'natural' form is not something you rush into". You have to get to know the setting and the people. You have to establish your credibility and earn their "trust". To earn the participants trust and credibility, I reminded them of the purpose of my research before the interviews commenced. Apart from it being stated in the consent form, I also emphasised that the purpose of my research was not to evaluate their teaching, but to find out their individual teaching practices and what guides their teaching practice. I also did this with the intention to avoid any discomfort during the interviewing process as well as to discourage them from saying what they thought I wanted to hear.

With regard to the research process, information was collected through a combination of structured and semi-structured interviews. According to Cannell (1968) a research interview is:

A two-person conversation initiated by the interviewer for the specific purpose of obtaining research-relevant information, and focused ...on content specified by research objectives of systematic description, prediction, or explanation. It involves the gathering of data through direct verbal interaction between individuals. (Cannell et al, as cited in Cohen et al, 2000: 269)

It is for this reason that I found interviews an appropriate research tool for my study. I piloted my research questions two months prior to the actual date of my interviews. The pilot interview consisted of two sections where I discussed the teacher's educational background and ideas on critical reflective teaching practice.

Initially I planned to work and engage with these teachers for a 6-month period but due to time constraints I could not execute it as such. As a result, I could only interview them

once. Apart from aforementioned, securing an interview with teachers in full swing with their basic teaching loads proved to be challenging because the interview with Mrs Mula was postponed more than three times, Mr Patrick twice and Mr Tadi once. Whenever I turned up for the interviews as scheduled, they were fully occupied with schoolwork. Thus I had to be patient all along hoping for a chance to collect data.

The data collected consisted of 4 formal interview transcripts. The first transcript was a pilot interview transcript and the remaining three were the transcripts of the actual interviews. I collected data mainly through interviews and document analysis. My role during the interview was to pose questions, clarify questions, listen attentively and probe for further deliberation on particular aspects that I deemed relevant to my research.

Two of the three interviews where conducted in the afternoons between 15h00 to 16h00 and one interview before 13h00 when the interviewee had no lessons to present. Each interview took about an hour of discussion with the transcribing process lasting 2 to 3 hours. Mr. Patrick was interviewed twice, during the pilot interviews and the actual interview, whereas Mrs. Mula and Mr. Tadi were interviewed only once.

The actual interview consisted of five sets of questions with a specific focus on the five arenas of reflection. I focussed on the teacher's educational background, experiences as a teacher/learner, core values/beliefs, and teaching practice and own knowledge as a teacher. With regard to educational background, discussion centred on the teacher's academic and professional qualification and how this informed their teaching at present. Pilot interview questions were expanded on and changes were made with my supervisor in April 2008. By then I had already interviewed Mrs. Mula in February 2008. Being a principal, Mrs. Mula had many commitments. It was therefore not possible to reinterview her for the second time. Nevertheless, during the interview process, Mrs. Mula gave a detailed discussion of her teaching from which rich data was generated.

3.6.2 Document analysis

The interview questions were derived from literature on critical reflective teaching practice that had been analysed by myself (see appendix I). Questions were based on aspects of teaching that a teacher may focus on. I also focussed on what critical reflective teaching in mathematics teaching implies. In line with Maxwell's (1996: 6) recommendation, the purpose of my study was "informed by current theory and knowledge, whereas the choice of relevant theory and knowledge" was informed by my research question and goals. With their permission I also analysed the three teachers' lesson plans to gain insight about their way of reflection. This was also a form of triangulation of data.

3.7 VALIDITY

According to Maxwell (1992) validity, in a broad sense, pertains to the relationship between an account and something outside of that account, whether this something is construed as objective reality, the constructions of actors, or a variety of other possible interpretations. This implies it is possible and important to get other equally valid accounts from different perspectives. Therefore despite interviews and analysis of documents, I consulted a range of literature to unpack more pertaining to reflective teaching in mathematics teaching practice.

For the purpose of triangulation, as pointed out by Anderson (2000), I used a variety of data collection methods, such as interviews and document analysis. Anderson (2000) further outlined that triangulation could help eliminate bias and may detect errors or anomalies in my discoveries.

All the interviews were tape recorded and transcribed. The cassettes, as well as the transcripts, are safely stored for reference and verification of my interpretation of the data gathered. Hammersley and Atkinson cited in Maxwell (1992:4) suggest that "data in themselves cannot be valid or invalid; what is at issue are the inferences drawn from

them". The data was analysed in light of the goals of my research to find how these three teachers use critical reflection in their teaching practice. For increased credibility, the transcripts were member checked by the participants.

3.8 ETHICAL RESPONSIBILITIES

Anderson (2000) insists that a researcher needs to obtain formal permission from a relevant authority such as the principal and the participants to conduct the research (see appendix C, D, E, F, G and H). He continued that one has to know the structure of the:

- ... Organization or community,
- Learn ... about the setting, how, why, where and what people do,
- ...Formal and informal political dynamics,
- ...Names of key people,
- ... Most appropriate way to communicate with people,
- [And] how to fit in with both... appearance and behaviour. (Anderson, 2000:126)

Anderson (2000) further recommends that a researcher needs to gain and keep respect and trust of the people working within the research process. One has to consider respect for persons, respect for truth and respect for democracy.

Drawing from Denzin & Lincoln (2000: 447),

Case studies deal with matters, such as personal views and circumstances, of public interest but for which there is neither public nor scholarly "right to know"; quality researchers are guests in the private spaces of the world; and should therefore have good manners.

Therefore, before involving the three participants in my research, I informed the teachers of the purpose of the interview and the period within which it was to be carried out. I also informed the school principal in writing (see appendix A). In order to avoid any fear of exposure I informed these teachers that they would remain anonymous (see appendix B). I also emphasised their right to withdraw from the research at any stage of the research process and the right for them to verify my interpretations drawn from their

ideas. After the introductory discussion, each teacher signed a consent form indicating that they participated willingly and they understood the purpose of the interview.

During the interview process, I probed where necessary, but tried not to impose my ideas about critical reflective teaching practice on any of the three teachers I interviewed. When I noticed that one of the teachers was not willing to disclose his professional qualification, despite probing, I respected the individual teacher's decision and carried on with other questions.

3.9 DATA ANALYSIS

I used a qualitative data analysis strategy. According to Anderson (2000), qualitative data analysis is a continuous activity that constantly evolves. I found the five basic phases of analyses identified by Moustakas very useful in writing my own analysis.

- *Immersion*, with the experience;
- *Incubation*, a time of quiet contemplation;
- Illumination, active of increased awareness, expanded meaning and new clarity;
- *Explication*, new connections are made and one prepares to communicate findings;
- *Creative synthesis*, the research findings and experience are wound together, written and communicated. (Moustakas, as cited in Anderson, 2000:131)

According to Gillham (2000:71),

Transcriptions should be carried out as soon as possible after the actual interview: your memory will help you in hearing what is on the tape...the essence of content analysis is identifying *substantive* statements-statements that really say something.

A few days after the interviews were conducted, in June 2008, the interview transcription process began. I carried out formal and informal analysis of the interviews closely noting aspects of critical reflective teaching. During the analysis process, I focussed on relevant statements made by the respondent to address my research goals. The main ideas

selected were then bulleted according to the 5 arenas of reflection and captured in a table. I then noted common aspects of critical reflection that emerged from all 3 interviews.

3.10 LIMITATIONS

My case study has limitations. Individual teachers reflect differently while others may perhaps not reflect critically in light of the 5 arenas of reflection outlined in chapter 2. As this is a case study, the findings will refer specifically to the three teachers and cannot be generalised in a broader context. Other limitations, such as time constraints also need to be considered. The nature of a half thesis limits the time within which the research is carried out.

3.11 CONCLUSION

In this chapter, I discussed the methodological framework I found most suitable for my research. The methodological framework was designed in line with my research goals. Presentation and justification of my choice of approach, research methods, sampling as well as techniques and methods of data collection was also done. I outlined and discussed validity and ethical issues in my research. I then discussed how I analysed my data and the limitations thereof. In the next chapter I will present and analyse the data collected.

CHAPTER 4 DATA ANALYSIS AND DISCUSSION

4.1 INTRODUCTION

In this chapter I will present and analyse my case study findings pertaining to the critical reflective teaching practice of three mathematics teachers. I focused on finding out how these 3 teachers critically reflect on their classroom practice, what they reflect on and the purpose of their reflections.

Firstly, I present a brief description of the school context in which the research was conducted. Secondly, I outline the focus of the interview in line with Handal's et al (1987) framework for understanding the sources of teachers' practical theories, which I refer to as arenas of reflection. Thirdly, I provide a brief description of the three participants and their teaching practice. I collected data through interviews and designed an analysis table that enabled me to classify data collected into four categories. These are, when, what, how and why the teachers reflect critically (see chapter 2, p.17). Furthermore, I analysed my findings according to the five arenas of reflection. I then employed an analysis table I designed which reflect Kilpatrick's et al (2000) strands of teaching mathematics proficiently (see chapter 2, p. 26). The purpose of this is to identify and outline the three participants' common aspects of reflection. This is followed by an outline of the three teachers' individual ideas on what critical reflective teaching is.

Through critical reflection, teachers could carefully and critically examine their classroom practice. A discussion pertaining to critical reflective teaching of the three mathematics teachers is also discussed in this chapter.

4.2 DESCRIPTION OF CONTEXT

My research was carried out in 3 different secondary school settings, two senior secondary schools and a junior secondary school, situated in the Northeastern region of

Namibia. These schools are situated in Rundu, the town I reside in. I interviewed 3 mathematics teachers from each of the respective schools aforementioned. Two of these schools were established before independence while the other one was established after independence. English is the medium of instruction in these three schools. Learners attend lessons in the morning while afternoons are used for extra-classes or general study time. These schools accommodate learners ranging from a total of 700 learners to 1500 learners in the larger schools with more than sufficient classrooms, desks and chairs for the learners. These schools each have a science laboratory, a library, a sports field and an orchard. Parents contribute an amount of N\$ 150 - N\$ 300 per annum depending on each individual school's stipulated funding policy. Both senior secondary schools offer hostel accommodation for learners except the junior secondary school. Two of these schools accommodate grade 8-12 learners while the other school enrols grade 8 - 10 learners only. Learners are accommodated irrespective of their social class, gender, language or race. The staffs at all three schools comprise of male and female teachers - mostly black teachers. The school governing board of each school consists of teachers, learners and parents.

4.3 THE INTERVIEW FOCUS DURING THE INTERVIEW PROCESS

I interviewed 3 mathematics teachers to explore how they use critical reflective teaching in their mathematics teaching. During the interview process I focused on the 5 arenas of reflection, namely:

- Received knowledge and training,
- Core values/beliefs,
- Experience as learner,
- Teaching practice, and
- General view on what critical reflective teaching is in mathematics education.

With regard to received knowledge, Elbaz as cited in Liston et al. (1996) claims that the practical knowledge (or theories) of teachers is concerned with knowledge of self as the

teacher, of the milieu or context of teaching, of subject matter, curriculum development, and instruction. Johnston-Wilder (1999: 226) emphasised that:

...What your pupils learn about mathematics, will depend on what you have already learned, the new experiences you have and the use you make of them...the more interested you become in how you operate as a teacher, the more interesting and rewarding teaching will be.

Liston et al. (1996:25) indicated that educational experiences and other life experiences form an "experiential" basis for teachers' practical theories. These "…are frequently the 'stuff' to which we refer when we think about how we want to teach" (Liston et al, 1996:25).

In terms of core values/beliefs, Culver (1990) emphasised that "a major barrier to changing the learning environment is our own preconceived notion of how students should learn and how we should teach" (Culver, as cited in Kilpatrick et al. 1997: [1]).

Harrison et al (2005) cited Macintyre on the importance of reflecting on the technical aspects of teaching. Macintyre (1993) emphasised that the kind of teaching taking place in the classroom can either facilitate the acquisition of knowledge through construction or can impede the learning process.

With regard to critical reflection in general, Higgs (1995), outlined the idea of reflecting before, during and after the lesson. This shows the relevance of meta-cognition theory within the critical reflective teaching process as it is necessary to think of the lesson process, identify problems to solve the ones that need immediate attention, being flexible and acting professionally throughout the lesson. The aforementioned are some of the driving factors in my research.

4.4 DESCRIPTION OF THE RESEARCH PARTICIPANTS AND THEIR TEACHING PRACTICE 4.4.1 Mrs Mula

Mrs. Mula is a young coloured female teacher. She lives in Rundu town with her family. She is the principal of the particular school in which she is teaching. She has been teaching for more than 6 years and teaches large classes of around 40 learners per class. She offers grade 11 and 12 mathematics.

4.4.2 Mr. Patrick

Mr. Patrick is a young black male teacher. He resides in Rundu and has 4 years teaching experience. He offers grade 9-mathematics, but is qualified to teach grade 8, 9 and 10. He teaches large classes of 40 to 45 learners.

4.4.3 Mr. Tadi

Mr. Tadi is a young black male teacher. He resides in Rundu and offers mathematics to grade 8, 9, 10, 11 and 12 learners; and has 13 years teaching experience. He also has large classes of about 40 learners. Mr. Tadi is the head of the mathematics and science departments at the school in which he is teaching.

4.5 PRESENTATION OF FINDINGS

In this section I will present a summary of my research findings in table form. I will then analyse it according to the 5 arenas of reflection. I will first analyse data generated from interviews with Mrs. Mula; secondly, Mr. Patrick and finally Mr. Tadi. As a starting point to launch into the 5 arenas of reflection, Tables 3.1, 3.2, 3.3 summarise and synthesise the three teachers' transcripts separately. The tables are divided into reflecting before, during and after the lesson incorporating what they reflect on, how they reflect and why they reflect on these particular aspects.

My decision to analyse data according to the 5 arenas of reflection is supported by the literature reviewed in chapter 2. Liston et al (1996) cited Handal et al who recommends that personal experiences, received knowledge and an individual's central values are helpful analytical constructs to understand teacher reflection. In terms of personal experiences I focused on their own experiences as a learner.

4.5.1 Mrs. Mula's interview

Table 3.1, on the following page, summarises Mrs. Mula's interview transcript. The location in the transcript of a particular sentence discussed in the table is indicated with a line number enclosed in brackets at the end of each statement. The table indicates Mrs. Mula's reflective teaching practice in terms of when she reflects, what she reflects on, how she reflects on particular aspects of the lesson and why she reflects on them.

When	What	How	Why
Reflecting before the lesson	Content	- Thinks of how to bring reality into the classroom (6).	 To make mathematics fun to the learners (6). To link new knowledge to learners' existing knowledge (6).
		 Thinks how to link content to real life (6). Thinks of how to get learners to understand the basic principles of a topic e.g. algebra (16). 	To design practical examples (6).Ensure understanding before giving challenging tasks (16).
	Teaching method.	 Thinks of how to enhance understanding among all learners (6). Thinks of how to connect the known to the unknown and how to make mathematics interesting to the learners (6). 	 To find out alternative teaching methods to enhance understanding (6). She believes learners are good at what they are interested in and learning mathematics becomes easy to the learners (4). Make mathematics fun to the learners (6).
	Past experience	- Thinks of how she was taught as a learner and as a student (4).	- To make mathematics fun as it was done by her teacher/lecturer.
Reflecting during the lesson	Learners' understanding	 Circulates in class checking learners' work to detect problems as they are working (10). Checking to see if the learners understood or not. If all her learners get the class work right then understanding has prevailed (8). 	 To address these errors in the next lesson by showing the correct way of doing it (10). To find out whether the lesson objective has been achieved or not (12).
Reflecting after the lesson	Lesson objectives	- Thinking of whether the lesson objectives were achieved or not (12).	- Indicates to repeat the lesson if not completed (10).
	Learners' understanding	- If all learners work out the homework correctly then math's content work has been understood (8).	- Not to proceed with a new lesson when understanding of work covered is not reached (16).
	time management	- Ininking of management of time (14).	- To find out whether time was effectively used or not (14).
	Teaching method	- Thinks of the appropriateness of the teaching method used (10).	 To find out whether it enhanced understanding or learners got confused (10). To plan the next lesson such that alternative approaches are used to clear-up confusion (10).
	Scope of work	- Thinks of how to finish the scope of work (18).	- Plans to offer extra-classes both in the afternoons and over the weekends (18).

Table3.1Analysis of Mrs. Mula's interview transcript

Received knowledge and training

Mrs. Mula started teaching without any teaching qualification for two years. After which she enrolled for a diploma and later for a degree in education, specialising in mathematics education. She indicates that her university lecturers made mathematics fun by bringing reality to the classroom through practical examples. It is this same way of presenting mathematics that she emulates to teach her learners.

Core values/beliefs

She believes if a learner is interested in something then s/he will excel in it. On the other hand if something is boring to the learners that they are not even interested in listening, then the subject becomes very difficult for the learners. Mrs. Mula also feels that it is not easy to plan a mathematics lesson. She stressed that it takes a lot of research to find out possible ways to teach mathematics for understanding. She believes a teacher should not proceed to a new lesson when learners have not mastered the work at hand or the work under discussion. She pointed out that:

...To plan in mathematics sometimes people think it is very easy. Eh but you need to do a lot of research sometimes to bring the content...to bring the content at the easiest way... possible way to learners (Interview transcript, line 6).

According to her for learning with understanding to prevail, learners need to understand the basic principles of a topic such as algebra. For example they have to understand when to multiply and divide, before giving them more complicated or challenging tasks. She feels it is important for a teacher to reflect on their work to enable learners to connect the known to the unknown mathematical knowledge.

Experiences as a learner

Mrs. Mula reflects that she had very good mathematics teachers at school that got her interested in mathematics. Since she had an interest in mathematics, she was good in it. Thus she draws from her experiences emulating from the method her teacher used to enhance understanding. She said, "... They made you see mathematics like through the eyes. How they were to ...bringing mathematics to me I am trying to use that same method because I believe it is the best way" (Interview transcript, line 4).

Teaching practice

Mrs. Mula indicated she teaches her learners in the same manner in which her university lecturers approached mathematics, through linking classroom mathematics to real life situations. She stressed that:

...So what I am trying to do, if possible at all times, is to link the content that we are doing to link it with situation in real life and of course very important whenever I start of with my lessons to make sure that I am taking learners from what they already know to introduce the topic. (Interview transcript, line 6).

Critical reflective teaching in general

Before the lesson, Mrs. Mula thinks of how to bring reality into the classroom and link mathematics content to real life with the idea to design practical examples. According to her, it is to enable her to make mathematics fun to the learners and to link new knowledge to learners' existing knowledge. Mrs. Mula asserted that:

Ask them questions and get them interested on things that they already know and then we are moving from the known to the unknown and in that way we are bringing in examples of daily life things that they are doing. Daily life examples so that they can link the work that we are ... are doing in class; link it with everyday ...practical examples that they are dealing with in everyday life. (Interview transcript, line 6)

When planning, Mrs. Mula reflects on mathematic content and the teaching method she will employ to instruct the learners. Within this process she thinks of a method through

which understanding can be enhanced. Therefore she thinks of alternative teaching methods to enhance understanding and learners' interest in mathematics, for example connecting the known to the unknown and giving real life examples such as cars driving at high speed. In her opinion teaching in this way avoids boredom among learners, because learners are good at what they are interested in and mathematics becomes easy to learn. During the planning process she reflects on how to get learners to understand basic principles of a specific topic like algebra. It is important for learners to understand when to multiply or divide before they are given challenging tasks to work on. She stressed that:

If a learner does not even understand the basic... basic principles of algebra, you know like when do you multiply, eh when do you add with, eh, what is it? Numbers and all this even if you subtract, how do you expect them to do more complicated examples in algebra. (Interview transcript, line 16)

From my findings Mrs. Mula does not reflect during the lesson as much as she does before and after the lesson. During the lesson she reflects on learners' understanding of the topic discussed. She does this through checking learners' work while they are busy with a task. This helps her to find out what learners did not understand. Through this she is able to detect common errors and prepare to address these issues by showing learners the correct way of working out a specific mathematics problem.

After the lesson, she reflects on the lesson objectives, learners' understanding, and progress of the lesson or teaching process, the teaching method used and the scope of work. When reflecting on lesson objectives she thinks of whether the lesson objectives were achieved or not. This is done through checking learners' understanding after giving them homework. If the homework is done correctly, she feels she met her objective. If the lesson objective is not met then she opts to repeat it the next day. It also enables her to determine whether to proceed with a new topic or not. Mrs. Mula also reflects on the teaching process in terms of time. When reflecting on the teaching method, she thinks of the appropriateness of the teaching method she used during the lesson. According to her this helps to evaluate the teaching method in terms of facilitating understanding. She added that evaluation of the teaching methods used during the lesson enables her to plan

the next lesson considering alternative approaches to clear up misconceptions. Finally, she reflects on how to cover the prescribed scope of work, to enable her to plan extraclasses, which are to be offered in the afternoons or over weekends.

4.5.2 Mr. Patrick's interview

Table 3.2, on the following two pages, summarise Mr. Patrick's interview transcript. The location of a particular sentence in the transcript discussed is indicated with a line number enclosed in brackets at the end of each statement.

When	What	How	Why
Reflectingbeforethelesson.	Content	- Thinks of how he will introduce the lesson (65).	- To find ways to introduce the lesson in a stimulating manner (65).
		- Thinks of how to bring reality to class (8).	- To facilitate learning through bringing reality to class (8) &(51).
	Activities and time.	 Thinks of how interesting the activity is and whether the work is sufficient or less for the forty- minute period (65). Thinks of giving practical activities (19). Learn formulae through investigation (19). 	 To ensure sufficient work is given to the learners (65). To design tasks beginning with easy ones moving towards challenging ones (51).
	Learners' ability	- Thinks of how to accommodate learners with different ability or levels of understanding (6).	- To engage fast, average and slow learners in tasks (2).
	Role as a teacher	- Thinks of what he will do in class during the lesson and how to explain to the learners (65).	- To enhance understanding and maintain discipline.
	Conclusion of the lesson.	- Thinks of how to round off the lesson (65).	- To conclude properly (65).
	Classroom management.	 Thinks of how to address new encounters related to understanding and discipline (44). Thinks of how he dealt with disciplinary issues encountered during the lesson in the past (44). 	- To draw from previous encounters to address new issues confidently (44).
	Past experience as a learner.	- Thinks of how he was taught as a learner and how he succeeded as a result of good attitude (38).	- Emulate the method used by his former teacher to assist his learners and encourage learners to behave well (38).
	Teaching method	- Thinks of how to assist slow learners (38).	 To accommodate all learners in his teaching despite their ability (65). To design easy and challenging tasks (51). To plan better and bring all learners to the same level of understanding (6).

Reflecting during the lesson.	Learners' understanding.	 Creating an atmosphere for learners to ask questions (21,55,57). Observe if learners do not participate in class discussion it means there is a problem. Through checking the task as learners work on activities during the lesson (49). 	 To identify problems learners are experiencing (21). To improve on classroom occurrences (55). To get a direction on what he has to do next (10). For learners to find out more information on their own (25). To identify areas where learners require more explanation. To know learners in terms of their pace of learning. To monitor, guide and direct (69).
Reflecting	Learners'	- Thinks of what happened when learners do not	- To discover the problem (27).
ofter the lesson	performance	perform well in tests and examination and whether	To advice learners to be well disciplined to perform well
arter the lesson	performance.	he carries out his teaching as expected (27)	(38)
	Loomore' attituda	Asking loomars to explain why they foiled to do	Encoura za laarmara ta davalan a nasitiwa attituda tawarda
	Learners attitude	- Asking learners to explain why they failed to do	- Encourage learners to develop a positive attitude towards
	towards	homework given, when homework is not done	their work and improve in life, to be serious and do
	mathematics.	(38).	homework (38).
	Teaching method	- Thinks of whether the lesson was effective or not	- To ensure learners follow instruction correctly (51).
		(44).	- To consider alternative approaches to clarify instruction
		- Thinks of the degree of clarity provided on a	(23).
		specific topic (44).	
		- Reflects on good aspects of the lesson and how he	
		explained a specific tonic	
	Feedback	Control learners' work focusing on the result of	To motivate learners to work hard through nationce
	Гесираск	- Control realities work focusing on the result of	- To motivate rearners to work hard model patience,
		mainematics activity to find out learners freactions	showing interest in the subject and plaining better (42).
		towards mathematics in terms of whether it is easy	- To achieve good results and commit himself to his work
		or difficult subject (18).	to set a good example to the learners (42).
	Lesson flow	- Thinks of whether the planned work was	- To adopt problem-solving approaches that emerged
		completely covered during the lesson or not (59).	during the lesson (61).
		- Thinking of new problem solving strategies (61)	

Table 3.2Analysis of Mr. Patrick's interview transcript.

Received knowledge/training

According to Mr. Patrick he was trained as a learner-centred teacher at college level, in terms of how to control the class and how to involve all learners in his teaching. The training he received opened his mind where he received information about mathematics as a subject.

Core values / beliefs

Mr. Patrick believes learners benefit when parents assist them through discussion and explaining of schoolwork. In his opinion this improves understanding and it may meet teachers' halfway. He is inspired when learners understand the work covered and perform well. He is also inspired by more experienced colleagues at school. He feels that practical tasks facilitate learning.

He further believes that it is his responsibility to ensure mathematical understanding in class. With a learner- centred education system in place, he feels learners should do more. From his perspective mathematics is a gateway that opens up one's mind. For example problem solving is about finding out what and why things happen in a certain way. According to him mathematics is all we do in life. It is what a person does and it is an everyday activity.

He teaches mathematics according to basic principles as it helps to understand the world around us and to find out what other people have already tried out in life. Mr. Patrick feels a teacher has to be patient with the learners and understand them. According to Mr. Patrick he shows interest in the subject at the same time demonstrating that he enjoys teaching mathematics. He added on saying that a teacher has to give learners the impression that mathematics is not a difficult subject by encouraging practicing mathematics. He argued that it is important because mathematics is about mastering content. He is proud when he is able to solve a challenging question straight away. He believes if he is to do his work effectively, then it may be helpful to his learners.

Experiences as a learner

When he was in school, learners were sometimes labelled as slow learners, particularly those who were unable to work out a given task correctly. He understood mathematics better when he was at the college of education. At school his teacher convinced him that mathematics is not a difficult subject as long as you are committed and practice a lot. As a result he teaches in a similar way. His teacher often came up with innovative ways to solve mathematical problems.

Teaching practice

He tries to bring reality to class to facilitate learning. He plans activities for learners to find out information as a group. It is through these activities that he assesses learners' understanding during the lesson. This helps him to pick up information during the lesson in terms of learners' progress. When learners do not participate in classroom discussions he feels there is a problem.

When teaching, he begins with easy tasks moving towards challenging ones. Fast learners are given more challenging questions. This drives him to design tasks on different levels. It is through these tasks that he finds out whether or not more explanation is required. He tries to give instruction clearly because learners may not complete the given work correctly if instruction is not carried out properly.

Eh activities are either I normally start with the very simple ones. I normally give learners questions that are too simple and then try to give some challenging learners...I mean some challenging questions...So this is how I normally design them into different levels based on that specific topic...when you go through to mark ...what has been done, learners definitely you will see that there is something that should be explained very well to the learners. And there is also instruction when I give learners instruction I...I also picked up something that you may not...if instruction is not correctly followed, eh...worked ...eh work to be done is not always going to be done as expected. This is the way how I normally do it (Interview transcript, line 51)

Furthermore, to him a textbook is very important in addition to other resources such as receipts from shops when discussing money and finance.

Critical reflective teaching in general

Mr. Patrick reflects before, during and after the lesson. Before the lesson he reflects when planning considering the following aspects of teaching: mathematics content in terms of how to introduce it in a stimulating way, learners' ability in how to accommodate learners with different levels of understanding, his role in terms of what he will carry out during the lesson, classroom management to maintain discipline, his past experience as a teacher and as a learner, and how to conclude the lesson.

When planning, he reflects on how stimulating his introduction of the lesson will be to the learners. When designing an activity he considers how interesting the activity will be, and whether the planned lesson would be sufficient for the forty-minute lesson. He pointed out that:

So I also look at time, it is very important. I ask myself is this information that I am going to give my learners ...will it be sufficient? So this is some of the things that I normally look at. (Interview transcript, line 65)

This enables him to roughly estimate and prepare enough mathematical tasks to do in class. Thinking of how to accommodate learners with different abilities or levels of understanding enables him to design tasks where learners begin with easy tasks moving towards more challenging ones. He plans on how to engage both slow and fast learners as well as the average learners in mathematical tasks during the lesson and how to assist slow learners. Mr Patrick's discussion about mathematical tasks complements Johnston-Wilder's (1999) recommendation for teachers to find tasks they think:

...Will provide stimulus for pupils to think about particular mathematical concepts and procedures; their connections with other mathematical ideas and their applications to real-world contexts (Johnston-Wilder, 1999:93).

Mr. Patrick reflects on his role as a teacher whereby he thinks of what he will do in class during the lesson and also how to explain a specific topic to the learners. This directs him to consider ensuring that learners receive clear instruction. As he indicated that:

...For me I as a teacher I just monitor, guide, direct them eh and also help where I...they see that a lot is needed in terms of explanation (Interview transcript, line 69).

Within the process of planning he looks at how the lesson will be concluded. He pointed

out:

Eh there are a number of factors or issues to say that I normally look at when I am planning a lesson. First of all the lesson is divided into different parts, we talk about the introduction, content and conclusion. Well I ask myself "how do I introduce this topic so that it is stimulating to my learners?" That is number one. I also look at the activity that I give to the learners "how interesting is the activity?" or how to accommodate all learners...different levels in the class both fast and eh those ones that are in the middle group. So I also look at time, it is very important. I ask myself "is this information that I am going to give my learners... "Will it be sufficient?" so this is some of the things that I normally look at, and also maybe I also look at "how will I end my lesson?" All in all the activities that I am going to... for as learners are going to do in the class. That is what I normally look at (Interview transcript, line 65).

With regard to classroom management, he considers how to address new encounters such as questions related to mathematics and issues pertaining to discipline. As a result he thinks of alternative approaches to teaching and avoids confusion among learners. It is during this moment that he thinks of how he dealt with disciplinary issues encountered, during the lesson, in the past and how he was taught as a learner. Thus he draws from those previous encounters to address new issues confidently and assist his learners. When reflecting on the content knowledge, he thinks of how to situate real life mathematics within the classroom context with the purpose to facilitate mathematical understanding.

During the lesson Mr. Patrick creates an environment of inquiry whereby he encourages learners to ask questions in connection to mathematics. Through this he is able to identify problems the learners are experiencing in class and during examinations. Learners' understanding is observed through their level of participation in classroom discussions. This directs him on what needs to be done next after identifying the problem through tests and homework. He also detects problems through group activities and individual tasks carried out during the lesson. He gives tasks that allow learners to find out more information. This enables him to determine where more explanation is required to find more about the learners in terms of ability to work out mathematical tasks.

After the lesson he reflects on learners' performance and attitude towards mathematics. When learners do not perform well in a test or classroom activity he thinks of what has really happened. He thus plans to motivate learners to develop a positive attitude towards mathematics for the sake of good performance. In addition, he motivates learners to commit themselves to their schoolwork with emphasis on homework. He outlined:

I mean they do not take the...the subject seriously somehow. You give them homework they do not do it." (Interview transcript, line 46).

Finally, he reflects on instruction whereby he analyses whether he does his work as expected. He thinks of the effectiveness of the lesson with regard to how he explained a specific topic as to whether it was clear to the learners or not. According to him, understanding is also checked as he goes through homework given to the learners the previous day. He pointed out that:

And there is also instruction, when I give learners instruction I \dots I also picked up something that you may not...if instruction is not correctly followed, eh, work, eh, work to be done is not always going to be done as expected. (Interview transcript, line 51).

4.5.3 Mr. Tadi's interview

Table 3.3, on the following two pages, summarises Mr. Tadi's interview transcript. The location of a particular sentence in the transcript discussed is indicated with a line number enclosed in brackets at the end of each statement.

When	What	How	Why
Reflecting before the lesson	Resources.	- Thinks of resources to use that will make the lesson easier (87).	- To identify resources to use and to plan how to use them in class (87).
	Content	 Thinks of preparing more work for learners to do in class and explaining more before giving a task (25). Thinks of how to teach mathematics for understanding and asks other teachers to look at his lesson plan before he teaches the learners (91). 	 To give learners practical tasks eventually saving time (73). To discuss the utility of mathematics in real life (43). To find out if the plan will enhance understanding and whether it is inclusive in terms of different levels of understanding (slow, fast and average learners) (91).
	Learners' ability.	- Thinking of a way to identify slow learners at the beginning of the year (33).	- To give learners more work and appropriate tasks to facilitate understanding (21).
	Teaching strategies.	Thinks of the strategies he used in the past three years (58).Where the teaching strategies used in the past effective or not (58).	- To use easy methods to enhance understanding (6).
	Past teaching experience.	 Thinks of whether he produced the desired results or not (58). Thinks of how to motivate learners and solve problems in different ways (54) 	- Find the way forward after identifying the weaknesses (94).
	Classroom management.	 Thinking of designing subject and classroom rules (100). Thinking of teacher conduct whereby he thinks of setting a good example, as a role model (98), being confident and interested in mathematics (39). 	 To maintain discipline and get learners to work towards the desired symbol (100). Discipline is required for teaching/learning to prevail (98). To enhance discipline for learners to emulate good characters from the teacher (98).
	Time management.	 Thinking of how to incorporate modern technology in mathematics teaching in addition to local materials to save time. Planning examples and formulae to save time during the lesson (89). Thinks of how to use time allocated to mathematics period (87). 	 Make use of laptops and computers since they are easy to use and enhance understanding (60). To design a live activity e.g. Using cool drink cans to learn about circumference (8). Not to spend more time writing on the chalkboard (89).
Reflecting during the lesson.	Learners' understanding.	 Pose questions to slow learners to evaluate his lesson (75). Observes learners while they are working; the slow ones often finish work last (63). Highly involving all learners through class activities (69). 	 To find out whether the desired goal was achieved (12), if the weakest learner gives the correct response then his lesson went well (31). To identify slow learners and get fast learners to assist them in conjunction with the teacher (35). Bring in real life examples e.g. comparing fuel prices for different months to work out the percentage increase (50).
-------------------------------------	-----------------------------	--	--
Reflecting after the lesson.	Teaching approach.	 Thinks of whether he is doing his work the right or wrong way (94). He thinks of where he went wrong and what happened, sometimes he reflects together with the learners (102). 	 To find the way forward (94). To build on his strength by working on his weaknesses (94) and to maintain his strength (102). To come up with a plan different from the first one and plan differently (102). To repeat the lesson for clarification (79). To measure his teaching practice in terms of goals achieved (12).
	Understanding.	- Thinking in terms of giving homework and topic tests (21).	- To find out how successful the lesson was. If learners pass the test, then the lesson was successful (75).
		- Reading through the examiners' report that outlines learners' common errors in exam (81).	To guide his teaching practice.To work hard towards improving results (81).

 Table 3.3 Analysis of Mr. Tadi's interview transcript.

Received knowledge/teacher training

Mr. Tadi explained he gained knowledge on how to teach mathematics through a variety of instructional methods. Mr. Tadi also stated that, from the use of a variety of teaching methods he adopts the methods that facilitate understanding. He also gained knowledge on how to assess work based on a topic and how to assess his work as a teacher. He continuously gains knowledge through workshops organized by the University of Namibia.

Core values/beliefs

According to him he feels learners learn mathematics more effectively when they are involved in activities and when they are given more homework to learn. In his perspective,

The best way how learners can learn mathematics is for them to be involved, give them activities, more homework to learn from it, it should not be something that the teacher is just talking and them they go (Interview transcript, line 8)

Mr. Tadi believes that when teaching mathematics, the teacher should be highly involved. This is through working out examples of how to solve a specific algorithm; before giving learners a task to work out on their own. He believes if the weakest learner gives the correct answer then his lesson went well. He feels a teacher must know his/her learners well in terms of their ability in order to give them the right activity and assistance. The fast learners are instructed to assist others and also to be given more challenging work on the same topic.

Mr. Tadi feels mathematics is all about doing calculations (adding and subtracting). Mathematics is a daily life subject since it is things learners experience daily. They need to know how to solve daily life problems. For learners to explore more ways of calculating they have to be given more work. He feels that a question paper below standard may give a wrong impression about your teaching and weaken future planning.

To him poor performance serves as an indicator that points out that more effort is required. He also pointed out that a teacher might discuss his/her lesson preparation with other colleagues to improve their teaching practices; because planning of lessons should not be regarded as something secretive. He feels discipline needs to be displayed by both teachers and learners for teaching and learning to occur. Teachers should set a good example for learners to emulate. Parents should involve themselves to discipline learners at home as well. Learners need to know what is expected from them in terms of the objectives to be able to evaluate the lesson together with the teacher.

Experiences as a learner

His primary school teacher motivated him during the colonial era through competitions and incentives. He reiterated that he was motivated and understood mathematics to be an important subject. He was also motivated by community members to study hard as there were no mathematicians in the area he grew up in. In his community he recalls, for example, mathematics being used to calculate the amount of money owed to the municipality for consumption of water.

...My primary teacher is the one who motivated me. So we were to make competitions just at the primary during the colonial time. So that time we did not know that this subject its an important subject...So through that when I came to the secondary again, it applied the same so even though there I got another teacher but now from there I was made to understand. I think the other way of motivation is the area where I grew up. It was an area whereby you could not find mathematicians. So it was like the highest educated person they only ended up in grade...grade 7...so that this are some of the things that they use to tell us that maybe we will be the first people to help the calculation of water ... I can recall it was one of the problem that we were having. People were taking the meter reading converting them it was a problem. So we were told that you will help this people in the near future. (Interview transcript, line 46)

Teaching practice

Mr. Tadi makes mathematical understanding easier through accessible methods and practical tasks. He explained:

For instance you are to teach let me take a simple ...for grade 8, you are to teach the learner a topic on 'pie'. So that instead of them to using the pie they must use the number 3.14...the numbers goes on like that. So you can bring a live activity to that class whereby you bring a...a tin, you ask them to measure the circumference of that tin. So that is the other method...hmm I was suggesting that you can make it a real activity. So that when you talk that what does that 3...where the 3.14 come from the decimal number they will also figure it out, hmm (Interview transcript, line 8)

When planning he knows what is expected from him due to the kind of training he had undergone. He stressed that he teaches the way he does because it is the way through which learners understand best. When teaching, he brings in the use of mathematics in real life such as fuel prices and food prices. He also asks learners to make use of newspapers to look at petrol prices and compare different months and calculate the percentage increase. He uses a strategy of giving learners more work to identify the learning areas they are experiencing difficulties in. Mr. Tadi considers the use of materials such as cool drink cans, computers and laptops, textbook and books from the local library.

When teaching he explained that he first gets highly involved where he explains how to work out a certain task thereafter, learners are expected to work out given tasks on their own or in groups at times. He designs group work according to the task given. According to Mr. Tadi, at times he gives practical tasks such as collecting data in town for the topic on statistics and assesses the learners in groups. Evaluation of his lesson is done through posing questions to weaker learners. If a weak learner gives the correct answer then the lesson was successful. He also evaluates his lessons through homework and topic tests he gives his learners. If learners pass the test the lesson was successful. He reflects together with the learners at the end of the period whereby he asks, "where did we go wrong?" This helps to repeat a lesson for clarification. Another way he tries to improve his teaching is by analysing the examiner's report that outlines learners' common errors to guide the teacher's mathematics teaching practice. He said he often reflects in his diary and on the lesson plan. He has subject rules and classroom rules to guide his teaching and maintain discipline among learners. Learners are referred to the classroom rules when they fail to do homework or any other given task.

Critical reflective teaching in general

Mr. Tadi reflects before, during and after the lesson. When planning before the lesson, he reflects on resources to use in class, how to identify problematic learning areas and slow learners. Mr. Tadi also reflects on teaching strategies and results, discipline, teacher conduct, time management and mathematics content knowledge.

When planning he thinks of resources that may make the lesson easier. He does this to identify appropriate resources and plan to understand how to use them in class. To identify problematic learning areas, he thinks of preparing more practical tasks for learners to do in class. He attempts to save time by explaining more through providing an example on how to work out a mathematics task using a formula. He thinks of a way to identify slow learners at the beginning of the year to give more appropriate tasks to facilitate understanding. Mr. Tadi reflects on the teaching strategies he used in the past 3 years to evaluate their effectiveness in terms of good performance. According to him, the aforementioned serves to direct him towards the way forward through analysing his weaknesses. Discipline is another aspect Mr. Tadi reflects on in terms of how to ensure that good discipline prevails in the classroom. He thus designs and negotiates subject and classroom rules. Being a role model is something Mr. Tadi considers as a way through which learners could emulate acceptable behaviour. He stated that:

For teaching to materialize well discipline is part of it. There must be discipline, discipline within and discipline let me say maybe from outside also. This is where parents of the kids are needed; their involvement must be there. And then if the parent involvement is not there no matter you are a good teacher having what so ever papers there is nothing that will be going on there. The only result will be chaos, because there is no discipline. And then the discipline will not only be to the learner the teacher must set a very good example must be a role model if you talk about discipline. The conducts must be there (Interview transcript, line 98).

In addition, Mr. Tadi tries to incorporate modern information technology such as computers and laptops in his teaching to facilitate understanding, and save time. In addition he uses local materials like cool drink cans to teach circumference and diameter for understanding. When reflecting on content knowledge he thinks of how to teach mathematics with understanding. When it comes to understanding, he plans to discuss the use of mathematics in real life. Before the lesson delivery Mr. Tadi involves other teachers to assist him anticipate the possibility of understanding prevailing; among all learners, slow, fast and average learners, based on his lesson plan.

Hmm the other thing that I wanted to say on planning a lesson, the teacher should not regard yourself that you are the master. Always consult, you ask from other teachers if you are ...have other teachers teaching the same subject you ask how is my lesson preparation. Do you think my learners they will understand it? Or you think you ask your colleague the level of your preparation; does it include all the levels? Slow learners the average one and the brilliant one. So always you must consider all those when you are doing the preparation of your lesson. There should not be a secret that it is only mine no one can see it, you can share it to someone (Interview transcript, line 9).

In line with Mr. Tadi's argument, Johnston-Wilder, 1999:93 & 101 argues that "...your planning needs to be explicit and detailed...Review and evaluate your work and both seek and act on advice". Meaning teachers need to expose their lesson plan to other teachers to receive advice to shape their practice in light with effective practice.

After the lesson he reflects on his own teaching. He thinks of whether he is doing his work correctly or incorrectly. He also reflects on where he went wrong and what happened. This forces him to find a way forward, to build on his strength by working on his weaknesses. He tries to find the way forward through planning differently from the first plan and repeat a lesson for clarification if required. To assess understanding he gives homework and topic tests. This also indicates the success of the lesson. He feels if learners pass a test or task given then the lesson was successful. Johnston-Wilder (1999:103) emphasised the aforementioned idea pointing out that:

Every teacher needs to make judgements about pupil attainment in order to evaluate the effectiveness of their teaching and to inform their planning.

4.6 GENERAL DISCUSSION

Though my research is not centred on Kilpatrick's et al. (2001) five strands of proficiency per se, critical reflective teaching embraces these strands. Kilpatrick et al. (2001:116) outlined that:

A comprehensive view of successful mathematics learning...recognizing that no term captures completely all aspects of expertise, competence, knowledge, and facility in mathematics, we have chosen *mathematical proficiency* to capture what we believe is necessary for anyone to learn mathematics successfully.

The five strands of mathematical proficiency (2001:116) are:

- Conceptual understanding comprehension of mathematical concepts, operations, and relations
- Procedural fluency skill in carrying out procedure flexibly, accurately, efficiently, and appropriately
- > Strategic competence ability to formulate, represent, and solve mathematical problems
- Adaptive reasoning capacity for logical thought, reflection, explanation, and justification
- Productive disposition habitual inclination to see mathematics as sensible, useful, and worthwhile, coupled with a belief in diligence and one's own efficacy.

Therefore, the analytic table 4.6.1 below was developed not only as a checklist to identify common aspects of reflection and aspects the teachers do not reflect on; but also to determine the quality of reflection the three teachers embark upon in their teaching. I use the table to rate how critical they are in their teaching. Table 4.6.1 was developed using Kilpatrick's et al (2000) five strands of proficiency. Each strand is divided into indicators of quality teaching. I used Weiss's et al. (2003) indicators of quality to guide me in the design of this table.

		Mula	Patrick	Tadi
1.	Conceptual understanding			
	Mathematics content knowledge	*	*	*
	Activities	*	*	*
	Learners' performance		*	
	Clarification of tasks		*	*
	Clarification of concepts			*
	Learners' understanding of instruction		*	*
	Own knowledge as a teacher		*	
	Linking content to real life activities		*	*
	Connection between related concepts and			
	topics			
	Linking content to other subjects			
	Learners' prior knowledge	*	*	*
	Teaching pace	*	*	
	Scope of work			
	I I			
2.	Procedural fluency			
	Teaching method	*	*	*
	Focused thinking			
	Extended thinking	*		
	Planning	*	*	*
	Learning procedures with understanding		*	
	Introduction		*	
	Conclusion		*	
	Learners' participation		*	*
	Resources		*	*
	Objectives of the lesson	*	*	*
	Lesson delivery		*	*
	Carrying out procedures flexibly			
3	Strategic competence			
5.	Learners' ability to formulate, represent and		*	
	solve non-routine problems			
	F			
4.	Adaptive reasoning			
	Learners' capacity to think logically			
	Consideration of alternatives	*	*	*
	Learners' and teacher's ability to justify and			
	prove conclusions			
	Assessment	*	*	*
	Evaluate understanding	*	*	*
	Make instructional decisions	*		*
	Diagnose readiness before the lesson		*	*

5.	Productive disposition			
	Learners' ability to learn mathematics		*	*
	Classroom management		*	*
	Time management		*	*
	Teacher's role		*	*
	Promote active learning		*	*
	Motivate learners		*	*
	Model acceptable behaviour		*	*
	Values/beliefs	*	*	*
	Mathematics as useful and worthwhile	*	*	*
	subject			
	Stereotype threat			
	Peer pressure			
	Teacher's expectation	*	*	
	Past experience	*	*	*
	Feedback	*	*	*
	Learners' interest	*	*	
	Teacher interaction with learners			*
	Learners' interaction with learners.		*	*

Table 4.6.1 Analytic table using Kilpatrick's et al (2000) strands of teaching mathematics for proficiency

From the interviews I held with these 3 teachers, I picked up common aspects on which they reflect critically. I used table 4.6.1 to indicate common aspects these 3 teachers reflect on as well as aspects of teaching they did not indicate to reflect on.

When analysing table 4.6.1, I observed that all of them reflect when planning. During this process the three teachers focus mainly on:

- Mathematics content knowledge,
- Teaching method,
- Time management,
- Past experience,
- Learners' understanding and
- Lesson objectives.

This however does not imply they think about these aspects in exactly the same way. The aspects on which they reflect may be common but each reflect from a different perspective and reflect with a different focus, as I will discuss below.

Reflection on learners' ability to learn mathematics

Even though Mrs. Mula did not specifically point out a strategy of identifying slow learners as such, she emphasised that understanding among all learners is something she regards as vital.

When reflecting on learners' ability, Mr. Patrick thinks of how to accommodate learners with different abilities.

Mr. Tadi discussed that he thinks of how to identify slow learners at the beginning of the year.

Mathematics content knowledge

Mrs. Mula thinks of how to bring reality into the classroom whereby she plans on how to make mathematics interesting for learners through linking new knowledge to learners' existing knowledge/link content to real life situations. She takes into consideration how to cover the scope of work where she plans to teach over time whenever possible. This according to her enables her to design practical examples to facilitate understanding.

Mr. Patrick considers how to introduce and conclude mathematics content to the learners in a stimulating manner and also how to bring reality to class. This is done with the purpose to facilitate learning through connecting classroom mathematics to reality outside the classroom. Mr. Tadi focuses on difficult learning areas and plans to prepare more work for learners to do in class to save time; he explains more before giving a task. Practical tasks are also given to save time as they facilitate understanding.

Teaching strategy

Mrs. Mula searches for alternative teaching strategies that may enhance understanding among all learners and at the same time looking at how to make mathematics interesting to the learners. In her understanding, the aforementioned facilitates understanding because she feels learners are good at what they are interested in and it becomes easier for them to learn. She also draws from past experiences in how mathematics was taught interestingly to her as a learner and as a student. After the lesson she thinks of the approach used whether it enhanced understanding or confused the learners. It helps her to plan future lessons to clear up any confusion. She looks at how to get learners to understand the basic principles of a topic, for example algebra, to ensure understanding before giving challenging tasks.

Mr. Patrick directs his thinking on assisting slow learners with the intention to accommodate every learner despite their ability. Designing easy and challenging tasks helps to uplift learners' understanding to the same level. It also enables him to plan tasks such that learners move from easy to challenging tasks at the same time thinking of the approach on how to introduce the lesson and conclude it. He also reflects on how he was taught as a learner and emulates the method of assisting slow learners. He also reflects on the effectiveness of the lesson and the degree of clarity he provided to the learners on a specific topic. He focuses not only on bad aspects but also on good aspects of the lesson as well as considering alternative approaches to mathematics teaching.

Mr. Tadi reflects on teaching approaches he employed the past three years of his teaching, whether these approaches were effective in terms of enhancing understanding. He draws from his past teaching experience in terms of results, whether he produced the desired results or not and how he was motivated as a learner and how to solve

disciplinary issues. This enables him to find a way forward after identifying his weaknesses and give more work. He also reflects on the way he does his work, whether he does it correctly and thinks of where he went wrong and what happened. He thinks of how to teach mathematics for understanding and involves other teachers to evaluate his lesson with the intention to receive feedback. The feedback is for him to find out if the approach will enhance understanding or not and if it includes all levels of understanding in terms of fast, slow and average learners.

Time management

Mrs. Mula reflects on time use after the lesson whereby she tries to find out whether she used time effectively or not. She considers using more of her spare time to ensure understanding and the completion of the scope of work.

Mr. Patrick prepares enough work for the lesson period and ensures that it is not insufficient for the duration of the lesson.

Mr. Tadi thinks of how to incorporate modern technology in his teaching process to save time as they facilitate understanding. He also reflects on how to effectively use the time allocated to the period not to spend more time writing on the chalkboard. He prepares enough examples and provides formulae to save time during the lesson. My view is that Mr. Tadi seems to be more concerned with saving time than teaching formulae for understanding as Mr. Patrick pointed out in the interview.

Activity design

Mrs. Mula designs practical examples and prepares challenging tasks to engage learners in once learners have understood the basic principles of a topic.

When designing activities, Mr. Patrick focuses on how interesting the activity is, whether the work is sufficient or not. When designing tasks he begins with easy ones moving towards challenging ones. He also prepares practical activities and investigative tasks creating the opportunity to derive and learn formulae with understanding. Reflection on the success of the activity carried out in class is done at the end of each lesson. He gives feedback based on homework given the previous day.

Mr. Tadi designs live activities to enhance understanding such as the use of cool drink cans to teach circumference.

Classroom management and discipline

During the interview Mrs. Mula did not explicitly discuss issues pertaining to classroom management and discipline.

Mr.Patrick, however, stressed he thinks of how to address new encounters regarding understanding and discipline. He reflects on his experience as a teacher in terms of his conduct, how he addressed disciplinary issues in class and the lack of stationeries. He reflects that his academic success was also a result of his good conduct in school and encourages learners to behave well. According to him he is exemplary, patient and shows interest in the subject for learners not to view the subject as difficult. Through this learners get motivated and interested to value the subject and achieve good results. He asks learners to explain why failing to do homework given and encourages learners to develop a positive attitude. This may keep all learners on task preventing a chaotic classroom situation. Before the lesson he thinks of what he will do in class and how to explain mathematical concepts to enhance understanding and maintain discipline. He has classroom and subject rules that learners should adhere to.

With regard to classroom management, Mr Tadi thinks of designing subject and classroom rules to maintain discipline and get learners to work towards the desired symbol. According to him discipline is necessary for teaching/learning to materialize. He asserted that a teacher should set a good example by displaying confidence and interest in

mathematics. This, in his opinion, gets learners to emulate good characters from the teacher.

Learners' understanding

Mrs. Mula circulates in class checking learners' works to detect problems learners are experiencing and whether they understood the work discussed or not. If all learners work out the task or homework correctly, she assumes understanding prevailed in class. Detecting errors enables her to address learners' problems in the next lesson by modelling the appropriate procedure to work out the task given. Checking for understanding enables her to decide not just to proceed with a new lesson.

Mr. Patrick identifies problems through discussing exam questions and creates an atmosphere of inquiry whereby he encourages learners to ask questions to improve. He also reflects on performance in exams or tests, to find out why learners did not perform well. This enables him to advice learners effectively. He observes during the lesson, if learners do not participate in class discussion it means there is a problem to get a direction as what to be done next. During the lesson he circulates to detect problems learners are experiencing based on the activity given. This enables Mr. Patrick to find out where more explanation is required and know different learners' pace of learning for him to guide and direct the learners.

Mr. Tadi poses questions to slow learners to evaluate his lesson. He circulates and observes to identify slow learners, as they will often complete the work last. He highly involves all learners in class activities to ensure understanding. He also enquires whether the desired goal was achieved. Mr. Tadi identifies and instructs fast learners to assist slow learners and brings in real life examples. He thinks and plans to give homework and topic tests to find out how successful the lessons were. If learners pass the test then the lesson was successful. In addition, he reads examiners report that outlines learners' common errors in exam.

Lesson objective

Mrs. Mula makes use of class activities to find out whether the lesson objectives were achieved or not. If the lesson is not completely taught, she assumes that the lesson objective has not been achieved. She thus indicates on her lesson plan to repeat the lesson the next day (see appendix J). Furthermore she checks for understanding through homework.

Mr. Patrick reflects on the flow of the lesson whether the lesson was completed or not and on new problem solving strategies to adopt.

Mr. Tadi thinks of his teaching sometimes together with the learners to measure his teaching in terms of goals achieved to plan differently or repeat the lesson for clarification.

Generally, the emerged theme is that critical reflective teaching is important to enable them as teachers to evaluate their practice to plan better and consider alternative teaching approaches to teaching.

4.7 INDIVIDUAL PARTICIPANTS' IDEA ON WHAT CRITICAL REFLECTIVE TEACHING IS

Mrs. Mula outlined that:

...According to me critical reflective teaching is you as a teacher you should be able to reflect back on your teach...on your own teaching and see whether things were going ok" (Interview transcript, line 14).

From her view, critical reflective teaching has to do with reflecting on the extent learners mastered the knowledge intended for a particular lesson; whether learners understand the basics of a specific topic before they could work on more challenging tasks.

Mr. Patrick pointed out that:

"...Critical reflection- teaching in mathematics in my opinion I would say it is looking back at the setback as a teacher what problems you are encountering when presenting lessons and also how do you plan your lessons in such a way that it has to be meaningful at the end of the day...This involves asking questions like, did I contextualise my topic? Contextualises in the sense that reality is brought to class" (Pilot interview transcript, line 22).

According to Mr. Patrick critical reflective teaching has to do with how he teaches, whether he does it correctly or incorrectly. This is in terms of finding out learners' understanding of work covered during a lesson. Furthermore, it has to do with situating mathematics within the classroom and real life context.

Mr. Tadi discussed that:

I think this one it has got to do with what to... knowing what we are doing. Are we doing it the right way or the wrong way? And it is to identify after let me say you have known whether we did it the right way or the wrong way. Is to make sure what is the way forward looking at the weakness and the strength that did exist (Interview transcript, line 94).

Mr. Tadi views critical reflective teaching as a process through which a teacher identifies his strengths and weaknesses. This has to do with whether he does his work appropriately or not. In his view, that directs a teacher towards addressing misconceptions to build on his strength. Evidence of reflection is provided on their lesson plans (appendices F, I and J). From the evidence provided on their lesson plans, their thoughts are recorded through noting down their experiences, in form of a description, outlining what happened during the lesson. Their reflective notes mainly indicate issues requiring particular attention. For instance, he outlined that:

The only note... that I normally write on the lesson preparation is either the topic has been completed or not. If the topic...for that specific day... That is what I normally do (Interview transcript, line 59).

With regard to reflective notes, Mrs. Mula and Mr. Patrick record their thoughts on the lesson plan too (see appendix J and K).

4.8 ASPECTS OF REFLECTION THAT THE THREE TEACHERS DID NOT INDICATE TO REFLECT ON

From the table 4.6.1 I extracted the aspects not marked with stars. The blank entries on table 4.6.1 show that none of the three teachers indicated reflecting on the particular aspects. These aspects are:

- Connection between related mathematical concepts and topics,
- Linking content to other subjects,
- Developing learners' capacity to think logically,
- Stereotype threat,
- Peer pressure

In order to analyse critical reflective teaching of the three teachers, I had to consider what good practice entails in broad terms. In-depth reflection is my understanding of the word 'critical'. Thus the extraction of the aspects I outlined above simply shows that the three teachers reflect critically except on the few aspects noted above. Liston (1996) pointed out that reflective teachers are fallible. Therefore the fact of not reflecting on the above mentioned aspects demonstrate that professional growth is a never-ending process.

4.9 DOCUMENT ANALYSIS

From document analysis, I found that in an effort to enhance critical reflection in general, the Ministry of Education drafted a document on National Standards and Performance indicators for schools in Namibia. From the performance indicators a 'Teacher Self-Evaluation Instrument' is developed. The Teacher Self-Evaluation Instrument (2005) requires teachers to evaluate their teaching in line with the aspects below:

- Lesson planning and lesson preparation
- Classroom as a conducive environment
- Setting academic targets
- Lesson delivery

- Teaching strategies used during ... lesson presentations
- Learner engagement while teaching
- Learning materials
- Learners' work in class during [a] lesson
- Assessment and evaluation during lessons
- Subject file and personal file
- [Indication of] external support received (Namibia. Ministry of Education, 2005:1-3).

It is stipulated "An honest self-evaluation will allow the individual teacher to measure himself/herself against the ideal standards set in the National Standards and Performance indicators from Namibian schools. Weaknesses can then be improved on and strengths can be sustained" (Namibia. Ministry of Education, 2005:1). I therefore stress that a similar self-evaluation instrument is necessary for mathematics teachers.

In another document, Education and Training Sector Improvement programme (ETSIP) (2006) it is presented that:

Improvements in teacher qualifications have not yet translated into effective teacher quality and effective teaching...even those who are formally qualified still lack competencies critical to improved student learning, including English... mathematics and science. Many teachers have problems in interpreting and implementing the curriculum (Namibia. Education and Training Sector Improvement programme [ETSIP], 2006:20)

In addition to the challenges outlined by the Education and Training Sector Improvement programme ETSIP (2006); the Kavango Regional Education Conference (2008) reports that:

There is a lack of professional development in many educators, so as to keep abreast with new developments and changes in the field. There is no culture of reading among many in the region. There is a lack of innovative competency in teachers and educators. There is a lack of quality leadership in educators and thus hampering performance. There is a problem of attitude among some educators...the continuous professional development should be geared towards uplifting our professional traits such as personal, social, academic, innovative and evaluative competencies. (Namibia. Ministry of Education, 2008: 6 & 7).

In reviewing the literature I quoted Elliot as cited in Altrichter (1993), from whose perspective I argue, that it is important for subject advisors and other stakeholders in education to initiate effective school-based staff development programmes.

Despite the aforementioned, Liston et al. (1996:73) emphasised that "a reflective teacher is one who is committed to his or her own professional development". Therefore, in my opinion, instead of only depending on workshops and other staff-development programmes, teachers need to take the initiative to develop their own proficiency in teaching mathematics as discussed in the literature review.

4.10 CONCLUSION

In this chapter I analysed the data generated through interviews held with the three teachers who were part of my case study. The participants are mathematics teachers teaching at secondary school level. The sample comprised of one female teacher and two male teachers and their ages are in the mid thirties to early forties. The three schools are all situated in Rundu, in northern Namibia, the town in which I reside. These schools are readily accessible to me. During the interview process I focused on teachers' received knowledge and training, core values/beliefs, experiences as learners, teaching practice and their general view on what critical reflection is in general. The findings were first summarised on a table showing how they reflect before, during and after the lesson. Further analysis was done according to the 5 arenas of reflection. Another table was used to ascertain common aspects of reflection using Kilpatrick's et al. (2001) 5 strands of teaching mathematics proficiently with Weiss's et al. (2003) key indicators of quality teaching. I then outlined how all three teachers reflect on the common aspects identified. Since critical reflective teaching enables effective teaching, it has to comprise of all components of effective teaching. However, as displayed on table 4.6.1 the three teachers do not reflect on all components of reflective teaching as such, where I then extracted the aspects of reflection they do not reflect on and listed them.

In the next chapter I will conclude by summarising the entire research process, discussing the potential value of my research, presenting an overview of my findings, limitations and making recommendations thereof.

CHAPTER 5 CONCLUSION

5.1 INTRODUCTION

This chapter serves to conclude my study. Firstly, I will discuss the purpose of the study. Secondly, I will provide a brief outline of the research process where I discuss the aims of my study and the methodology that informed this study. Thirdly, I will present an overview of the research findings. Fourthly, the potential value of my research will be discussed. Fifthly, limitations will be pointed out and finally I will present my recommendations and suggestions for further research.

5.2 PURPOSE OF THE STUDY

The purpose of my research was to investigate critical reflective teaching practice in three mathematics teachers. With the adoption of the Namibian Education reform policy, transformation in teaching practices is imperative. Successful implementation of the policy rests upon informed and innovative teaching. The Kavango Regional Conference document (2008) outlines that despite undergoing a reform process in education, not much has been achieved in terms of teaching mathematics proficiently. With this lack of effective teaching, critical reflective practice may possibly be the key to the development of proficiency in mathematics teaching. In addition, since knowledge is not static rather dynamic, critical reflective practice is vital not only for the realization of the Namibian Education reform ideals but also for teachers to be aware of the latest development in mathematics instructional approaches. Literature points out that the realization of any reform depends on the professional development adopted to attain the reform ideals.

Literature further emphasizes that teachers' disposition; in terms of being whole-hearted, responsible and open-minded, underpins critical reflective practice. Attitudes such as whole-heartedness, responsibility and open-mindedness may trigger teachers to reflect on

their experiences, own mathematical knowledge and own values/beliefs towards mathematics teaching and learning.

5.3 A BRIEF OUTLINE OF THE RESEARCH PROCESS

Since my research is in line with the Namibian education reform ideals, I sought to compare literature on critical reflective practice and its implementation in practical situations. It is for this reason I embarked upon a qualitative case study, oriented by the interpretive paradigm, to examine reflective practice. The interpretive paradigm informed and guided my research in the collection and analysis of data in a more credible and effective way.

I selected three urban schools located near my workplace and home. I drew one participant from each school. The participants were mathematics teachers; one teaching grades 8 to grade 10 and the other two teaching graded 8 to 12. The sampling was purposive whereby I selected experienced secondary school mathematics teachers whose teaching is exemplary. Since I had already worked closely with these teachers in workshops I quickly established a good rapport with them. Before conducting interviews, each teacher signed a consent form confirming their voluntary participation and awareness of the purpose of the interview. However, in addition to the informed consent, I had to ensure their trust through a verbal assurance for anonymity and that my study was not going to evaluate and rate them.

Interviews were semi-structured to probe the teachers' ideas on how they reflect and use critical reflective practice in their classroom situation. Documents were analysed to look into ideas pertaining to professional development through critical reflective practice.

The design of my research was guided by the literature I reviewed. The literature outlines that critical reflection requires teachers to analyse their teaching considering arenas of reflection. Therefore, Interview questions were designed in light with the five arenas of reflection. Namely:

- Educational background and teacher training,
- Experiences as a learner,
- Core values/beliefs,
- Teaching practice
- Critical reflective teaching in general.

I designed two different analytical tools in line with Kilpatrick's et al (2001) strands of teaching mathematics proficiently. The analytical tools were designed to analyse my findings in two different ways. Firstly, individual teacher's interview transcript was summarised in a table form where data was classified into four categories 'when, what, how and why' they reflect. Secondly, I analysed data from the three teachers on one table where I compared common aspects of reflection and aspects they do not reflect on. Thirdly I presented a discussion based on the findings as well as data from the National and regional documents I analysed.

5.4 OVERVIEW OF THE FINDINGS

5.4.1 Kind of reflection the three teachers pursue.

The result of this study reveals that participants demonstrated a level of reflection in a broad sense. The interviews show that the three teachers engage in what Hall in Van Harmelen (2006) referred to as 'deliberate and systematic reflection'. The participants indicated to reflect before the lesson (when planning), during the lesson (when teaching) and after the lesson (when teaching is over).

5.4.2 Extent of reflection

During the process of reflection, the three teachers think of the mathematical knowledge they received through training, their educational experiences, core values/beliefs and their teaching practice. In the interviews they discussed the importance of critical reflection in general. According to them critical reflective teaching transforms classroom practice.

They defined critical reflection as being conscious of learners' progress to evaluate their own teaching practice as teachers. It is also a process of being conscious of what they teach, how they teach and whether they teach as expected. They pointed out that critical reflection enables teachers to find alternative approaches to teaching, which may enhance the learning of mathematics with understanding. They pointed out that critical reflection also helps to anticipate problems instruction may pose to the learners. Furthermore, they emphasised that critical reflection enables them to decide whether to proceed with a new lesson or not.

Evidence of reflection in the three teachers is demonstrated on their lesson plans. In the analysis chapter, the extracts from the interviews provide evidence of how the three teachers reflect on their teaching and their views on critical reflective teaching. The theme that emerged is that critical reflection directs planning in terms of future actions to execute.

Details on aspects the three teachers reflect on and the purpose of reflecting before, during and after the lesson are provided below.

Before the lesson the three teachers reflect on:

- **Content knowledge** thinking of how to link classroom mathematics to real life mathematics.
- **Teaching method** that may facilitate understanding through connecting prior knowledge to new knowledge.
- **Past experience** to emulate good practice from their previous teachers/lecturers.
- Activities learners may find interesting and practical. Also for learners to work extensively beginning with easy tasks towards challenging ones.
- Time so that adequate work is prepared.
- Learners' ability in terms of finding ways to identify slow learners with the intention to accommodate slow, average and fast learners in their lessons.

- **Role as a teacher** with regard to how to explain mathematical tasks and content knowledge.
- **Conclusion** to find ways to conclude the lesson.
- Management to find ways to address new encounters related to teaching and discipline.
- **Resources** that may enhance learning with understanding in an easy manner.

During the lesson they reflect on:

• **Understanding** to observe progress and detect misconceptions. During the lesson, understanding is also checked through posing questions to slow learners.

After the lesson they reflect on:

- **Objectives** to find out the extent to which the purpose of the lesson has been achieved.
- Understanding of mathematical concepts discussed during the lesson.
- **Delivery** of the lesson with focus on the teaching pace and the clarity of instruction given by the teacher.
- **Time management**, evaluating the use of time during the lesson.
- Teaching method to find out if it facilitated understanding or not.
- Scope in terms of organising extra-classes to cover the large scope of work.
- **Performance in tests/examination** to gain insight on the extent to which learning with understanding has occurred. This helps to identify problems learners encountered in particular lessons.
- Providing feedback to address misconceptions for learners to rectify their mistakes.

While the study revealed an impressive range of elements of their teaching practice that these teachers reflected on, it also **uncovered some areas where these teachers did not reflect on**. These aspects were:

- Connection between related mathematical concepts and topics,
- Linking content to other subjects,
- Developing learners' capacity to think logically,
- Stereotype threat,
- Peer pressure

In order to analyse critical reflective teaching of the three teachers, I had to consider what good practice entails in broad terms. I understand the word 'critical' as in-depth reflection. Thus the extraction of the aspects I outlined above simply shows that the three teachers reflect critically except on the few aspects noted above. Liston (1996) pointed out that reflective teachers are fallible. Therefore the fact of not reflecting on the above mentioned aspects demonstrate that professional growth is an unending process.

While the literature appears overwhelmingly to show that critical reflection by teachers on their practice improves their performance as teachers, this study did not specifically conduct an independent test of improved performance by these teachers. All the subjects spoke about areas where they improved and backed these with examples, and these claims of improvement by these teachers seem very credible. Yet it needs be noted that this study did not conduct an independent test of these claims, which was beyond the brief of this study. Recommendations for further research to examine how these or other teachers follow up and take action on their reflection are suggested below.

5.5 POTENTIAL VALUE OF THE STUDY

Theory on critical 'reflection' shows that it is important that teachers think and reflect before, during and after the lesson. Through reflection, teachers become conscious of what experience has taught them. In addition, through consciousness of experience, teachers' thoughts and actions may inspire effective mathematics teaching strategies. Theorists also emphasise that reflective practice liberates teachers from impulsive and routine activity; eventually raising awareness for teachers in terms of their roles in their classrooms and their role in realising the reform ideals.

Since teaching has a direct impact on learner achievement, I think the need for critical reflective practice is inevitable if we are to teach mathematics proficiently. Teachers need to revisit their actions and their attitudes towards learners and mathematics as a subject. I think the success of the reform ideals rests on critical reflective practitioners. It is only when teachers re-examine their classroom practice from their own perspectives and from the perspective of others that innovative teaching and professional growth may develop.

Until teachers analyse their teaching in line with the reform ideals, transformation in education will remain ineffective. This may impede the success of the implementation of the Namibian education reform. Central to this is teachers' beliefs towards the nature of mathematics as a subject and their beliefs pertaining to instructional approaches in mathematics.

Overall the value of the study does not lie solely in this simplified, though impressive, list of topics that these teachers reflected on but also in the rich texts of the descriptions they have shared with us and the array of insights, nuances and interplay of action and reflection contained within the confines and opportunistic spaces that classrooms offer in their real world of these busy and committed teachers of mathematics. For their willingness to share so fully and lucidly their thinking and experiences, and to share so fully with us their inner thoughts and reflections about life in their mathematics classes, I am most grateful.

Finally, the potential value of my study cannot be overemphasised. I perceive critical reflective practice as fundamental to professional development. Once operating as a critical reflective practitioner, exploration of different aspects central to mathematics teaching is critical, but cannot be achieved overnight.

5.6 LIMITATIONS

Due to time constraints, I was unable to carry out classroom observations to experience first hand information on the three teachers' act of reflecting critically in the classroom. Since my study involved only three teachers, these findings cannot be generalised. If I were to conduct this study once more, I would carry out an intervention study through action research; where I could observe lessons to follow up on how teachers reflect on their lessons.

5.7 RECOMMENDATIONS

Though no generalisations can be made from this study, it casts light on and paves the way for larger-scale research. It may serve as a starting place for further research with the purpose to improve classroom practice. One of the suggestions made during the Kavango Regional Education Conference is that professional development should cultivate in teachers professional traits such as personal, social, academic, innovative and evaluative competencies. Thus, I recommend that administrators, curriculum planners and policy makers embrace the notion of critical reflective practice and develop inservice programmes for teachers in this area. I think it is inadequate to only outline in printed handouts or brief presentations the importance of critical reflective practices; rather it is necessary to assist teachers to develop as reflective practicinoers too. Additionally, my suggestion is that a 'Teacher-Self Evaluation Instrument', could be developed particularly to guide mathematics teachers on key aspects to focus on during reflective competence and through it their own mathematics teaching proficiency in conjunction with other developmental programmes in education.

This study serves to enlighten teachers on the understanding of what critical reflective teaching entails within the mathematics classroom, but the principles most probably apply to other subject disciplines as well. Therefore pre-service, in-service teachers, teacher educators, policy makers, as well as other administrators in education may find this study helpful in terms of professional development. Though being a researcher, in this study, my role was more of a student eager to broaden my understanding of critical reflective practice. Personally I found this study a wonderful eye opener. I learnt both from the literature I reviewed and from the teachers I worked with.

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APPENDIX A

P O Box 228 Rundu 21 January 2008

The Principal Rundu

Dear Sir/Madam

I am registered as a part time student at Rhodes University Grahamstown (student number 0lL0012). I have been studying for a Master's degree in mathematics education since February 2007. I would be most grateful if you would allow me to involve one of your mathematics teachers I have selected as part of my research sample.

The aim of my research is to collect data pertaining to critical reflective teaching by teachers in mathematics education. This is expected to emerge from interviews and document analysis I intend to carry out. I will ask the concerned teacher for permission to audiotape record these interviews and your school will remain anonymous. The concerned teacher will also be assured of anonymity in the final report. At the same time the teacher will be exposed to the final draft to ensure that the data collected is not misinterpreted.

Yours truly Luwango L.Z. (Mrs) (066-255993)

APPENDIX B

P O Box 228 Rundu 21 January 2008

The Principal Rundu

Dear Sir/Madam

I am registered as a part time student at Rhodes University Grahamstown (student number 0lL0012). I have been studying for a Master's degree in mathematics education since February 2007. I hereby request your voluntary participation in my research. Your withdrawal from the research is possible at any stage of the research.

The aim of my research is to collect data pertaining to critical reflective teaching by teachers in mathematics education. This is expected to emerge from interviews and document analysis I intend to carry out. I therefore ask for your permission to audiotape records these interviews and your identity will remain anonymous. I will expose the final draft to you to read and ensure that collected information is not misinterpreted.

Yours truly Luwango L.Z. (Mrs) (066-255993)
APPENDIX C

CONSENT FORM

Luwango Luiya is hereby given permission to involve one of my Mathematics teachers in her research for the completion of her Master's Degree. I understand that the data for analysis will be collected from interviews and document analysis, and that information obtained may be used in the final report. I have been assured that my in her research for the completion of her Master's Degree. I understand that the data for analysis will be collected from interviews and document analysis, and that information obtained may be used in the final report. I have been assured that my

APPENDIX D

CONSENT FORM

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APPENDIX E

CONSENT FORM

Luwango Luiya is hereby given permission to involve one of my Mathematics teachers in her research for the completion of her Master's Degree. I understand that the data for analysis will be collected from interviews and document analysis, and that information obtained may be used in the final report. I have been assured that my

APPENDIX F

Mrs Mula

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CONSENT FORM

I hereby agree to assist Luwango Luya in her research. I understand that she will interview me and analyze some necessary documents; and tape record the interview for later transcription and use in the research report.

1.1 TEACHER'S STENATURE

26-02-08

APPENDIX G

Mr Patrick

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CONSENT FORM

I hereby agree to assist **Luwango Luya** in her research. I understand that she will interview me and analyze some necessary documents; and tape record the interview for later transcription and use in the research report.

THEATMAN 5/06/2008 [.ay 8 TEACHED'S CWINIATIDE

APPENDIX H

<u>Mr Tadi</u>

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CONSENT FORM

I hereby agree to assist Luwango Luya in her research. I understand that she will interview me and analyze some necessary documents; and tape record the interview for later transcription and use in the research report.

10 TEACHER'S SECNATURE 26/06/08

APPENDIX I

INTERVIEW QUESTIONS

Received knowledge/training

- What aspects of you teacher training made you a good teacher?
 How have your experiences in your teacher training assisted you in planning your
- lessons?
- 3. Do you reflect on your own knowledge?4. Do you attend mathematics content workshops?

Core values/beliefs

- 1. What inspires your work as a mathematics teacher?
- 2. What is your view how learners best learn mathematics?
- 3. How do you ensure mathematical understanding among all learners?
- 4. Do you think of why you teach the way you teach? Why?
- 5. What makes you critically think of your teaching?
- 6. What is your perception what mathematics education is?
- 7. How do you reflect on the mathematical knowledge to be taught and the purpose of teaching it?

Experiences as a learner

- 1. Reflect back when you were a learner at school, what childhood experiences impacted on your teaching now?
- 2. Do you reflect on how mathematics is used in the community in which you live? How do you use this in your teaching?
- 3. Who were your role models in your mathematics teaching? Why?
- 4. What aspects of their teaching affect you today?
- 5. How do you use your past teaching experience to guide your teaching now?

Teacher practice

- 1. What are your strategies to identify learners' difficulties in learning mathematics? (Elaborate).
- 2. What kind of resources do you use to teach mathematics?
- 3. What different teaching strategies do you employ in your classroom?
- 4. How do you evaluate your lessons to find out whether the objectives have been met or not?
- 5. How do you involve learners in your lesson evaluation?
- 6. How do you use exam results to evaluate your teaching?
- 7. Do you write down your thoughts and actions?

Critical reflection in general

- 1. What do you think critical reflective teaching in mathematics education is?
- 2. What is the importance of reflecting critically?
- 3. Despite reflecting on the learning that occurs within your classroom, what other lesson aspects do you reflect on that enable or obstruct learning?
- 4. How do you use critical reflection (thinking critically about your lesson) in your teaching?
- 5. What else do you do to improve your mathematics teaching practice?

APPENDIX J

<u>Mrs Mula</u>		Formatted: Font: 14 pt
·		Formatted: Font: 14 pt
<u>Gr.10</u> 19-02-08 (continue 20-02-08)		
Ratio & Proportion		
Objective: Learners should be able to understand and different ate "between direct and inverse propertion as well as solve problems on DP and IP.		
Leoson: Direct Proportion vs Inverse Proportion 1 opple > 2,00 5 girls → 20 min	109	
$S appleo \rightarrow 10,00$ $4 \rightarrow 25 \text{ min}$		
decreace increase l'increase		

Homework:

Homework: Direct/Inverse Proportion

- 1 I can buy 10 bags of coal for N\$800,00. How much will I pay for 16 bags of coat A na ecopiane travelling at an average speed of 250 km/h takes 4 hours to complete a journey. How long would it take to complete the same journey if it takes (400 km/h?)
 J if 6 kg of beef cost NS63,00, what will be the cost of

 (a) 9 kg.
 (b) 4 kg?

- (a) 9 kg. (b) 4 kg?
 4 Mogau takes 36 minutes to read 15 pages of a book. If the book has 95 pages, how long will he take to read the book? (He always reads at the same rate.)
 5 At a speed of 5 km/h, Nsala takes 40 minutes to walk to school. How long would Nsala take to go to school at speeds of

 (a) 4 km/h, (b) 8 km/h?
 6 men take 10 days to dig a ditch. How long would the job take
 (a) 12 men, (c) 4 men?
- 2

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APPENDIX K

APPENDIX K

Mr Patrick

Formatted: Font: 14 pt (Juss: 94 -Grade: 8 Subject! Maths Topic! Transformation Date : 20.00 Bhsic competencies Draw and describe role of plane figure around on Vie-trois or midpoind of the 111

ald: Charleboard, Plane papers, Chart, R.

NB. Notes !! The following topics was not well understood by many learners, Circle, Transformation, pythagonas theorem. learners perfem peop peorly in the as class actusties given. fest as wed Much time was spend, lots of exercise given but the result shows no Improvement, for bansformation learners are not ask to fee the difference between Reflection and Rotation Illustrate and demonstrate Practicas dave to N

APPENDIX L

Mr. Tadi		Formatted: Font: 14 pt
MATHEMATICS & SCIENCE LESSON PLAN	200_2	Formatted: Font: 14 pt
SUBJECT:Mathematics	DATE: 03/03/05 - 2	
TOPIC : Estimation	GRADE: j]	
SYLLABUS REFERENCE: _/(h)	1 Rounding	
		113

(b) might of an insect. (b) weight of a ball soccer ball
(c) weight of a bicylie man provide Example
* Give approximations to specified number of
(a) Rounding a given number to a given decimal place.
$\frac{e_{2}e_{3}mple(1)}{(1)} \xrightarrow{0,393} \xrightarrow{-10} 2, \frac{2}{39} \xrightarrow{-0,31} \xrightarrow$
(h) Rounding off to a specified significant figures
$\frac{1}{(1)} \begin{array}{c} 028, 59 \\ (1) \end{array} \begin{array}{c} 028, 59 \\ (1) \end{array} \begin{array}{c} 16 \\ 15 \\ 25 \\ 16 \\ 16 \\ 16 \\ 16 \\ 16 \\ 16 \\ 16 \\ 1$
$\begin{array}{c ccccccccccccccccccccccccccccccccccc$
Example (1) $028, 59$ to $25f = 29.0$ (ii) $028, 59$ to $25f = 28.6$ (iii) $028, 59$ to $35f = 28.6$ (i) 44734 to $35f = 44700$ (iv) $478, 89$ to $35f = 709$ (v) $708, 89$ to $35f = 709$ (v) 7218 casionable dictinately in the confesed of

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