A critical exploration of Grade 10 rural learners' experiences and attitudes towards learning mathematics in Acornhoek classrooms, Mpumalanga Province

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As the candidate's supervisor, I have approved this dissertation for submission.

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Date

DECLARATION

I declare that **A critical exploration of Grade 10 rural learners' experiences and attitudes towards learning mathematics in Acornhoek classrooms, Mpumalanga Province** represents original work by the author and has not been submitted in any form to another university. Where use has been made of the work of others, this has been duly acknowledged in the text and a complete, alphabetised reference list has been provided. I fully understand that the University of the Witwatersrand will take disciplinary action against me if evidence suggests that this is not my own unaided work or that I failed to acknowledge the sources of the ideas or words in my writing.

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Date

ABSTRACT

The purpose of this study was to critically explore Grade 10 rural learners' experiences and attitudes towards learning mathematics in Acornhoek classrooms, Mpumalanga province. The study further sought to understand factors that shape learners' experiences and attitudes towards learning mathematics. While the widely accepted view of the study of individuals' attitudes fall in the quantitative research approaches, this study used critical phenomenological qualitative methodology. I should make it clear that I have deliberately used qualitative approaches to critically explore and interrogate learners' experiences and attitudes towards mathematics and mathematics learning, because interviews and observations of behaviours are some of the methods that can be used to gain insight into individuals' experiences and attitudes. Semi-structured one-to-one individual interviews and non-participant classroom observations of twelve learners during learning were used in this study. In addition, this study uses Fairclough's analytical framework of Critical Discourse Analysis and Bronfenbrenner's Bioecological systems theory as the theoretical framework to give meaning to the information provided by the learners about their learning of mathematics.

To date, the dearth of mathematics education research in rural areas and schools has not been able to offer an account of learners' experiences and attitudes towards mathematics and mathematics learning within rural schools. Thus, this study is the beginning for other researchers to start researching rural learners' learning in general, specifically the learning of mathematics in ways that pay respect to the dynamic relationships of various factors that shape the experiences and attitudes of learners towards learning mathematics. The findings emerging from the study illustrate that even when learners are taught in the same way in the classroom by the same teacher, their experiences and attitudes towards mathematics and its learning are inevitably different, which resonates with the research ontology for the study, which is constructionism.

Keywords: experiences, attitudes, learners, learning, rural, mathematics, learning mathematics

ABBREVIATIONS

ANA – Annual National Assessment

CDA – Critical Discourse Analysis

CDE – Centre for Development and Enterprise

DBE – Department of Basic Education (Republic of South Africa)

DoE – Department of Education (Republic of South Africa)

GMCs – Guides in Mathematics Contents

HSRC – Human Sciences Research Council (Republic of South Africa)

KZN – KwaZulu-Natal

MDE – Mpumalanga Department of Education

MKO – More Knowledgeable Other

MMLs – Motivators of Mathematics Learning

NEIMS – National Education Infrastructure Management System

OECD – Organisation for Economic Co-operation and Development

PPCT – Person, Process, Context and Time

TIMSS – Trends in International Mathematics and Science Study

TVET – Technical and Vocational Education and Training

ZPD – Zone of Proximal Development

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DEDICATION

I dedicate this dissertation to my mother, Shaniseka Rose Mabasa, and my partner Lebohang Mahasela.

To my mom, thank you very much for being the source of my motivation to attend school and participate in learning with positive attitude.

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Chapter 1

UNDERSTANDING EDUCATION AND RURAL MATHEMATICS EDUCATION

"A child without education, is like a bird without wings" ~ Tibetan Proverb

1.1. The significance of education and mathematics

The view of education as a necessity for social improvement and progress has, over the past decades, dominated the way individuals perceive it in various societies. According to the South African Department of Basic Education (DBE) "the importance of education as well as its role in human *and social* development is hardly in doubt today" (Department of Basic Education (DBE), 2010, p. 7 italics added), because of the association with securing better standards of living. This suggests that education is a tool that individuals can use to improve their standards of living, which includes getting a job to sustain themselves, their families, their community, as well as their countries at large. If this is the case, it is crucial that every individual receives quality education, irrespective of their socio-economic and educational background, to address social justice and ensure equitable human development in the society. Similarly, mathematics is perceived as one of the important school subjects which could help to improve an individual's standard of living; and mathematics knowledge is perceived as advancing socio-economic needs (Hodgen & Marks, 2013), an individual's career horizons (Norris, 2012; Burghes, 2012), and is fundamental for its own nature (Vorderman, Porkess, Budd, Dumme & Rahman-Hart, 2011). If the urgency of making mathematics and mathematics literacy compulsory subjects in schools is taken into consideration in South Africa, this suggests the importance attached to learning mathematics and have some skills in the subject.

Of concern, however, is the existing unequal opportunities that are influenced by different social contexts, the nature of schools, and teachers' mathematics qualifications or lack thereof. Despite the individual's right to access high quality education being enshrined in South African educational legislation, there are still challenges that learners, especially in rural and farm schools, are confronted with (Sharplin, 2002; Emerging Voices, 2005;

Moletsane, 2012). In order to understand learners' lived experiences within a rural context, it is important to note that the social issues that rural people are faced with daily influence teaching and learning in schools. Rural schools are predominantly characterised by long walking distances to school, seclusion, scarcity of water supply[1], and limited humanitarian institutions that supplement the cost of education like in some urban[2] and township schools, as well as high levels of unemployment[3] (National Education Infrastructure Management System (NEIMS, 2011). These characteristics have major effects on the schools' infrastructure, limited teaching and learning resources, qualified teachers - especially mathematics teachers - school attendance rate[4], attaining good results in all subjects, and the particularly poor results in mathematics. Also, a lack of facilities for various sporting codes, levels of parental involvement, the proximity and lack of community libraries and other amenities that can be taken for granted play major roles in facilitating teaching and learning in rural schools.

In relation to the learning and performance in mathematics, Van der Walt, Maree and Ellis (2008) point out that South African learners' learning and performance is distressing in rural areas, because of "general poverty of school environment, general poor quality of teachers and teaching (including poor subject knowledge and poor motivation), language of instruction (often not the same as learners' mother tongue) and an inadequate study orientation" (pp.490-491). Although it could be argued that this statement seems to homogenise rural areas, this is the common understanding of the standard of education and mathematics in South African rural areas. While not specific to rural and farm learners, Spaull (2013) stated that the national proportion of learners who take mathematics in school, as opposed to mathematical literacy, continues to drop "as more pupils opt out for the easier maths literacy". Both the comments made by Van der Walt et al. (2008) and Spaull (2013) point to the appalling standards of mathematics education in South Africa, and in order to

[1] Amongst Mpumalanga schools, 26 schools do not have any sanitation facilities at all, and 1772 schools have been reported as having no water supply. (See NEIMS. School Infrastructure Report, May 2011.)

[2] "A formal urban settlement is structured and organised. Land parcels (plots or erven) make up a formal and permanent structure … services such as water, electricity and refuse removal are provided, and roads are formally planned and maintained by the council. This category includes suburbs and township" (Statistics South Africa, 2001, p. 187).

[3] Mpumalanga has been rated the province with the second highest levels of unemployment after KZN. (Socio-economic Review and Outlook of Mpumalanga, Mpumalanga Department of Finance, November 2011).

[4] Equal Education submission, Western Cape hearing, 26 November 2011.

address this state of affairs, there is a need to conduct research, particularly within rural and farm schools, to gain insight into learners' experiences and attitudes towards learning mathematics.

1.2. Background of the study

Considering the socio-political history of South Africa and its educational system, Nkambule, Balfour, Pillay and Moletsane (2011) posit that "rurality and rural education have been marginalised bodies of knowledge in South Africa" (p. 341). This view addresses the fact that in both the apartheid and democratic dispensations in South Africa, rural communities, their knowledge, and their educational experiences, are unknown, overlooked, and silenced. It is acknowledged, however, that scholars in institutions of higher learning in South Africa are slowly focusing on researching various attributes of the nature of rurality and rural education (Nkambule et al., 2011; Masinire, 2015). While this is the case, "little is known of the focus of various studies and the state of rural education and rural education research" (Nkambule et al., 2011, p. 341), especially an understanding of learners' experiences and attitudes towards learning in general and in particular the learning of mathematics. To date, the paucity of mathematics education research in South Africa has not been able to give account of rural learners' experiences and attitudes towards learning mathematics within rural schools.

Since the educational issues in South Africa involve various stakeholders such as politicians, the business community, communities and learners, there are always contentious debates about the challenges that confront our education system (Msila, 2007). The systemic transition from the apartheid education system to the new democratic system has not been smooth, because "in the past, South African education reflected the fragmented society[5] in which it was based…" (Msila, 2007, p. 146). This had implications for teacher training in Black African, Coloured, and Indian schools, especially Black African rural mathematics teachers for this study, because it perpetuated poor teaching in Black South African[6] schools,

[5] The fragmented society herein refers to the racial categories that were established by the Apartheid government in South Africa, which were 'White', 'Asian', 'Coloured' and 'Native'. The societal status for each racial group was in this order, with whites seen as the superiors and the native (herein referred to as Black South African) as the lowest rank (Carrim & Soudien, 1999). All apartheid laws reflected racial discrimination.

[6] In population classifications in South African statistics, four 'formal' races are always distinguished: Whites, Asians, Coloureds and Black (Treiman, 2005). The author further discusses that these racial categories are subdivided along the language used in the homes, with the exception of the 'Other Blacks' "(these are mostly migrant workers from neighboring South African states)" (Treiman, 2005, p. 6).

particularly the teaching and learning of mathematics (Carrim & Soudien, 1999). To be noted is that the "legacy of apartheid for mathematical education includes the subordination and exclusion of the majority of population from access to and participation in the mathematics-related professions" (Macrae, 1994, p. 1). The apartheid government deliberately excluded black people from participation in mathematics because the subject was regarded to be for the elite, and the concern for Verwoerd, the then South African Prime Minister, was that the Native people see the Europeans as superior (Khuzwayo, 2000).

While it has not been easy to locate research that provides information about all learners' performance in mathematics during apartheid, it is assumed that learners' performances were shaped by teachers' training experiences, the nature of content knowledge, and mathematical pedagogical knowledge. In the post-apartheid era, there is continuing concerns about teachers' lack of mathematics content knowledge, which appears to shape learners' performances in different international, regional, and local tests (Sharplin, 2002; Howie & van Staden, 2012; Spaull, 2013). Khuzwayo (2000) states that mathematics education in South Africa bears major scars of the apartheid education system, and argues that since the primary focus of mathematics teaching under apartheid was the "occupation of our minds" (p. 307), there is a need for mathematics education researchers to configure ways to end this 'occupation'. The scars are influenced by Verwoerd's statement: "... there is no place for [the Bantu] in the European community above the level of certain forms of labour … what is the use of teaching the Bantu child mathematics when he cannot use it in practice?" (Hirson, 1979, p.45). Without being obsessed with the statement, it is clear that the teaching of mathematics during apartheid was to ensure that Black people[7] viewed themselves as subordinate to their white counterparts. Thus, it also becomes interesting to gain insight into whether learners in the post-apartheid dispensation generally have changed their mind-set about the nature and learning of mathematics, especially as some learners continue to face challenges in "developing (mathematical) conceptual understanding that requires some level of learner agency to develop" (Graven, 2013, p. 6). While research continues to suggest that learners continue to experience challenges with mathematical content and conceptual engagement, in particular rural and farm learners, some still choose to study mathematics irrespective of the challenges.

[7] In this study, the term Black people refers to a socially based classification related to being African South African, the group previously classified as Natives during apartheid.

1.3. Problem statement

Since 1994, various curriculum reforms have been introduced in South Africa to symbolise change from the apartheid to a democratic educational system (Mouton, Louw, & Strydom, 2012). According to Christie (2006), "Education policy and provision was one among many areas that required immediate attention to break with the racial distortions and assumptions of apartheid" (p. 378). It failed to provide access for all learners, including full participation in education generally and mathematics in particular (Msila, 2007). It is distressing that despite the curriculum reforms in South Africa since 1994, the standard and quality of education continues to be a challenge, especially the levels of the majority of learners' achievement in mathematics in different international, regional, and local tests (Van der Berg, 2011; Howie & van Staden, 2012; Spaull, 2013). This also addresses access to qualified mathematics teachers and effective teaching and learning of mathematics, as mentioned in different sections, considering the test results that suggest learners' continuing problems with mathematics (for example, Trends in International Mathematics and Science Study (TIMSS, 2011) and Annual National Assessments (ANA, DoE, 2014) results. It appears that learners, in particular Black African learners' challenges with mathematics have a source if Verwoerd's earlier fundamental statement is seriously considered. While the statement referred to all Black learners, it is currently assumed that teachers and learners in rural schools were and continue to be disadvantaged, due to the nature of training teachers experienced and challenges with retaining qualified quality teachers in these schools.

Numerous researchers in mathematics education have illuminated several inadequacies in the teaching and learning of science and mathematics in South Africa (Howie, 2003; Siyepu, 2013; Spaull, 2013). These include challenges that teachers experience in managing activities during the learning and teaching processes, inadequate levels of proficiency in the language of communication between learners and teachers during learning, overcrowded classrooms, and the pressures to meet the demands of the syllabi stipulated by policymakers. Similarly, Van der Berg (2007, p. 854) summed up the South African educational standard as follows:

> South African schools generally perform at an even lower level than most of their African counterparts, despite greater South African resources, less acute poverty and more educated parents. International tests show that intervention is required at a much earlier stage than matric. Promotion to higher grades appears to be relatively easy, thus educational attainment (years of education completed) may exaggerate progress in cognitive levels mastered.

Although it is unclear what Van der Berg means by "greater South African resources, less acute poverty, and more educated parents", if rural and farm schools and communities are seriously considered, it possibly means there are still challenges in South Africa to offer high quality and equitable education. Rural schools and their learners' learning have been misconceived to be equivalent to their urban and township counterparts (Gardiner, 2008), irrespective of contextual and experiential differences. Moletsane (2012) cautions that learner educational and occupational aspirations or lack thereof largely stem from their school location, whether rural or urban. Hence, the learning experiences between rural and urban learners are imbalanced, if the contextual challenges that impinge on the effectiveness of teaching and learning in schools are taken into consideration.

It is the abovementioned concerns and gaps that shaped the conceptualisation of the current study, to critically explore and interrogate learners' experiences and attitudes towards learning mathematics. Of concern is the over-concentration of research in urban contexts while rural voices remain silenced due to marginal education research done in rural contexts and schools, in particular with learners. Thus, there is a need to conduct research with rural learners if the urgency of addressing issues of social justice is to be realised through education and particularly mathematics education in South Africa.

1.4. Rationale of the study

The rationale for carrying out this study is vested in the well-documented findings in the literature about the role of learners' experiences and attitudes towards learning mathematics and their achievement. For example, Nicolaidou and Philippou (2003) posit that learners' negative attitudes in mathematics are a result of frequent failures in learning the contents of the subject matter, or due to challenges that learners face when engaging with mathematical tasks. Although they have not explicitly included the notion of experience in their discussions, they seem to suggest that learners' attitudes towards mathematics is shaped by their experiences of mathematics and mathematics learning in and out of the classroom, which, according to the authors, shapes learners' academic engagement and achievement in mathematics. In addition, South Africa's education standards, particularly in mathematics, have been ranked lower throughout the years despite rigorous attempts to develop and implement a better education system through curriculum reforms since 1994 (Siyepu, 2013;

Spaull, 2013). In particular, findings in mathematics education research state that learners in rural areas suffer most when learners' mathematics achievements are considered in South Africa (Gardiner, 2008; Balfour, 2012; Siyepu, 2013), and due to little research in this context the reasons for such suffering are unclear, hence this study is located within a rural context.

My interest in gaining insight into learners' experiences and attitudes towards mathematics and also learning mathematics emanates from my informal observations as a high school mathematics teacher, and also from my informal engagements with high school mathematics learners about mathematics learning and achievement. From the informal conversations with the learners about the reasons for low performance in mathematics, I learnt they were based on their experiences when learning mathematics in the previous grades with other teachers, and also the challenges they have to learn mathematics with understanding. The informal observations and conversations with learners resulted in research interest, to explore if there is a relationship between mathematics learners' experiences and attitudes towards mathematics, and their engagement with the subject. At first I was undecided whether to research attitudes and experiences with teachers or with learners. However, it was when I attended Professor Jill Adler's PhD seminar presentation where she suggested that research output in mathematics education predominately focuses on teachers with little research on learners (11th of March 2016), and also my engagement with reviewed literature, that I became interested to find out learners' experiences and attitudes towards learning mathematics. I hope this study will add value to the existing knowledge related to learners' learning of mathematics, in particular rural learners.

1.5. Purpose of the study

The purpose of this study is threefold. It firstly seeks to critically explore and interrogate Grade 10 rural Acornhoek learners' experiences and attitudes towards mathematics. Secondly, to examine and critically analyse learners' experiences and attitudes towards learning mathematics. Thirdly, to understand factors that shape the experiences and attitudes towards learning mathematics. This study is located within a larger research project that explores conditions of teaching and learning that facilitate and/or constrain learning in rural high schools.

1.6. Objectives of the study

The objectives of the study are as follows:

a) To gain insight into Grade 10 learners' experiences and attitudes towards mathematics.

b) To describe and discuss learners' experiences and attitudes towards learning mathematics.

c) To locate and explain factors that shape learners' experiences and attitudes towards mathematics.

1.7. Research questions

The main study research question is:

What are Grade 10 rural learners' experiences and attitudes towards learning mathematics?

In order to explore the main research question, the following sub-research questions were identified:

a) What are Grade 10 rural learners' experiences and attitudes towards mathematics?

b) How do learners' experiences and attitudes towards mathematics shape their learning?

c) What are the factors that influence learners' experiences and attitudes towards learning mathematics?

1.8. Operational definitions of concepts in the study

Table 1: The operational definitions of concepts in the study

Concept	Operational definition
Attitude	There is a contestation in the literature in the ways in which attitudes are operationalised in research. One of the operationalisation of attitudes that stands out for most researchers is that attitudes be construed in terms of three components; namely the affective component, behavioural component and the cognitive component (Clore & Schnall, 2005; Hendrick, Fischer, Tobi & Frewer, 2013). The affective component of attitude is concerned with reflecting the general feelings of an individual directed towards an object, the behavioural component is associated with the actions that are overt which an individual executes and "represent verbal statement about intended behaviour" (Jain, 2014, p. 4) against the object. And lastly, the cognitive component represents an individual's knowledge as well as the awareness that he or she has concerning an object (Jain, 2014). This study uses the behavioural and cognitive components, because the focus is gaining insight into individual learners' knowledge and

	awareness of their experiences and attitudes towards mathematics and the nature of action that is taken to learn mathematics, which are explained through interviews. As noted in the reviewed literature, the study of attitudes has a rich tradition within the field of psychology. Attitudes are commonly taken to be directly unobservable and this in turn suggests that attitudes can only be measured using the quantitative research approach. While it might be argued that learners' attitudes towards learning mathematics cannot be observed directly, as this is a qualitative study[8], I infer learners' attitudes from their utterances about their past and present experiences in learning mathematics as well as their future aspirations associated with learning and owning particular knowledge and skills in mathematics (Schwart & Bohner, 2001). I am not interested in measuring and quantifying learners' attitudes in this study. To be precise, attitude in this study refers to learners' enduring evaluation of the nature of mathematics and its learning. Determining learners' attitudes towards learning mathematics involves focusing on the relation between the learner and their experiences of learning mathematics.
Experience	Experience may be viewed as motivated action embedded in a particular context, and is shaped by the individual's past and consequently modifies future expectations (Kankainen & Fulton-Suri, 2001). Along a similar line of discussion, Sanders (2002) views experience as a spark of the current lived moment, between what the individual has encountered in the past and future expectations. In the current study, experiences of mathematics are taken to refer to a learner's motivated actions in engaging with activities in mathematics, guided by their previous encounters in learning mathematics which results in modified personal future learning expectations in mathematics.
Learning	"Learning is the process whereby knowledge is created through the transformation of experience" (Kolb, 1984, p. 38). Kolb's experiential learning theory stipulates that learning involves a cycle of four stages that are mutually interdependent. (1) The learner first has a concrete (learning) experience, which is followed by (2) the learner reflecting on that particular experience, which in turn leads to (3) the learner analysing his or her experience with the subject matter contents and drawing conclusions and consequently this becomes (4) the basis of future encounters. For Kolb, for one to say they have learned something, they need to complete the four-stage cycle as discussed above, although they might not necessarily follow the order as suggested. Kolb seems to suggest that learning is the creation of particular forms of knowledge based on experience. Hence, in this study, learning refers to learners' accomplishment(s) in moving

[8] Kumar (2010, pp. 167-175) for a clear elucidation of the differences between the study of attitudes in quantitative and qualitative research.

	through Kolb's four stages when a learner is interacting with his or her teachers, fellow students, and also parents or siblings which is aimed at advancing his or her response to the subject contents' knowledge. Kolb's view of learning as a creation of knowledge links and expands the chosen theoretical framework, which understands learning as a social act that is dependent upon a variety of interactions among individuals and their tools and environment (Bronfenbrenner, 2001).
Rural	It is important to note that our conceptualisation of the term 'rural' has a major impact on what we can say about rural people. Informed by the apartheid urban and rural classification, South Africa's rural and urban differentiation can be considered to be purely South African and varies from other classifications in other countries (Gardiner, 2008; StatsSA, 2001). The international definition of a 'rural area' is generally taken to meet two criteria: "… one related to place of residence and land settlement pattern, and the other related to the type of work that residents engage in" (Atchoarena & Gasperini, 2003, p. 36). These definitions seem to place much focus on rurality as space, not people, and thereby take for granted the apparent truism that it is not places that face challenges, but it is the people within spaces, and that different people within the same spaces may experience different challenges (DBE, 2005; Gardiner, 2008). Rural cannot be conceptualised as a single space even if the issue was space, but as multi-faceted structures of "social spaces that overlap the same geographic area, with each social space having its own logic, its own institutions, as well as its network of actors" (DBE, 2005, p. 8). Thus, in the context of these statements about rural contexts, Coladarci (2007) argues that "there is no singular or multifaceted definition (of rural) that will suffice to satisfy the research … that employ the concept" (p. 2), however, the theory of rurality as proposed by Balfour, Mitchell and Moletsane (2008) appears relevant. According to Nkambule et al., (2011, p. 344), the dynamic theory of rurality "focuses on the generative and variable interaction of particular drivers peculiarly experienced in rural environments". I prefer to view "rural" as dynamic and shaped by a wide range of systems and specifically by individuals who live in rural areas. Hence, in this study, I view rural as a social representation[9], a culture of life constructed by individuals living in those areas.

1.9. Structure of the dissertation

This dissertation contains six chapters; the main purpose of **chapter 1** is to provide the background of the study, highlighting the importance of understanding the role of learners' experiences and attitudes towards learning mathematics. This chapter also presents debates

[9] For example, see Halfacree (1993) for a comprehensive summary on the debates about the differences between viewing "rural" as a geographic concept or as a social representation, and substantive arguments in support of viewing "rural" as social representation.

about the standards of learning mathematics in rural contexts. The rationale for conducting this study, the purpose, specific objectives and research questions are also provided.

Chapter 2 presents literature that addresses learners' experiences and attitudes towards learning mathematics. The chapter also provides literature associated with rurality and rural education, since this study was conducted with rural learners within a rural context. This study looks at the bidirectional influences between learners' experiences and attitudes towards learning mathematics, that is, whether learners' experiences of learning mathematics can shape their attitudes towards learning mathematics. In turn, whether learners' attitudes towards learning mathematics can shape their experiences of learning mathematics. While this study focuses on learners' experiences and attitudes towards learning mathematics, aspects of teaching and academic achievement in mathematics will be mentioned as the study unfolds due to interrelated nature of this topic. I also acknowledge that learners' experiences and attitudes towards learning mathematics should be studied alongside teachers' teaching of mathematics and learners' academic achievement, however, due to time and space constraints the main focus is on learners' experiences and attitudes. I am planning to pursue a PhD, and the above-mentioned aspects will form part of the study.

In **chapter 3**, I present the conceptual framework that is espoused to critically explore learners' experiences and attitudes towards learning mathematics. To do this, I discuss in detail Bronfenbrenner's Bioecological systems framework and highlight how the framework is used in the current study.

Chapter 4 provides the overview nature of this study. The selected research methodology for the study is provided. While it is commonly assumed that the study of attitudes uses a quantitative research approach, in this chapter I present to the reader how this study uses a qualitative research approach and methods. In addition, I also discuss the sampling technique and the justification of the sample size is examined. The issues of credibility, transferability, dependability and confirmability are also highlighted.

Chapter 5 presents the findings and discussions from the interviews in relation to the findings from classroom observations, and these are discussed in light of the reviewed literature and the identified theoretical framework for the study.

Chapter 6 provides a summary of the findings in relation to the theoretical framework, the research questions and the reviewed literature. In addition, the significance of the study in light of the identified gaps in the existing literature is also presented. The limitations of the study are also highlighted. Lastly, the chapter ends by suggesting possibilities for future research.

Chapter 2

LEARNERS' EXPERIENCES AND ATTITUDES TOWARDS LEARNING MATHEMATICS: A REVIEW OF THE LITERATURE

"The rural carriers are unloved and not getting the attention they deserve" ~ Greg Gorbatenko

2.1. Introduction

There is continuing distress in South Africa about the state of mathematics teaching and learning nationally, and particularly in farm and rural schools. Without disputing the role that teachers play during the teaching and learning processes, the focus of this study is on learners' experiences and attitudes towards learning mathematics, as already discussed in chapter 1. While the state of mathematics learning remains appalling in South Africa generally, and particularly in rural areas, the importance of mathematics continues to be in doubt globally. The reason is because "modern societies have increased in complexity and accompanied by rapid technological development, so the teaching of mathematics has come under increased scrutiny" (Nunes, 1993, p. 1). This means that various stakeholders in education see mathematics as one of the important subjects in school curriculum, since "a strong mathematical background is necessary for many career and job opportunities in an increasingly technological society" (Sasman, 2011, p. 1). Both Nunes (1993) and Sasman (2011) see mathematics as playing a major role in enhancing and ensuring human development and progress, considering the increase and advancement of technology in the society. Of concern is the continuing dominance of urbanised research knowledge, resulting in marginalisation of research education in rural areas and their schools. This in turn informs the policies to be too 'metro-centric', and overlooks the rural lived experiences (Barter, 2008). Thus, there is an overarching need for intensive research that focuses on understanding learners' experiences and attitudes towards mathematics and how they engage with various tasks, which might provide information regarding learners' choice of and performance in mathematics.

Current debates in mathematics education research in South Africa are predominately concerned with the standards of mathematics teaching and learning, and the performances

from such processes (Khuzwayo, 2000; Siyepu, 2013; Spaull, 2013). The focus of this chapter is to discuss the literature related to learners' experiences and attitudes towards learning mathematics in general, and particularly in rural schools and classrooms. The definition of what 'rural' and 'rural education' means has received great attention from various scholars (Balfour, Mitchell & Moletsane, 2012; Balfour, 2012; Mukeredzi, 2013; Masinire, Maringe, & Nkambule, 2014), and this chapter begins by engaging with the contentious debates of what rural and rural education means considering the context of the current study. This is followed by a presentation on the importance of mathematics and researching (rural) mathematics internationally. I then present a comprehensive review of mathematics education research conducted in the South African context. Furthermore, I critically explore various researches done on learning experience in order to construe how these experiences influence learners' learning of mathematics, which closely links with their attitudes to learning mathematics. Lastly, the contentious debates on what constitute learners' attitudes towards learning mathematics, and how these attitudes possibly shape learners' learning in mathematics will be discussed critically as illustrated in Figure 1 below.

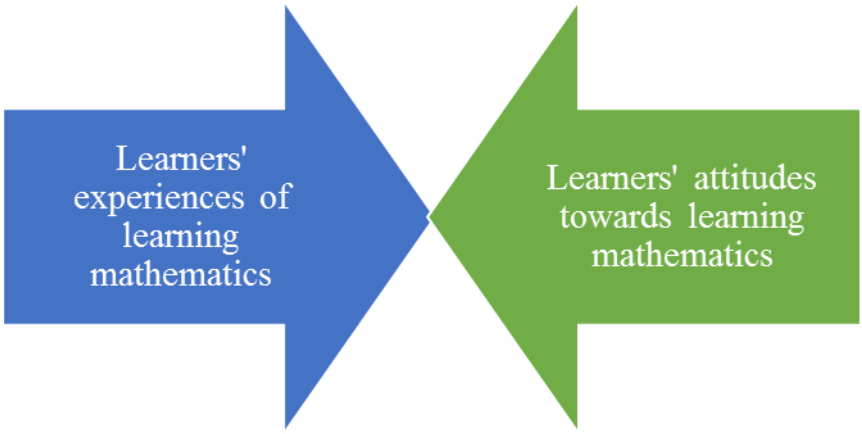


Figure 1: The operational understanding of the relationship between learners' experiences and attitudes towards learning mathematics

In this study, I look at the dialogic influences between learners' experiences of learning mathematics and learners' attitudes towards learning mathematics, which is presented in Figure 1 above. The dialogic relationship between the two aspects should be read in relation to each other, rather than as stand-alone discussions. While this is the case, the literature associated with the two concepts, experiences and attitudes, are reviewed in separate sections, to make sure that I engage with each concept in depth. The rationale for this is because they

are complex concepts and I am concerned that if discussed together certain important aspects might be overlooked.

2.2. Understanding the meaning of rural and rural education

Rural education research has looked at multiple factors that influence educational experiences in general (Balfour, 2012) which include race (Bhopal, 2014), gender (Collins & Coleman, 2008) and individuals' identities (Reed-Danahay, 1996). While this is the case, there are contentious debates about what the word 'rural' means. 'Rural' is a concept that has different conceptualisations and could be interpreted differently within the same country and different countries (Wako, 2005), making it difficult to generalise. In the United States of America, the definition of a rural area is generally taken to meet two criteria: "one related to place of residence and land settlement pattern, and the other related to the type of work that residents engage in" (Atchoarena & Gasperini, 2003, p. 36). Most researchers and policymakers seem to conceptualise 'rural areas' to be all areas that are 'non-urban' (Pizzoli & Gong, 2007; Acker & Gasperini, 2008). Part of the confusion found in various researches and policy documents when defining rural comes from having to make mental 'imagination' to focus on the non-described aspects of rural areas which are assumed to be 'flips' of what is described in urban definitions. Atchoarena and Gasperini (2003, p. 36) state that given the contentious nature of defining rural in research, "one is tempted to adopt J. Robinson's attitude by saying that even if we cannot define what an elephant is we are able to tell when we see one". Even though this might be the case, it is also important to be careful and aware that not all rural areas have the same characteristics, and overlooking that different people exist in various rural areas and interact in different ways to sustain themselves within these communities might be disadvantageous. From the brief discussion above it is clear that the term 'rural area' is not a precise concept as posited by various authors (Atchoarena & Gasperini, 2003; Acker & Gasperini, 2008; Gardiner, 2008), but there is a need for a clear conceptualisation of rural areas for researchers and administrative purposes such as improving the quality of education in those areas.

Thus, Mukeredzi (2013) posits that "devising a clear and objective definition of 'rural' presents a conceptual problem" (p. 2), and draws from Chikoko (2011) to define rurality as "synonymous with remote area and refers to an underclass model describing a notion of rurality in social development" (p. 92). Balfour (2012) argues that there are many

assumptions that people make about rural contexts and education, such as viewing them narrowly as disadvantaged, backward, depopulated, conservative, exclusive and isolated. While these features may be apparent in some rural areas, it is important to conceptualise these areas in terms of their differences rather than deficit descriptions and discourses. According to Gardiner (2008, p. 8), the meanings of "the terms urban and rural have a complicated history in South Africa", as it remains unclear what formally constitutes a rural area and differentiates rural areas from urban and township areas (Stats SA, 2001). Balfour et al. (2008) contend that the understanding of rurality in South Africa has been constructed on common sense compassion, meaning the understanding of rural areas has been in negative terms, whereby "isolation, disease, poverty, corruption, traditionalism, conservatism and entropy are all synonymous with rural places" (Masinire, 2015, p. 3). This biased perception of rurality has overlooked that people in rural areas are not merely subject to the environments in which they live (Halfacree, 2007; Moletsane, 2012), but "make use of time, space and resources differently to transform an environment" (Balfour, 2012, p. 2). This calls for a move beyond representing rurality with a deficit paradigm (Moletsane, 2012), and seeing it as dynamic and generative (Balfour et al., 2008). Considering that education does not take place in a vacuum, there are also underpinning socio-economic, political, educational, and cultural factors that shape a teacher's teaching approach and learners' engagement with learning in rural contexts, leading to different performances in mathematics (and in turn dropouts) (Smink & Reimer, 2005 and Adedeji & Olaniyan, 2011).

2.3. The importance of mathematics and researching rural mathematics

Irrespective of where a learner is located contextually, it is agreed that mathematics and even basic mathematical skills are important for all individuals to have for basic operation and survival. In spite of the fact that all subject areas in the school curriculum are important, there is long-standing recognition that mathematics is important and plays a significant role in influencing how individuals engage with various spheres of their individual lives, as well as their social lives (Norris, 2012; Burghes, 2012). This possibly justifies reasons why mathematics is compulsory for all learners who go through secondary education in countries such as Hong Kong, USA, Germany and Kenya (Hodgen, Marks & Pepper, 2013). It also seems that learning and owning particular knowledge and mathematical skills is fundamental, making it important for learners to achieve outstanding results to ensure access and acceptance into some competitive university courses with mathematics as a prerequisite

(Siyepu, 2013). With this in mind, it is assumed that some learners choose mathematics in school even if they might be experiencing challenges and underperforming due to status and future opportunities. Without generalising, the same might be said about some rural learners who choose mathematics in South Africa when they reach Grade 10, a reason it is important to gain insight into their choices, experiences, and attitudes towards learning mathematics. If it is true that learners' experiences and attitudes shape effective learning of mathematics, reflection should be part of their learning process.

It is beyond the scope and the primary purpose of this section to attempt to provide a comprehensive review of all the international research in mathematics education. Of importance is to highlight the trends that are apparent in various mathematics education researches conducted in various international contexts. From the various studies that were reviewed in mathematics education, research with learners is not well established. Trends in international mathematics education studies shows that the primary focus was on teachers' knowledge and beliefs about the nature of mathematics (Hill, Schilling & Ball, 2004; Walshaw & Anthony, 2008; Hill & Ball, 2009), which links with teachers' pedagogical approaches (Wood, 2002; Runesson, 2005; Wiliam, 2007; Zevenbergen & Lerman, 2008). It is undeniable that understanding teachers' beliefs and pedagogical practices in mathematics classrooms is important in order to provide information about learners' performances in mathematics; however the disadvantage is that learners' voices and experiences of learning mathematics remain silent. The subject of focus in mathematics education research has broadened in recent decades and include topics such as: learners' mathematical reasoning and communication (del Mas, 2004; Lithner, 2008), ethnomathematics (Barton, Poisard & Domite, 2006; Orey & Rosa, 2008), anxiety in learning mathematics (Gresham, 2008; Hoffman, 2010; Taylor & Fraser, 2013), technological integration in mathematics classrooms (Yerushalmy, 2009; Zelkowski, Gleason, Cox & Bismarck, 2013; Kitchen & Berk, 2016), the nature of tasks given to learners (Sullivan, Mousley & Jorgensen, 2009; Silver, Mesa, Morris, Star & Benken, 2009), assessment in mathematics (Russ, Lee & Sherin, 2012; Heng & Sudarshan, 2013), gender differences in mathematics performance (Else-Quest, Hyde & Linn, 2010; Devine, Fawcett, Szűcs, & Dowker, 2012) and mathematics curriculum (Clements & Sarama, 2008). Although research has broadened to include these topics, it is noticeable that researching with learners has been overlooked.

In Australia, there is a great deal of research that has been conducted focusing on 'mathematics education in rural areas' (James, Wyn, Baldwin, Hepworth, Mclnnis & Stephanou, 1999; Williams, 2005; Lyons, Cooksey, Panizzon, Parnell & Pegg, 2006; Panizzon & Pegg, 2007; Jorgenson, 2015). Most of the mathematics education studies conducted in Australia contend that bridging "the gap between rural and non-rural education requires resourcing rural schools with skilled teachers and teaching supplies in line with current world expectations and needs" (Hudson & Hudson, 2008, p. 2). This means researchers in Australia set out to research mathematics education within rural communities and their schools to enhance the conditions of learning and teaching for the learners, provide support and meet the needs of the teachers within rural contexts, and to teach mathematics and elicit understanding of learners. What I noted is that researchers in Australia also over-focused on researching teachers' mathematics teaching and few studies focused on learners' learning of the subject (Goos, Dole & Geiger, 2011; Beswick & Jones, 2011). In South Africa, the same trends in the existing mathematics research is predominant; learners' experiences and attitudes towards learning mathematics have been overlooked as a key influence on their learning in schools.

2.4. Mathematics education research in South Africa

In South Africa, the emphasis continues to grow that learners should be empowered in the sciences and mathematics as well as technology, since these subjects are seen as attributes to economic development and growth (Msila, 2007). For example, the conceptualisation of the democratic education system in a post-apartheid South Africa was rooted on the belief that learners must be encouraged and empowered to gain skills that are necessary for becoming effective citizens as well as to enhance individual enrichment (DoE, 2002). Mathematics is believed to be one of the subjects needed to achieve these kinds of individuals in South Africa, due to the potential to inspire learners to play a role in advancing the society and the nation's economic development. This perception resulted in most learners being enticed to take mathematics as one of their subjects at school hoping that it would maximise their opportunities in the marketplace. Considering this, mathematics education research is gaining prominence in South Africa, although it has overlooked the importance of knowledge from rural and farm contexts and prioritised urbanised knowledge. This study argues that rural knowledge can contribute unique knowledge because rural contexts, experiences, and

practices are not the same as urban, making it imperative to expand the horizon of research focus.

South African mathematics education research focuses on many aspects, but is focused mainly on seven entities: mathematics curriculum (Khuzwayo, 2005; Kazima, 2008), knowledge and pedagogy in mathematics (Leendertz, 2013), teachers' assessment criteria in school mathematics (Lubisi, 2005), ethnomathematics (Horsthemke, 2007; Vithal, 2012; Nyoni, 2014), teacher education (Taylor, 2014), performance in mathematics (Graven, 2014; Spaull, 2013), and language and mathematics (Adler, 1998; Setati, 2003; 2008; Essien, 2010; Setati & Planas, 2012). The research focus on language and mathematics, and ethnomathematics appears to be politically motivated[10], and seeks to explore the connections and disconnections between mathematics, language and culture and identify their effects on the processes of learning and teaching. Although an oversupply of research focusing on these aspects exists, rural areas, with their diverse and unique local languages and cultures, remain under researched in South Africa despite their greater potential to unveil thought-provoking understanding about connections and disconnections between mathematics, language, culture and mathematics education. In addition, little mathematics research focuses on rural learners' learning of mathematics, particularly their experiences and attitudes towards learning the subject within rural contexts. This resonates with the findings of Venkatakrishnan, Adler, Rollnick, Setati and Vhurumuku (2009) in their review of mathematics and science education research in South Africa, that for research output in mathematics education "urban contexts were explicitly and solely focused upon …" (p. 11).

Venkatakrishnan et al. (2009) did not give reasons for this exclusive focus, but if we are serious about addressing educational disparities between rural and urban areas there is a need to conduct research with rural learners to diversify and expand the existing knowledge. Although the authors further acknowledge that the limitation of research "done in rural schools is problematic given that the majority of South African learners are educated in these contexts" (p. 11), little research continues to be prevalent in current mathematics education research in South Africa. Along the same line of discussion, Nkambule et al. (2011) conducted a meta-analytical study on South African postgraduate education research that focuses on rurality and rural education. The authors were concerned that even in rural

[10] See Setati (2005). Mathematics education and language: policy, research and practice in multilingual South Africa. Setati provided a comprehensive overview about the language-in-mathematics education contexts of South Africa.

universities little research has been conducted by scholars and postgraduate students, and that rural life is not considered to be a factor influencing the "phenomenon being explored" (p. 356). Nkambule et al.'s (2011) findings suggest that research in rurality and rural education seems marginalised not only in urban institutions, but also in rural universities, which seems to mean that recommendations that are made for urban schools in mathematics education research are generalised to rural areas and their schools, irrespective of the different contexts. Thus, there is a serious need to popularise research that will inform various policy formulations to address the challenges and enhance the conditions for rurality and rural education in South Africa (Nkambule et al., 2011).

In light of the foregoing discussion, Khuzwayo (2005, p. 307) makes an interesting point about who conducted mathematics research on whom during apartheid, which consequently informed the order of research in the post-apartheid dispensation. He states that:

> … a history of mathematics education research in apartheid South Africa may be analysed chronologically and racially – racial classification was a foundational construct of apartheid – into the main categories of: 'research on whites by whites' of the early apartheid years; 'research on blacks by whites' that followed the Soweto school uprisings in the late 1970s and early 1980s, and 'research on blacks by blacks' in the dying years of apartheid … (Khuzwayo, 2005, p. 307)

This quotation highlights the racialisation of mathematics education research during apartheid, with whites researching each other, and also researching black people. Alluding to the point I made earlier about white supremacy and mathematics, Khuzwayo's statement shows that black people never did research on white people during apartheid and it is still unclear in the post-apartheid dispensation whether this has changed or not. Although the above quotation mentioned the "research on blacks by black", little is known of the focus of the researches that blacks conducted on each other. In Khuzwayo's research, the over-obsession of the two racial groups, blacks and whites is also noted; suggesting research exclusion of Indians and coloured racial groups that also did mathematics. While Khuzwayo (2005) looked at mathematics education research during apartheid along historical and racial lines, there is no emphasis on the contexts in which mathematics education research was predominately located. While it is understandable that "South Africa is a country where the disparities in mathematics education represent a history of unjust social arrangements" (Khuzwayo, 2005, p. 309), the continuation of the disparities in mathematics education in rural areas post-apartheid is alarming.

2.5. Understanding debates about the meaning of experiences and learning

There are contentious debates about what constitute experiences; authors such as Passmore (1980) view experiences as "the variety and depth of our encounters with the world around us" (p. 58). This view of experiences seems to suggest that our repeated encounters with various aspects of our social and physical world shape our experiences about people and objects we interact with within such environments. It also implies that some learners' past performances in mathematics is the effect of their experiences with the subject. Usher (1989) draws on Foucault's work and proposes three theses of experiences. First, without language and discourse it would not be possible to talk of any experience since one's experience is the effect of language and discourse. Usher (1989, p. 29) posits that "it is language which is prior to experience" and as such "language regulates and forms experience rather than simply being a device for naming it" (1992, p. 208). Usher's conception of experience seems to foreground the social aspect of experience, since language is a social construct (Leeds-Hurwitz, 2012). This resonates with Robles (2012) that "language use is consequential to communities and that participants' terminological choices matter in the everyday construction of meaning" (p. 1). As such, narratives made about mathematics and learning are embedded in how the community in which a learner lives talks about mathematics, and socially constructs their own "discursive practices[11]" during the engagement with mathematics.

Secondly, the experience subject "is itself constituted in language" and acknowledges that "experience belongs to us as individual subjects; we are not the authors of the meaning of our experience" (Usher, 1989, p. 29). This addresses the point that language is a very important entity in our construction of knowledge and 'reality', but it should be noted that it represents and is influenced by the socio-cultural, historical, and educational dynamics of the societies in which we live (Fairclough & Wodak, 1997). Accordingly, beyond gaining insights into learners' experiences of learning mathematics, it becomes important to understand "conditional … meanings which are not personal" (Usher, 1993, pp. 170-171), but also socially and politically influenced. Thirdly, the subjects have the capability of transforming themselves, as Usher (1989, p. 30) writes that "discourses have their effect through individuals, although the latter do not choose their subjectivities and are not the authors of their interpretations, they are nonetheless capable of changing these subjectivities and reassessing the texts of their experience".

[11] See Foucault (1970, pp. 31-55) for an account on discursive formations and practices.

Another account of learning experiences is Mäkelä & Fulton-Suri's (2001) model of individuals' experiences and is presented in Figure 2 below.

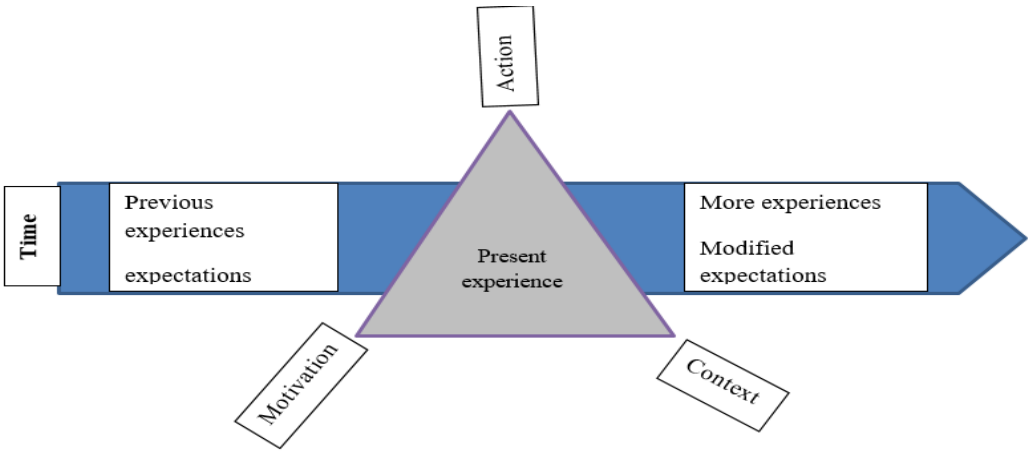


Figure 2: Experience as motivated action embedded in a particular context (Mäkelä & Fulton-Suri, 2001).

This also suggests that learning processes are entrenched within the societal praxis, meaning that the societal ideologies shape the processes of teaching and learning in schools. That is, learners' present experiences in the process of learning are informed by their previous learning experiences as well as societal expectations of how they should learn their subjects in school. Further, learners' current learning experiences are the basis for further learning experiences and the modification of mathematics learning experiences and attitudes to learn (Csizér & Kormos, 2009; Kolb, 2014). It is important to realise is that learning experiences are context dependent (Hupbach, Hardt, Gomez, & Nadel, 2008), which means that the nature of the schools and the mathematics classroom environments are major shapers of learners' experiences of learning mathematics (Anderson, 2007; Tsui, 2007; Stables, 2009). In terms of the relationship between learning and experiences of the learner, learning takes place when the learners are stimulated by the environment in which they are situated (Lewin, 1951). The experiences of the learner play a pivotal role in the process of a learner, since "there is no meaning in a given situation until we relate our own experiences to it" (Jarvis, 1987, p. 164). Despite the interest to study individuals' experiences across disciplines such as in psychology

and sociology, there remains a lot to be learned about learners' experiences of learning mathematics, especially alongside learners' attitudes within rural and farm communities.

2.6. Attitudes towards learning mathematics

The reviewed studies on learners' attitudes towards learning mathematics focused solely on measuring attitudes to mathematics performance, and have not explicitly shown how learning experiences in mathematics shape learners' attitudes to mathematics (see Nicolaidou & Philippou, 2003; Memnum & Akkaya, 2012; Mata, Monteiro & Peixoto, 2012; Mubeen, Saeed & Arif, 2013; Mensah, Okyere & Kuranchie, 2013). Attitude as a concept does not have a static definition but is contested, and owes its tradition to the field of psychology. Attitude is understood as a predisposition that has been learned by an individual in terms of how they *verbally* (italics added) respond to a particular object, idea, situation or a person (Mata et al., 2012). Similarly, Wasiche (2006) defines attitude as a feeling that an individual has towards a particular object or person, and that an individual's attitude may be reflected in their behaviour. This means that another way to understand an individual's feeling towards an idea or situation is by engaging in a conversation to gain insight into the origin of the feeling that results in an attitude. Interviews and the observation of behaviours and practices are some of the methods to be used to understand learners' attitudes towards mathematics and learning mathematics in a rural context.

In relation to the current study, other studies conceptualised attitude towards learning mathematics as the tendency to behave either positively or negatively towards handling mathematical tasks (Memnum & Akkaya, 2012; Mensah, Okyere & Kuranchie, 2013). This refers to the perception that learners form towards mathematics and then learning mathematics, and might also be shaped by learners' experiences of learning the subject in and outside the classroom. Drawing from Wasiche (2006), learners' attitudes towards mathematics may be reflected in the way they talk about and engage with mathematical tasks in and out of the classroom. In this study, learning mathematics involves qualitative experience which is dependent on the descriptions that learners put on their experiences of learning the subject, which is the inherent relationship between the experiencer (learner) and the experienced (learning mathematics) (see Marton & Booth, 1997). Although learners' engagement with mathematics out of the classroom was not observed, I relied on their explanations about the engagement with it during interviews. I also observed all learners' activities during teaching and learning in the classroom.

There is a vast amount of evidence internationally pointing to the importance of understanding learners' attitudes towards learning mathematics, in relation to how they learn the subject and eventually their academic achievement (Nicolaidou & Philippou, 2003; Memnum & Akkaya, 2012; Mata et al., 2012; Mubeen, Saeed & Arif, 2013; Mensah, Okyere & Kuranchie, 2013). Nicolaidou and Philippou (2003) contend that learners' negative attitudes towards learning mathematics emanate from their engagement with mathematical tasks without success, and that there is a possibility that these negative attitudes may become permanent. This is because during the process of learning mathematics, learners may start to see themselves and be seen by others such as their classmates and teachers as either capable or incapable learners of mathematics (Wenger, 1998; Anderson, 2007). This is posited by authors such as Anderson (2007) to be the major constituent of learners' attitude in learning mathematics. For Nicolaidou and Philippou (2003), in the Foundation Phase children seem to have positive attitudes towards mathematics and appear to develop negative attitudes as they progress with school grades. These authors further argue that learners' attitudes towards mathematics become prominent when they get to high school because learners start to see the alignment between mathematics and other spheres of their lives. A notable exception is Pepin's (2011) comparative study of Norwegian and English secondary students' attitudes towards mathematics. Pepin suggests that learners' attitudes to mathematics are closely linked to their experiences in learning the contents of the subject matter, and that both experiences and attitudes are context dependent. Regarding this, Bishop and Nickson (1983, p. 20) stated that:

> As a result of the kind of mathematical experience they (learners) will have had at primary level and, more particularly, their achievement or lack of it with respect to the subject, attitudes to it are likely to be entrenched by the time they enter secondary school.

Bishop and Nickson (1983) seem to offer a more detailed account of learners' learning experiences of mathematics than Nicolaidou and Philippou (2003). For Bishop and Nickson (1983), learners will hold negative attitudes to mathematics if there is lack of achievement in learning the contents of the subject matter, and positive attitudes to mathematics if they have been succeeding in learning mathematics. On the other hand, Nicolaidou and Philippou (2003) have not explicitly stated what causes learners' attitudes to become entrenched with school grades.

2.7. Chapter summary

In this chapter, literature related to learners' experiences and attitudes towards learning mathematics were explored. The chapter began by exploring contentious debates relating to the meaning of 'rural' and 'rural education'. Various authors contend that rural contexts are underrepresented and people tend to homogenise all rural areas, and overlook the complexities of the lived experiences that rural people have within their contexts – a reason it is important for Moletsane (2008) to move beyond homogenising rural areas, and view them as dynamic and generative (Balfour et al., 2008). I also explored literature about the importance of mathematics and researching rural mathematics education. From the reviewed literature, it seems learners' eagerness to learn the subject matter invariably shapes their learning and/or achievement in mathematics. In order to understand the nature of mathematics education research in South Africa, attention was paid to the type of research that South African mathematics researchers conducted. It appears that conducting research with learners about their learning of mathematics is not popular in South Africa, particularly with rural learners.

The literature also suggests that internationally the view of mathematics as an important subject continues to grow and is linked to the development of the country's economy (Hodgen & Marks, 2013). While this is the case, many assumptions are made about the compatibilities between rural and urban schools and learners' experiences, and this is often done by people who do not conduct research in rural areas, or in both contexts to construe whether the two contexts are compatible or not. They make assumptions that whatever findings they get when they conduct research in urban areas and schools, the results are transferable to rural and farm schools. I fully believe that research in general should be done, above all taking heed of the context(s) within which the research is embedded. Also, the tendency of homogenising contexts and the lived experiences of teachers and learners should cease if the urgency of conducting research to inform practice and vice versa is considered. This chapter has illustrated that there is a great need for rural education researchers, and there exists relatively minimal research done within rural schools in South Africa, in particular with learners. Of course, teachers play a major role in ensuring that learners learn effectively since they have the content knowledge, and research should be done with them, however, learners are also key participants in the processes of learning and teaching, hence there is a need to popularise research with learners focusing primarily on their experiences and

attitudes towards learning. This study contributes to the knowledge in rural mathematics education research, and can help researchers to understand how rural learners' experiences and attitudes shape their learning of mathematics.

Chapter 3

RECONCEPTUALISING LEARNING AS EXPERIENCES AND ATTITUDES: THEORETICAL FRAMEWORK

"Like success, failure is many things to many people. With Positive Mental Attitude, failure is a learning experience, a rung on the ladder, a plateau at which to get your thoughts in order and prepare you to try again." ~ (W. Clement Stone)

3.1. Introduction

According to Eisenhart (1991), a theoretical framework refers to "a structure that guides research by relying on a formal theory … constructed by using an established, coherent explanation of certain phenomena and relationships" (p. 205). This means that a theoretical framework consists of a theory that a researcher selects, and shapes the thinking about the nature of the study as well as planning the study processes. To support this, Eliot (1988) stated that, "I have always been in favour of a little theory: we must have thought; else we shall be landed back in the dark ages" (p. 15). Thus, to develop a detailed critical analysis of learners' experiences and attitudes towards learning mathematics, Bronfenbrenner's Bioecological systems theory (1977, 1994; Bronfenbrenner & Morris, 1998) was chosen for this study. The Bioecological theory is one of the contextual perspectives of human development, and contextualists view an individual as an inseparable entity interacting with their situated environment (Papalia, Olds & Feldman, 2009). This theory takes into consideration the close relationships between the development of an individual and the environmental factors that shape the development (Härkönen, 2007). It also offers a holistic lens to understand the various factors influencing the development[12] of a learner in relation to the experiences and attitudes towards learning mathematics. I acknowledge that Bronfenbrenner formulated the Bioecological systems theory to encompass the development of an individual for his or her entire lifespan. In the current study, I use the theory to critically

[12] Development for Bronfenbrenner is "the phenomenon of continuity and change in biopsychological characteristics of human beings both as individuals and as groups. The phenomenon extends over the life course across successive generations and through historical time, both past and present" (Bronfenbrenner, 2001, p. 3). For the current study, of importance in these human biopsychological characteristics are the experiences and attitudes in learning mathematics.

explore and interrogate Grade 10 rural learners to gain insight into their experiences and attitudes towards learning mathematics.

In addition, the Bioecological systems theory provides a nuanced understanding of the complexities of experiences and attitudes that appear to be shaped by different levels of socialisation and development of the mathematics learner as an individual within a dynamic context. This chapter begins by providing a comprehensive and critical understanding of Bronfenbrenner's Bioecological systems theory, from its inception until its 'latest' form so that I do not use a partial version of the theory (Tudge, Mokrova, Hatfield & Karnik, 2009). Until 2005, Bronfenbrenner's theory has seen various developments, the famous microsystem, mesosystem, exosystem, and the macrosystem model is discussed first. Thereafter, I will discuss the four components of the Bioecological theory which Bronfenbrenner termed a Process-Person-Context-Time (PPCT) model, in which he acknowledges that in his former formulation of the theory he discounted the role of the person's development and over-focused on context (Bronfenbrenner, 1989). Bronfenbrenner (1979, p. 27) believed that the development of an individual "is always embedded and expressed through behaviour in a particular environment". The environment is viewed as a series of interrelated contexts, and operates as the environmental systems in relation to each other and within themselves as individual systems. This suggests that in an attempt to gain insight into an individual's development, it is important to consider the complexities of the individual's situated environment since the person's behaviour is shaped by the environment in which they live. For the current study, it becomes important to consider a variety of factors within the learners' environment in order to understand the emergence of their experiences and attitudes towards mathematics, as well as their engagement with learning mathematics.

3.2. The Bioecological theory: mathematics learning experiences and attitudes

The Bioecological theory focuses on the role that the environment together with the biological characteristics of an individual plays in shaping his or her development (Bronfenbrenner, 1977). Biological characteristics mean the child's own biology is the "primary microenvironment that is the fuel for development" (Härkönen, 2007, p. 2). The theory views a child as an active participant in the construction and deconstruction of the world in which they live. In the original authoring of the ecological systems model,

Bronfenbrenner (1977; 1979; 1986) posits that there are four environmental systems that have an influence on the socialisation and development of a child, namely: the microsystem, mesosystem, exosystem, and macrosystem. During the transformation of the theory, a fifth system, the chronosystem, was incorporated in order to illustrate how 'time' plays a role in the socialisation and development of an individual within the environment(s). Below is the model that explains the various systems of development, and how they interact to shape behaviour in a particular environment.

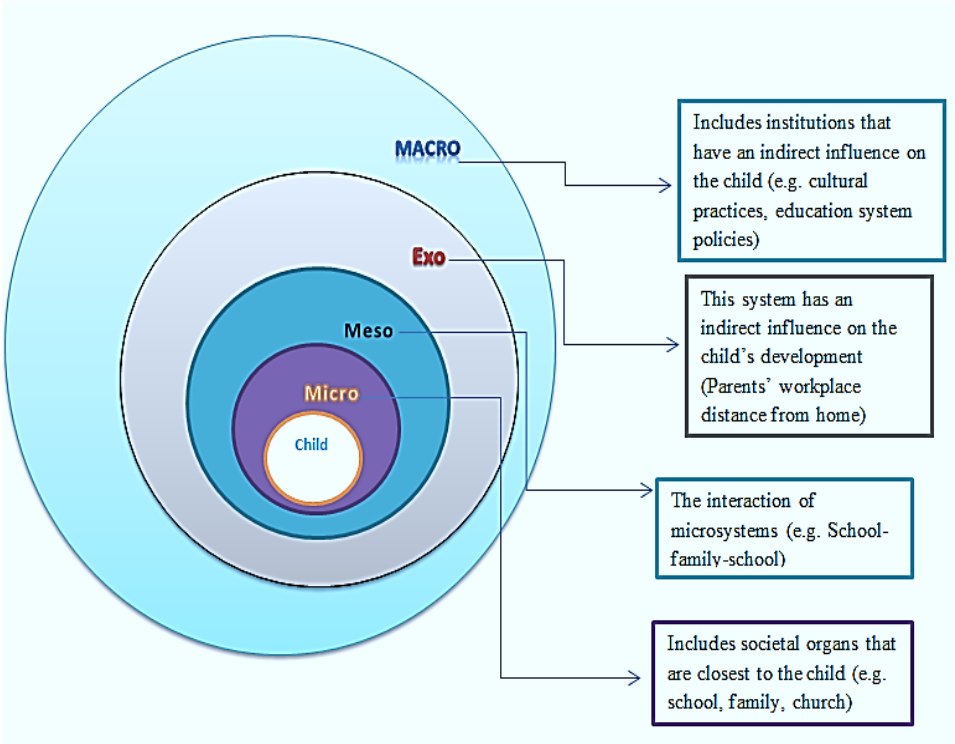


Figure 3: Bronfenbrenner's Bioecological systems model of child's learning and development

According to Lerner (2005) the four core systems mentioned above provide researchers with a lens to gain an insight into the multi-level environmental influence on individual development. As illustrated in Figure 3 above, a child is placed at the centre of the concentric systems, and depicts the reciprocal relationship between the child and the environment. In this study, these systems will provide a lens to critically explore, interrogate and understand the emergence of learners' experiences and attitudes towards learning mathematics and also the various factors that influence the experiences and attitudes.

3.2.1. The microsystem

The microsystem includes all the societal organs that are closest to the child such as the home, school, church or peer group, where the developing individual spends most of the time interacting with others (Bronfenbrenner, 1977; 1986; 2001). Thus, in order for development to take place, there is a need for ongoing, complex reciprocal relationships and social interactions[13] between the developing individual and his or her immediate social and physical environment. For this study, I critically explore how learners' interactions with the school staff, classmates, family members or relatives, friends, and neighbours at home encourage interest to learn and develop mathematics knowledge. This means that it is through social interactions with multiple parties in different environments that the understanding of the world, for this study mathematics, gets to be constructed, deconstructed, and reconstructed by a learner. This aspect was considered during interviews to understand the relationships that learners may have formed during their learning experiences, which further shape the nature of attitudes towards learning mathematics within rural schools. In addition, during mathematics classroom observations I focused on actions and interactions amongst learners, and also the manner in which they engaged during the teaching and learning processes. This was to understand whether and how the various relationships shape experiences and attitudes to mathematics and the learning of mathematics. Thus, the study takes the holistic approach to understand the role that different multi-microsystems play in shaping learners' experiences and attitudes to learning mathematics.

3.2.2. The mesosystem

The next level of the Bioecological systems theory is the mesosystem which can be defined as "comprising the relationships existing between two or more microsystems" (Bronfenbrenner & Morris, 2006, p. 817). The primary principle of the mesosystem level is that development, and in turn learning, is a result of forces emanating from multi-level settings and the interrelatedness among these settings. This means that the mesosystem amalgamates the interaction between different microsystems in which the developing

[13] For the primary purpose of this study, I define social interaction as dialogues that are meaningful in and outside mathematics classrooms between learners and their teachers, learners and family members, learners and peers, and among learners during learning in the classroom. Routman (2005, p. 207) posits, "Students learn more when they are able to talk to one another and be actively involved". This addresses the school level interactions. It is important to note in this study that focus is placed within and outside the school environments.

individual finds him/herself. In essence, the mesosystem comprises the relationships as well as processes taking place between two or more environmental settings of the individual, which includes the interrelations between school and home, family and church, friends and family (Bronfenbrenner, 2001). In this study, this construct of the Bioecological theory will be used to analyse participants' responses from interviews about different settings in which they learn mathematics. It will also be used to make sense of the interrelations between the settings, to critically explore how they shape their experiences and attitudes towards learning mathematics. This is in consideration of the idea that schools are not stand alone, but are organs of the society which are shaped by the societal culture and also shape the culture of a particular society. Thus, learner engagement with mathematical tasks cannot be limited to one setting, such as solely focusing on the influence of the school and the classroom to construe learners' learning. It is significant to understand the interrelations among various settings, and explore the multilevel influences on learners' experiences and attitudes towards learning mathematics because the learning of mathematics is not only limited to the classroom setting.

3.2.3. The exosystem

Schools and their systems are taken to be structure determined since they adapt to the political, social, and economic contexts while they evolve from the systemic memory which is embedded in the broader ideologies. The Bioecological theory establishes that not only the situated environment in which the individual seeks learning has an influential function on his learning, but the interaction between individuals and the wider societal, political as well as economic influences play a major role in the learning of an individual (Bronfenbrenner, 2001; Brendtro, 2006). Considering this, Bronfenbrenner (1977, p. 3) defines the exosystem as "an extension of the mesosystem embracing other specific social structures, both formal and informal, that do not themselves contain the developing person but impinge upon … the immediate settings in which that person is found, and thereby influence, delimit … what goes on there".

The development of the individual is not only shaped by the interactions within the situated environment, but also places and people that are not located within the individual's immediate environment. The spaces and people may include the broader neighbourhood, extended family members, the parents' workplace, and distance from the workplace. For example, the parents' workplace can probably constrain some learners' learning if they are

expected to sleep over - some parents in Acornhoek work in farms and are expected to sleep over during harvest times. This might shape parental involvement in the child's education when particular mathematics assistance is needed, and could constrain mathematics knowledge development resulting in particular experiences and eventually an attitude. The nature of experience and attitude also depends on the personal character of a learner because it does not mean learners respond similarly in different environmental situations. In this study, this will be taken into consideration in participants' responses, and also the role of neighbourhood assistance during parents' absence or late arrival at home considering the nature of the rural community.

3.2.4. The macrosystem

This system comprises members who share common "resources, hazards, lifestyles, opportunity structures … and patterns of social interchange" (Bronfenbrenner & Ceci, 1993, p. 25). For this study this means the society's overarching doctrines concerning what and how children should learn school mathematics, and for what particular purpose, has an influence on learners' experiences in the learning of mathematics. The doctrine also shapes learners' development of certain attitudes towards the subject and the learning of it. The overemphasis of the importance of mathematics in advancing one's career horizons and leading a good life both in South Africa and the world in general, could be possible reasons why learners choose to do mathematics in Grade 10 (Spaull, 2013). Also, within rural school environments, there may be peculiar ideologies that are manifested in the teaching and learning practices, and the 'rural envisaged learner' which may be shaped by various social factors and expectations. Thus, the above discussion discusses how an individual experience in an environment through which mathematics is learned can be shaped by cultural expectations or beliefs, learners' geographical location or the political influences of the country as well as the country's economic patterns (Bronfenbrenner, 2005). Of interest in the current study is how experiences of learners and their attitudes towards learning mathematics within rural schools shape their learning of mathematics, considering that mathematics is one of the subjects that are politically and economically considered worthwhile.

For Bronfenbrenner (1977) "macrosystems are conceived and examined not only in structural terms but as carriers of information and ideology that, both explicitly and implicitly, endow meaning and motivation to particular agencies, social networks, roles, activities, and their

interrelations" (p. 3). It is important to acknowledge that society is continuously undergoing evolution or development, however, there are social norms and values, cultural imperatives, and also dominant educational practices that remain fashionable. For example, the view in some schools and classrooms that mathematics is a male domain may prevail, and this may in turn shape learners' experiences and attitudes towards learning the subject. In addition to the four systems, Bronfenbrenner saw the need to incorporate time into his framework, to show that all interactions are time dependent. In order to discuss the aspect of time, I look at the new formulation of the Bioecological theory and discuss the PPCT model. In this study, the PPCT model is used to contextualise the rural Grade 10 learners' mathematics learning trajectories to gain insight into their experiences and attitudes towards mathematics.

3.3. The four components of the Bioecological systems theory

In the reformulation of the theory, Bronfenbrenner included the PPCT model in order to provide the integrated model of the developmental system. To further understand individuals' development and behaviour and the complexity of the environment, Bronfenbrenner's four components, referred to as the PPCT model, will be used alongside the four abovementioned systems (Bronfenbrenner, 2001). The PPCT enhanced the understanding of the environmental influence on socialisation of an individual. Again, the four components of the PPCT model are interrelated and should be read in relation to the four levels of environmental influence as discussed in the previous section.

3.3.1. Process

In the previous chapter, the reviewed literature shows that learners' experiences and attitudes towards learning mathematics are reinforced by continuous contextual processes which take place within learners' immediate context with others, symbols and objects in their environment (Bronfenbrenner, 1995). For Bronfenbrenner, for an individual to develop, an emphasis is placed on the role that proximal processes play in aiding development. Proximal processes are defined as "enduring, reciprocal, highly interactive processes between a developing organism and other individuals or objects in the environment" (Ceci, 2006, p. 173). In relation to this study, this means that learners' enduring forms of actions and interactions within their situated environment play a major role in their experiences of learning mathematics and the development of their attitudes towards learning the subject. The basic premise of the Bioecological systems theory is that learners that often succeed in learning are those who actively participate in the process of meaning-making in their situated

environment (Bronfenbrenner & Ceci, 1994). The situated environment in this study is the school, in particular mathematics classrooms where learners were observed to understand their process of learning mathematics with or without their classmates, to make sense of the emerging experiences and attitudes.

This resonates with Robinson's (1987) point that we are both products and producers of the environments in which we live. This suggests that during learning in mathematics classrooms learners construct their understanding of what mathematics is, which might also influence their learning of the subject, and development of experience and attitude. Bronfenbrenner (1995) also posits that the person's own dispositions or views about a particular phenomenon play a fundamental role in either reducing or enhancing the manner in which the child interacts with other people and their environment during learning. The actions and interactions that learners have with other people such as teachers and their peers during the learning of mathematics, shape their experiences and attitudes towards learning mathematics either negatively or positively (Lerner, 2005).

3.3.2. Person

This concept links with the microsystemic perspective as Bronfenbrenner (1989) looks at the role of the developing individual's genotype, phenotype, emotional, social and cognitive characteristics in determining the development. The focus was on the interplay between an individual's characteristics and the factors situated at the microsystem level, and how they influence the manner in which an individual interacts with the environment. Regarding this, Papilia et al. (2009) state that, "a person is not merely an outcome of development, but is also a shaper of it. Thus, people effect their development through their biological and psychological characteristics, talents and skills, disabilities, and temperament" (Papilia et al., 2009, p. 34). Of concern for Bronfenbrenner is that the characteristics of the individual have the potential to shape the subsequent action and exhibit particular behaviour. This makes it important to understand the role that individual characteristics play in the development of specific experiences and attitudes towards mathematics. The reason is because the behaviour

> … set in motion, sustain, and encourage processes of interaction between the developing person and two aspects of the proximal environment: the people present in the setting; and the physical and symbolic features of the setting that, in both cases, invite, permit, or inhibit engagement in sustained, progressively more complex interaction with and activity in the immediate environment (Bronfenbrenner, 1989, p. 97).

Considering the quotation above, Bronfenbrenner construed a richer understanding of the role the developing individual has in the process of his/her development. This addresses the extent to which an individual shapes the environment is inextricably linked to the emotional, mental, and physical resources at their disposal.

Bronfenbrenner and Morris (1998) suggest that there are three factors of the developing individual's biopsychological characteristics that are seen as fundamental in shaping the individual's action during the interaction process with the given activity. These are: resource characteristics, demand characteristics, and force characteristics. Resource characteristics are those that are linked to partly emotional and mental resources which include skills, intelligence, past experiences as well as material and social resources (educational opportunities, parental involvement, shelter, access to nutritious food) (Bronfenbrenner & Morris, 1998). Demand characteristics refer to those which Bronfenbrenner defined as personal stimulus characteristics, those that are apparent immediately to another person such as gender, physical appearance and skin pigmentation. Bronfenbrenner suggested that these characteristics can influence the way one reacts to the other person. Force characteristics are those characteristics associated with an individual's attitude, persistence, and motivation. In this study, learners' past experiences in learning mathematics, parental involvement or lack thereof, access to mathematics learning resources, existing mathematics skills, and cultural beliefs will be considered as factors that shape their experiences and attitudes towards mathematics. This is because learners' experiences of learning in general are not static but are shaped by a myriad of factors from multi-level environmental settings, as discussed earlier above. The above-mentioned factors will be used in this study as a tool to analyse participants' responses about different interactions and talking about mathematics, and whether and how they shape their experiences and attitudes towards learning mathematics.

3.3.3. Context

This characteristic addresses the dynamism of context and how processes that take place within various environments shape learners' understanding of themselves in relation to their situated environments. Of importance while reading this aspect is to understand that children are active participants in constructing and reconstructing their own understanding and realities in their environments (Bronfenbrenner, 1995), which allude to learners' sense of agency in learning. "Context refers to the multiple venues modifying the proximal processes …" (Krishnan, 2010, p. 6), which seems to mean that any actions or behaviours that an

individual may exhibit are inseparably linked to the environment in which the individual is situated. The context involves four interrelated systems that were discussed earlier namely the microsystem, mesosystem, exosystem and macrosystem. For Bronfenbrenner, the "environment is conceived as a set of nested structures, each inside the other like a set of Russian dolls" (Bronfenbrenner, 1994, p. 39). By this Bronfenbrenner suggests that to understand a child's learning, experiences, and development of particular attitude, it is important to focus within the context, which is commonly known as the ecological systems. It is important to note that the systems inexorably interact with and shape other aspects of the child's life, and time plays a major role in such interactions and the interlocking relations among the systems.

3.3.4. Time: the chronosystem

Since learners' experiences and attitudes are the results of myriad interactions or relations that the child has with other people and the situated environment, the time construct is included in this study to understand learners' descriptions of their experiences of learning mathematics. This includes "the historical period" (Bronfenbrenner & Morris, 2006, p. 821), in which the learner has engaged with mathematics content knowledge. Bronfenbrenner considered that over time, both the individual and the environmental characteristics change. Bronfenbrenner and Morris (1998) state that time is most prominent at three systems out of the four and writes:

> Micro-time refers to continuity versus discontinuity within ongoing episodes of proximal process. Meso-time is the periodicity of these episodes across broader time intervals, such as days and weeks. Finally, macro-time focuses on the changing expectations and events in the larger society, both within and across generations, as they affect, and are affected by, processes and outcomes of human development over the life course (p. 995).

From the quotation, time is constituted by three sub-categories, namely micro-time, meso-time and macro-time. In relation to the study, this mean that in order for the mathematics learner to learn and succeed, it is essential for him/her to participate in "progressive[ly] more complex activities, on regular basis over an extended period of time *in learning of mathematics*" (Bronfenbrenner, 2005, p. 9 italics added).

As indicated earlier, learners' interactions within a particular microsystem are important in understanding their learning; micro-time is also fundamental because it focuses on learners' articulated and observed continuity and discontinuity of engagement with mathematical tasks

during mathematics learning. To explore the continuity and discontinuity of learners' engagement with mathematics, in particular in relation to experiences and attitudes, if at all, the focus is in essence placed on various forms of interactions during classroom observation(s). These include learner-content interactions, learner-teacher interactions, learner-learning material interactions, learner-learner interactions, which are complex and shaped by various environments. This will show the dynamics associated with learners' learning of mathematics during an ongoing proximal process. In addition, the chronosystem of learning mathematics may also be represented by the day-to-day learning in the classroom (meso-time). Further, the year-to-year changes (macro-time) that happen in the life of the learner and his or her environmental systems, which include the teaching staff within the schools and subject choices that learners made, may shape learners' experiences and attitudes towards mathematics and its learning. In order to gain a nuanced understanding of learners' experiences and attitudes to learning mathematics, the time aspect helped me to critically explore learners' descriptions of their learning experiences across broader time intervals.

3.4. Chapter Summary

The Bioecological theory, as explained in this chapter, indicates its potential for conceptualising the emergence of learners' experiences and attitudes towards learning mathematics, and the factors that shape particular experiences and attitudes. In the chapter, I discussed that the development of a child takes place in a more gradual manner, and that there is the existence of a dialogic relationship between the child and the environment. Given this, the theory allows for a more detailed discussion of the experiences and attitudes that learners may have in learning mathematics within rural classrooms. I believe that this theory can be of great help in theorising multiple structures of multicultural societies, such as South Africa, in particular to understand the emergence and development of learners' experiences and attitudes towards learning mathematics and how they act as shapers of learners' learning of the subject contents. To provide a comprehensive framework of the Bioecological model of learners' experiences and attitudes to mathematics learning, the PPCT model was introduced to enhance understanding of the Bioecological model.

The theory suggests that in order to gain a detailed understanding of how children learn, and the outcome of their individual learning experiences, the researcher must consider the bidirectional relationship between two crucial phenomena: the roles of the child's biological

characteristics and the continuous changes within the environment which constitute his/her world. In addition, the Bioecological systems theory posits an understanding of learning and development which is subjective to each individual learner as the theory contends that the developmentally instigated features of the learner and the changing properties of their environment are specific to each individual child and are uniquely experienced.

Chapter 4

THE BEGINNING OF THE JOURNEY: RESEARCH METHODOLOGY

"With a library, it is easier to hope for serendipity than to look for a precise answer." ― Lemony Snicket

4.1. Introduction

In the previous chapter, I discussed a comprehensive theoretical framework that was chosen for this study, and highlighted how the Bioecological theory will be used to develop a detailed analysis of learners' experiences and attitudes towards learning mathematics. The focus of this chapter is to present the research process, the journey I underwent to address the purpose of this study, which is to explore and interrogate Grade 10 rural Acornhoek learners' experiences and attitudes towards learning mathematics. Walliman (2011) defines research as the search or investigation of the subject exhaustively, and the process should be as diligent as possible. According to Leedy and Ormrod (2010), the aim of research is to discover and interpret information about the subject under study, and possibly deconstruct and reconstruct the accepted theories, meta-narratives or laws in the light of the new discovered knowledge.

This chapter describes in depth the process and methods that were used to collect, organise and analyse the qualitative data which was gathered by means of semi-structured, in-depth individual interviews and non-participant observations (Creswell, 2012). These processes helped to realise the purpose of this study, the objectives as well as answering the predetermined interview questions. In order to familiarise the reader with the context in which this study is located, a brief but comprehensive description of the context is also provided. The explanation and justification of selected participants will also be presented, and the data analysis techniques will be described. In addition, the ethical considerations that I made as well as issues of trustworthiness and confirmability of the findings are also outlined. As stated earlier, this study is located within a larger research project that explores conditions of teaching and learning that facilitate and/or constrain learning in rural high schools.

4.2. Context of the study: the complexity of classifying Acornhoek

This study was conducted within two Acornhoek secondary schools with Grade 10 mathematics learners. Acornhoek is located at the heart of the Bushbuckridge[14] region, in the Greenvalley circuit in Mpumalanga province of South Africa. The prominent languages in this region are mainly Xitsonga and Sepedi. While I personally found it challenging to classify the region as rural, semi-rural, or deep rural, the information that was provided by the participants in my honours research presented mixed responses about the classification of Acornhoek. The area was classified as either semi-rural or deep rural. Those who contended that Acornhoek is a 'deep rural area' elucidated on their claims by referring to the high number of residents who work at the farms in order to provide food for their families and sustain themselves in general. Conversely, those who posited that the region is semi-rural referred to the shopping centre that was recently built, and that some families have big houses with flushing toilets and electricity. For this study, during informal conversations with the teachers and learners about the nature of their schools, they argued that Acornhoek is a 'deep rural area' because they teach and learn in dilapidated buildings with very limited resources, lack of sanitation, water, no proper roads to schools, and learners who have to walk long distances to schools. These are some examples that highlight the difficulty and complexity to classify the region through which this study was conducted.

From my observation of Acornhoek, the area is divided between those living close to the shopping centre and those living far from it, and do not have sanitation and share river water with cows. The closer you live to the shopping centre, the closer you associate it with semi-rural, so it is basically where people are located that shape their perception of the area. While this is the case, to me Acornhoek is a large village in the Bushbuckridge region. This standpoint is informed by my observations that the people in the region are still living under the traditional norms such as being governed by chiefs and sub-chiefs[15]. Below are some discussions on the research processes that I followed to address the primary purpose of this study.

[14] Since 2001, there has been provincial boundary changes in South Africa, as such "Bushbuck Ridge municipality was a cross boundary municipality between Limpopo and Mpumalanga and has now been allocated in full to the Mpumalanga province" (Stats SA, 2011, p. 11).

[15] The 2011 census Geography-classifications (namely urban, farm, traditional) are "based on administrative boundaries (namely built-up areas, farm parcels, traditional authority boundaries)" (Laldaparsad, 2006, pp. 3-4). Rural areas fall under the category of traditional authority boundaries. (See Stats SA (2011) for classification of Geography-types in South Africa.)

4.3. Research design

According to Babbie and Mouton (2007) research design refers to the plan that the researcher configures in order to address the research questions and objectives. Elucidating on this aspect, Cohen, Manion and Morrison (2007) state that devising a research design for the study involves determining the strategies which the researcher intends to use in order to address the objectives of the study. Thus, the research design involves outlining the entire plan for the study which includes the study methodology, the methods that the researcher used to gather data, the analytical tool that is employed to develop a nuanced analysis of the subject under scrutiny as well as an outline as to how the findings of the study are going to be presented. In short, a research design is a blueprint for the study.

This study uses critical, multi-instrumental case study design (Guba & Lincoln, 2005; Simons, 2009) and critically explores rural Grade 10 learners' experiences and attitudes towards learning mathematics in two different school sites in Acornhoek. The case study design used in the current study is "an in-depth exploration from multiple perspectives of the complexity and uniqueness of a particular … institution or system in a 'real-life' context" (Simons, 2009, p. 21). This links with Merriam's (2002) comments that the use of a case study research design enables the researcher to gain insight into a particular phenomenon within a particular bounded context. The phenomenon in focus in this study is the experiences and attitudes of Grade 10 rural learners towards learning mathematics within rural Grade 10 classrooms, with twelve learners in two secondary school sites representing multiple cases. Stakes (2005, in Denzin & Lincoln, 2005) distinguishes between three types of case study research designs: intrinsic, instrumental and collective case studies. Intrinsic case study involves gaining insight into a specific case better. On the other hand, a case is said to be instrumental "if a particular case is examined mainly to provide insight into an issue" rather than a case itself (Stakes, 2005, in Denzin & Lincoln, 2005, p. 137). And lastly, a multiple case study is defined as an "instrumental study extended to several cases" (Stakes, 2005, in Denzin & Lincoln, 2005, pp. 136 – 138). For this study, I incorporated a multi-instrumental case study design (Creswell, 2008) because twelve Grade 10 learners' descriptions and observations of their learning of mathematics were used to provide accounts of their experiences and attitudes towards learning mathematics within rural Acornhoek classrooms. The clarification of the researcher's philosophical underpinning is essential to the research design, in order to prompt the reader to the rationale for choosing a particular

methodology and the research methods that were used to collect the data for the study (Guba & Lincoln, 2005; Creswell, 2008). Below I provide a description of my ontological, epistemological underpinnings in order to discuss my paradigmatic disposition in this study.

4.3.1. Research Paradigm

In this section I provide a brief discussion of what the term "paradigm" refers to, then describe both my epistemological and ontological stances in this study and in turn my paradigmatic stance. The reason for providing these discussions is because I want to present my position in relation to my chosen paradigm, design and methodology. I believe there is a strong relationship between my ontological, epistemological stance and research paradigm and in turn the methodology that I have chosen for the study (Marsh & Furlong, 2002; Sikes, 2004). This is informed by Sikes' (2004) view that choosing a research methodology is mainly informed by the "researcher personality" (p. 17) and the philosophical standpoint about what constitutes beliefs, values, reality and knowledge. According to Kuhn (1970), paradigm refers to "the entire constellation of beliefs, values, techniques shared by members of a given scientific community" (p. 75), which means a paradigm is a frame of reference in understanding phenomena. This links with Babbie's (2007) point that paradigms "provide logical frameworks within which theories are created" (p. 31), and represent an individual's standpoint or broad view of what constitutes beliefs, knowledge and truth. The researcher's paradigmatic disposition informs his view of knowledge, truth and meanings, which consequently shape the engagement with the research participants to gain insight into a particular phenomenon (Sikes, 2004; Troudi, 2010).

Ontology refers to "the study of being" and focuses on the "kind of world we are investigating, with the nature of existence, with the structure of reality as such" (Crotty, 2003, p. 10). This means the researcher's ontological assumptions are concerned with the question "What is the nature of reality?" (Guba & Lincoln, 1989, p. 83). I believe that mathematics should be viewed as a social construction which is built upon the views and actions of the learners, teachers, and parents during the learning and teaching processes in and out of school contexts. It is noted that within the same school and classroom, learning experiences and attitudes towards learning mathematics are inevitably not the same, as from constructionist ontology, different learning experiences mean different perceptions of what reality is (Nightingale & Cromby, 2002; Bryman, 2004).

While ontology is about the nature of 'knowledge', epistemology refers to the ways we come to acquire such particular knowledge about phenomena in focus. Crotty (2003) provides a clear account of what epistemology is, and defines it as "a way of understanding and explaining how we know what we know" (p. 3). This can be taken to refer to the relationship between the phenomena that the researcher seeks to gain insight into and the assumptions they make about the nature of knowledge. Thus, this shows that the way the researcher views educational knowledge is inextricably linked to the chosen methodology for the study, in terms of the purpose and the envisaged goals for using such a methodology. In this study knowledge is "experiential, personal and subjective" (Sikes, 2004, p. 21) because I asked learners questions about their experiences of learning mathematics and in turn interpreted their utterances. As such, the epistemological stance I used in this study is social constructivism, which means knowledge and truth in learning mathematics are not discovered, but socially constructed, and learners are part of the construction, deconstruction and reconstruction processes of such truths and knowledge (Cohen, Manion & Morrison, 2006). Now that I have stated my ontological and epistemological positions, I can provide a description of my paradigmatic position.

Considering the discussion of this study's ontological and epistemological positions above, the underpinning philosophical assumptions in this study largely come from the critical theory paradigm. Critical theory, which owes its inception to the Frankfurt School, has largely influenced the establishment of critical pedagogy in mathematics education, with mathematics education for social justice (Gutstein, 2006) and critical mathematics education (Powell & Brantlinger, 2008; Frankenstein, 2009, 2010). Critical theory is complex and constituted by various conceptualisations (Kellner, 1989; Thompson, 2013; Tyson, 2014), and due to space constraints, in this section I discuss critical mathematics education as my paradigmatic position in this study. Shaped by my belief that politics is always inherent in the learning and teaching of mathematics, and my views of learners as active participants during the process of learning and teaching, my paradigm is critical mathematics. My interest in critical mathematics education is shaped by my concern for how learners learn mathematics, as a result of how they are taught in schools. Mathematics is not value neutral, objective or ahistorical, and drawing from Lerman (2000), mathematics has made a social turn, suggesting that mathematical knowledge is inextricably linked and situated in specific practices. Critical mathematics education critiques the assumed objectivity and neutrality of learning and

teaching mathematics, showing that these are human activities that are value laden, indistinguishably associated with social and political life (Skovsmore, 1994; Ernest, 2001). Furthermore, one of the assumptions of critical paradigm is that the researcher will bring about 'change' for the participants in the study. Thus, to help bring about change in the learners' experiences of mathematics learning, I will share the information with each individual learner about how their attitudes towards learning mathematics seem to shape their learning and help them configure strategies to best learn the contents of the subject matter. Having stated my paradigmatic stance above, in the next section I present the study's research approach.

4.3.2. Research approach

There are three research approaches, namely qualitative, quantitative, and mixed methods research approaches and the study is located within the qualitative approach. Patton and Cochran (2002) distinguish between qualitative and quantitative research approaches, stating that "qualitative research is characterised by its aims, which relate to understanding some aspect of social life, and its methods which (in general) generate words, rather than numbers, as data for analysis" (p. 2). On the other hand, quantitative research aims to give a measure of something (Patton & Cochran, 2002), and is not appropriate for this study because the purpose is not to measure anything but to understand individuals' experiences and attitudes. A mixed research approach refers to a procedure for collecting and analysing data using both the qualitative and quantitative research approach and methods in one study, to gain an insight about the subject under scrutiny (Creswell, 2012). Considering the different approaches, of importance for qualitative approach is the flexibility because it allows for 'open-ended' conversations with each participant, and the participants are presented with the opportunity to respond in an elaborative way (Creswell, 2012). It is because of this flexibility that the qualitative approach was chosen as participants were encouraged to speak freely, and some follow-up questions were guided by participants' responses. Another component of the qualitative research approach is that it focuses on the "collection of stories, narratives, and descriptions of others' experiences" (Morse, 2005, p. 139). Guided by open-ended questions, the participants of this study freely responded in their own words to describe in depth the aspect of their subjective experiences in learning mathematics and I made subsequent questions where elaboration or clarity was needed. As Patton and Cochran (2002) have stated, the qualitative methods generate words for data analysis, and the other reason for

using the qualitative approach is because I describe and analyse words from the respondents to develop themes for this study. Thus, I chose this approach over the quantitative approach because it allowed the usage of words rather than numerical values to describe the phenomena. As with the research approach, researchers have a variety of choices for methodologies that are used in their studies. In the following section, I discuss this study's research methodology.

4.3.3. Research methodology

According to Kothari (2004, p. 8), "research methodology is a way to systematically solve a research problem". This entails the steps that the researcher takes in attempting to address the research problem and the rationale for using "specific strategies and methods in order to construct, collect, and develop particular kinds of knowledge about educational phenomena" (Scott & Morrison, 2007, p. 153). To Scott and Morrison (2007), a research methodology is taken as a theory that informs the manner in which researchers gain understanding about the subject under scrutiny in research contexts, and the reasons for choosing particular strategies or methods over others to address the identified research problem. The chosen methodology for this study is critical phenomenology, because the purpose is to understand the meanings people make in social contexts and associated relations with the broader ideological structures. The rationale for choosing critical phenomenology is that learners' sense of who they are and how they learn mathematics in and outside the classroom, as well as their missions of learning the subjects arises from "their imbrication in systems of historically contingent meanings communicated by institutionalized patterns of behaving, thinking and speaking" (Tenorio, 2011, p. 192). This links with Van Dijk's (2009) argument that an individual's thoughts are manifestations of dynamic constructs termed social representations, which means that social structures in discursive interactions are "enacted, instituted, legitimated, confirmed or challenged by text and talk" (Fairclough & Wodak, 1997, p. 266).

According to Merrian (2002), critical phenomenology is used in critical qualitative research and enables the researcher to "investigate how the social and political aspects of the situation … affect the ways in which individuals construct reality" (p. 4). Thus, in the context of this study I began by understanding that learners' learning experiences are embodied and contingent on the learners' personal as well as cultural webs of signification of what mathematics is (Velmans, 2007; Denzin, 2008; Melancon, 2014). Critical phenomenology allowed me to determine different understandings of learning mathematics as experienced by

rural Grade 10 learners, and to understand the influence of language, broader ideology, politics, and power structures as they construct learners' learning experiences and attitudes. The statements that participants make might represent the ideological structures which systematically shape the manner in which learners describe their learning experiences. Thus, using critical phenomenology and Critical Discourse Analysis, as will be discussed later, enables me to demystify learners' utterances about their experiences of learning mathematics. This is done by focusing on the opaque relationship between learners' descriptions and the broader social structure, considering the theoretical framework, and this is done by means of open data interpretation and explanation. This is elicited by Melancon (2014), who views "critical phenomenology as an attitude that can be adopted in the context of either discipline, but also to defend the position that thinking is always a way to find ourselves in others and others in ourselves" (p. 1).

In addition, it is important for the researcher in critical phenomenological research to take heed of "all prejudgements as data is collected on how individuals make sense out of a particular experience or situation" (McMillan & Schumacher, 2010, p. 24). One way of addressing this is by identifying the presumptions which I held when I conceptualised the study and their influence on my data interpretation. For example, before I began with my study, I thought learners in Acornhoek classrooms learned mathematics in their home languages as this was how I learned mathematics in a similar rural context, but contrary to my presumption, they mainly learn mathematics in English with some code-switching when they interact with their teachers and amongst themselves as learners. It is generally known that mathematics is identified by many as a difficult learning area; as such critical phenomenology became a vehicle for exploring the controversial viewpoints (Kennedy, 1986). The next section deals with the research methods that I used to gain insight into learners' experiences and attitudes towards mathematics and its learning.

4.3.4. The collection of qualitative data: research methods

Walliman (2011) states that research methods are techniques that researchers use in the study to gather information about the subject under scrutiny, and these include questionnaires, interviews, observations, and case studies. With regard to methods of gathering qualitative data, Babbie and Mouton (2007) highlight that there are several ways in which one can collect data, which include interviews (basic individual interviews, in-depth individual interviews and focus group interviews), observation (participant and non-participant

observation), and using personal documents. Considering the focus of this study, I used individual semi-structured interviews and non-participant unstructured classroom observations to address the objectives of the study and attempt to answer the predetermined research question (Aspers, 2004).

4.3.4.1. Interviews

Interviews are the most favoured method and were argued to provide a way through which learners' experiences could be explored, and by which learners' attitudes could be examined through their accounts of learning experiences (De Vos, 2005). According to Gill, Stewart, Treasure and Chadwick (2008) the purpose of interviews "is to explore the views, experiences, beliefs and/or motivations of individuals on specific matters" (p. 292), and were appropriate in this study to gain insight into Grade 10 rural learners' experiences and attitudes towards learning mathematics. To Babbie and Mouton (2007) "a qualitative interview is an interaction between an interviewer and a respondent in which the interviewer has a general plan of inquiry but not a specific set of questions that must be asked in a particular order" (p. 289). There are structured, semi-structured and unstructured interviews (Gill et al., 2008), and this study used semi-structured interviews because they are flexible. The researcher can ask subsequent questions from the information that the participant has provided (Creswell, 2007) in order to gain a nuanced understanding of the participants' lived experiences through their undisturbed detailed descriptions and explanations.

4.3.4.1.1. Semi-structured individual face-to-face interviews

The use of semi-structured individual face-to-face interviews allowed me to have some flexible conversations with the learners, which in turn enabled them to freely recall their experiences of learning mathematics and provided thick descriptions about such experiences. At Dashboard Secondary School the interviews were conducted at the teachers' office because it was quiet. However, because at Bash Secondary School there is the challenge of not having teachers' offices, interviews were conducted in a computer lab. Although noise could reach the computer lab during interviews at Bash, it was the only place available in the school premises where the noise levels were not too disruptive. McMillian and Schumacher (2010, p. 355) state that in semi-structured interviews, "the researcher decides on the sequence and wording of the questions during the interview". Although I predetermined the topics to engage the learners in conversations about their experiences and attitudes towards learning mathematics, the sequence of the questions that I asked learners were based on what

they uttered and I tailored subsequent questions. To ensure that all information was captured, I used an audiotape to get detailed responses from the participants. Hence, the audiotaping provided the opportunity to listen attentively during interviews and identify missing information and more needed information, which links very well with the semi-structured interview style chosen for this study.

In addition, during data analysis, I needed to listen to the interviews several times in order to categorise the data, thus, audiotaping the interviews assisted me with accurately capturing what the participants were saying. This raises the authenticity of the study by proving the trustworthiness and credibility of data, and this is discussed fully later below. Creswell (2003) states that qualitative research is not only interested in what the research participants say but in the way they talk about a particular phenomenon. During data transcription, I needed to be aware of my own biases and ensure that I did not include my own opinion on what the interviewees had said, because this would affect the credibility of the study. The table below illustrates the time taken to complete each individual interview.

Table 2: Time taken to complete each semi-structured interview

Participant's Name[16]	**Time Taken**
Brilliant	58 minutes and 10 seconds
James	40 minutes and 48 seconds
Sunshine	52 minutes and 47 seconds
Tiny	1 hour, 21 minutes and 26 seconds
Musa	33 minutes and 20 seconds
Abel	44 minutes and 26 seconds
Mulo	40 minutes and 58 seconds
Letsatsi	30 minutes and 58 seconds
Masiza	31 minutes and 2 seconds
Mahlatse	54 minutes and 22 seconds
Bridget	52 minutes and 47 seconds
Tsan'wisi	57 minutes and 55 seconds

[16] In order to ensure the protection of the learners' identities in this study, I have used pseudonyms.

From the table above, it is clear that the time taken to complete each interview varied, and this is informed by the nature of semi-structured interviews; some learners had lot more information to share than others. According to Irvine (2011, p. 207), there can be a "substantial variation in the duration of interviews" because some participants may be more outspoken than others. Although the maximum time that was scheduled for each interview was one hour, considering the nature of semi-structure interviews as open discussions between the researcher and the participant, I could not interrupt some participants from elucidating their experiences of learning mathematics. Since the maximum time that I scheduled to have discussions with each of the twelve learners was an hour, I noted that this would take their social and family time since all the interviews were conducted after school. I could not conduct any interviews during subject contact times as this would disadvantage the learners as they would miss the content the teacher(s) would cover in class in their absence. Considering all this, to ensure that I did not take much of the children's social and family time, I scheduled one interview per day with the two schools altogether. This was to ensure that the interviewed learner was not left behind for a longer time at school, since they walk long distances to get home. Arrangements were made prior to the commencement of each interview that if the learner stays very far from the school, I could take them home with the 'research car'[17] so that they could get home before it was late and dark.

During individual interviews I was constantly called to task to refine my own misconceptions about the types of learners in rural areas such as Acornhoek. During the conversations with the learners, I came to learn that they can express themselves very well, and most of them are fluent in their usage of the English language. In spite of the literature that I reviewed that suggests that researchers should not view rural areas with a deficit model, I still expected to see learners who did not know how to speak in English. It thus became clear to me why Balfour et al. (2008) contend that rural areas are very dynamic. It does not mean that because the learners learn within rural schools they are inept at learning subjects such as English with understanding.

[17] As a research team, we hired transport from Johannesburg, and we also paid for daily travelling while in Acornhoek. The driver was familiar with the area and the schools, and this made it very easy to move from one school to another. Given that there is limited local transport in the area, if we had not made this arrangement, I believe we could have had challenges getting to the schools in the morning and to the accommodation facility after our daily routines.

4.3.4.1.2. Observations

Considering that qualitative research is aimed at providing an explicit interpretation of the broad patterns, order and the structure found among the study participants, observations are the best way to generate depth understanding of the nature of events which participants engage in (Guthrie, 2011). In an attempt to gain insight into classroom forms of interactions during learning, observations can "reveal classroom norms about teachers' authority, implicit rules about pupil participation, and the structure of classroom work and tasks" (Guthrie, 2011, p. 87). While this statement foregrounds the teacher(s) as the main actors within the classroom, it is important to note that observations can elicit understanding of how learners learn in the classroom, to understand a variety of factors that influence their learning or lack thereof.

4.3.4.1.2.1. Unstructured non-participant observations

For this study, I used unstructured non-participant observations to gain insight into learners' learning within mathematics classrooms (Creswell, 2007). In most cases, non-participant observations entail that the researcher sit silently in the class, taking notes as the learning process progresses (Cohen et al., 2007). However, considering the classroom environment, that is, overcrowded classrooms and the number of learners that took part in the study that were in each individual classroom, I could not stay detached from the learners. I had to walk around the classroom with the video camera and ensure that I captured every learner who participated in the study during learning. I realise that if I had had a videorecorder assistant with me during observations, it could have helped me to take extensive notes about all learners' interactions during learning in the classroom. Merriam (1998) suggests that the researcher should shift from a wide to a narrow angle observation by focusing on one person, actions and interactions, then returning to the broad environmental setting. In this study, I captured all the learners who took part in the study to ensure that I accessed in-depth information about each individual learner's learning in the classroom. I focused mainly on individual learners' ways of learning, their interactions or lack thereof with their teachers and fellow learners as well as their learning resources in the classroom.

Videotaping the learners during the learning and teaching process in the classrooms had its advantages as well as disadvantages. This allowed me to replay the videos "several times and therefore there was no pressure" (Wragg, 1995, p. 16), to try and videotape and take extensive notes at the same time. However, the disadvantage of having the video camera in

the classroom during learning is that it was disturbing and may have impacted on the ways the learners interacted and behaved during the lessons. For instance, in the first lesson that I observed at Dashboard Secondary, when the teacher asked the questions, almost all the learners had their hands up to participate and answer the questions. It was not easy to say if the learners in that class were reacting to my presence in the classroom with a video-camera or if it was how they normally interact and behave. According to Waxman (2013), "The presence of an observer may change teacher or student behaviors, perhaps resulting in reactive effects". Similarly, Vanderstoep and Johnston (2009, p. 172) state that "the act of observation causes a change in the actions of what or who is studied". Thus, I went back to observe the very same class without a video-camera. From the observations without a video-camera, it seemed that the presence of the camera in the first observation did have much influence on the behaviour of the learners since they exhibited different behaviours during the second observation and they were calmer possibly because they were getting to know me, as compared to the initial observations where they saw me as a stranger in their classroom. I had to ask learners to move their desks so that I could pass to another side of the classroom where the learners who took part in the study were seated. Consequently, this made the learners pay attention to me rather than the work being covered. Although this was the case, the learners reverted back to their normal ways of learning in the classroom.

The use of an unstructured observation technique in this study enabled me to "postpone definitions and structures until a pattern emerged", out of the conditions of learners' learning in the classroom that I observed (Bell, 2005, p. 185). This links with comments made by Cohen et al. (2007), that unstructured observations enable the researcher to "review the observational data before suggesting an explanation for phenomena" (p. 397). This means that rather than imposing predetermined collections of notions onto rural learners' learning of mathematical contents within rural classrooms, the trends and patterns honestly arose out of how learners participated in the classroom as the learning process progressed.

Although teachers were not participants in the current study, I handed consent letters to the two teachers whose classes I observed. This was to ensure that they understood the nature of the study and how their identities were going to be protected. I also followed McMillan and Schumacher's (2010) suggestion for conducting qualitative observations, as the authors state that it is important for the researcher to contact "a person who can grant permission for access

to the setting and participants" (p. 351). A preamble letter was handed to the two teachers whose learners took part in the study before the study could commence (see Appendix 6).

4.4. Research sampling technique

The selection of study samples in a qualitative study according to various authors (Creswell, 2007; McMillan & Schumacher, 2010; Babbie & Mouton, 2007) is based on the assumption that they are knowledgeable about the subject under scrutiny. This means, according to Babbie and Mouton (2007, p. 168), that the researcher "speaks of respondents as people who provide information about themselves, allowing the researcher to construct a composite picture" of the population which these individuals represent. This echoes statements made by McMillan and Schumacher (2010) that when the researcher selects people to form part of his or her qualitative study, they consider that the people they select are "knowledgeable and informative about the phenomena the researcher is investigating" (p. 326). With these comments in mind, Mouton (2011) defines research sampling as a process or a technique that the researcher uses in the selection of the sample that is suitable for the study. There are various types of sampling techniques located within two sampling techniques, namely probability and non-probability sampling techniques (Babbie & Mouton, 2007; Cohen et al., 2007). This study used a non-probability sampling technique because it allowed me to select specific participants - Grade 10 rural learners - whom I believed had the relevant information for my study focus. Non-probability sampling techniques include sampling strategies such as purposive sampling, dimensional sampling and convenience sampling, to name a few (Cohen et al., 2007).

4.4.1. Sampling strategy

Within a non-probability sampling technique, this study used purposive sampling. McMillan and Schumacher (2010, p. 138) state that in any qualitative inquiry, "the emphasis is on relying on the judgement of the researcher to select a sample ... that includes subjects with needed characteristics ... as qualitative researchers are more interested in selecting cases that are information rich". In this study, I believed that Grade 10 learners were most relevant and "most informative" (McMillan & Schumacher, 2010, p. 138) about their experiences of learning mathematics, since they had already chosen to pursue mathematics. When it came to selecting the region within which this study is located, convenience sampling strategy also came into play. The schools that I worked with were selected on the basis of their

involvement in the larger research project in which this study is located, as mentioned earlier. This made it easier to build a rapport with the school management team, the teachers as well as the learners since I had worked with them previously when I conducted my honours research project. The two schools are in close proximity, about 6 kms apart, this was an advantage because on a daily basis I could travel between the two schools for any scheduled interview(s) and/or observations.

4.4.2. Participants

The participants for this study comprised twelve Grade 10 mathematics learners. The selection of the learners was based on the criteria detailed in Table 3 below.

Table 3: Learner selection criteria for the study

Current Subjects:	Mathematics as one of the subjects
School:	Rural secondary school
Province:	Mpumalanga
Region:	Acornhoek
Grade:	10
Additional information:	In order to get varied accounts of learners' experiences and attitudes towards learning mathematics, with the help from the teachers and based on the learners' current performance, I selected two average learners, two above average and two below average learners in each school, making a total of six learners in each school.

According to Creswell (2003), the sample size that is required for phenomenological studies is between 5-25 individuals who are informative about the subject under scrutiny, and the twelve learners involved in this study met this criterion for phenomenological studies. The reason for choosing to have twelve learners was to maximise the variety of information during the process of data analysis, and to have manageable data considering time and space confines for the degree. This was very helpful since some of the participants such as Neo were not expressive no matter how hard I tried to tailor subsequent questions.

4.4.2.1. The distinctive characteristics of the two schools

The two schools[18] within which this research was conducted are located at the heart of the Acornhoek village in Mpumalanga. Both schools reflect the 'common image' about the appalling infrastructural conditions in most rural schools in South Africa (see images below). According to the Department of Education (2009)[19] there are three spaces which are referred to as space norms, which are the identified key spaces that each school in the country requires in order to provide high quality education to its learners. These are core educational spaces, administrative spaces and support education spaces. In order to present the nature of the two schools, I draw from the Department of Education (2009) specifications of the schools' space norms. Thus, when I entered each school I focused on finding out about the presence and quality of the aforementioned space types. Across the two schools, in terms of the learning space, they have overcrowded classrooms, making it difficult for learners to do their school work properly in the classrooms.

In both schools the teacher(s) cannot give learners individual attention and assistance since there is no space to move around in the classrooms. The classes in both Dashboard and Bash Secondary schools have poor ventilation, so they are too hot and stuffy. Taking into consideration that the area, Acornhoek, is characterised by extreme hot weather conditions throughout the year and that learners walk long distances to school each morning, by the time they arrive at school they are often sweaty, which consequently contributes to the stuffiness within the classrooms. This is evidenced by the opening of the windows (see Image 1 in Photograph 2 on page 56) to try and get fresh air into the classrooms. Moreover, as depicted by photograph 1 on the next page, in Bash Secondary School, the 'core education spaces' are largely appalling because some of the classrooms are not used due to the dilapidated structure making it dangerous for learning and teaching to take place (Images 1 & 6 in Photograph 1).

[18] In order to protect the identities of the two schools, pseudonyms have been used. Thus, throughout this research the schools are referred to as Dashboard Secondary School and Bash Secondary School.

[19] The National Minimum Uniform Norms and Standards for School Infrastructure (the document may be obtained at www.education.gov.za).

Image 1. Dangerous building structure

Image 2. New Technology, provided by MSTA

Image 3. A room with books on the floor

Image 4. MSTA provided Science equipments

Image 5. Library

Image 6. The classroom floor

Photograph 1: Bash Secondary School

The 'library' at Bash (Image 5 in photograph 1) does not have shelves, just a stack of books randomly packed; it is just a store room where books seem to be dumped and forgotten. While the school has a so-called library, some other books are put on the floor in one of the dilapidated buildings (Image 3). While the Mathematics, Science and Technology Academy (MSTA) provided the school with new science equipment and new technology which includes projectors (Images 2 & 4), for the three weeks I was in the school they were never used. Although Bash Secondary School seems to be advantaged because it is a sub-hub for the MST Academy, the two schools display similar contexts and this was very useful in understanding the role that context plays in shaping learners' learning of mathematics which is the major concern for this study.

Image 1. Classroom with windows open

Image 2. Computer lab

Image 3. Learners and staff toilets

Image 4. An old building structure

Photograph 2: Dashboard Secondary School

At Dashboard Secondary, the staff members and the learners share the pit toilets, four for ladies and four for men (Image 3). Not only are these toilets appalling because they are non-flushing, but they are surrounded by bush which poses a safety risk in the sense that snakes, for example, can make such spaces their habitat. Dashboard Secondary School has a fairly equipped computer laboratory (Image 2) which, based on my observations, is restricted for teachers' usage only. Image 4 of Photograph 2 shows the infrastructural challenge within Dashboard, this old building is kept standing in the school with the hope that one day the government will assist the school to renovate it so that they can use as a storage room. The above discussions illustrate the significance of context in understanding rural learners' experiences and attitudes towards learning in general, and specifically the learning of mathematics within educational spaces since these social realities largely create and develop the participants within such contexts.

With the 'core education spaces' described above for the two participating schools, it is unsurprising that the administrative spaces are very dilapidated. Administrative spaces are

taken to refer to "all spaces for direct use by a school administration and educators such as school principals' offices, storage rooms, printing rooms, etc. they also refer to spaces that are meant for learner use but fall under the management of a school professional staff and/or educators. Examples are pastoral care centres and sick rooms" (DoE, 2009, p. 14). Dashboard Secondary school has one appalling staff block comprising the principal's office, receptionist office and one room for all the educators in the school to share as their office. On the other hand, teachers at Bash Secondary School have departmental offices whereby, for example, teachers who teach mathematics share one office. In both schools, spaces such as sick rooms and storage rooms are non-existent. Although it is mostly taken for granted that 'administrative spaces' do not influence the processes of teaching and learning, my observations within the two schools gave me a different perspective. Consider the lack of a sick room for instance, when learners are sick, where do they go? Thus, there is a need to conduct research in rural areas to unearth such lived experiences that are mostly taken for granted by policymakers and the distributers of resources in those schools.

Support education spaces are the last spaces that have been identified by the Department of Education as essential for each school. These refer to spaces "that are also for learners' usage, but are not critical for the core functions of a school to progress smoothly. Examples include food gardens, sport fields, assembly halls, school kitchen, etc." (DoE, 2009, p. 14). Photograph 3 shows the identified support education spaces within Bash and Dashboard Secondary schools.

Image 1. Dashboard's vegetable garden

Image 2. Bash's vegetable garden

Image 3. Dashboard general sport field

Image 4. Bash's Tennis/netball field

Image 5. Bash's kitchen

Photograph 3: Some of the support education spaces within the two schools

Within both schools, the gardens appear to be taken care of. However, the conditions of the other spaces such as the sporting fields and kitchens are appalling. The sports field at Bash Secondary School is very bushy and dusty and it is apparent that it is never maintained. While Dashboard received sponsorship from the National Lottery to build the sporting facilities, in my observations it seems that these facilities are not being used. In the two schools there is a National Nutrition Programme[20], but the condition of the kitchens is not good; the women who cook for the children use firewood to cook and the structure of the kitchen is very dilapidated and lacks electricity. While the Department of Education identifies

[20] In April 2009, the National School Nutrition Programme (NSNP) was extended to Quintile 1 secondary schools, and all Quintile 2 and 3 Secondary schools in 2010 and 11 respectively. The learners in Quintiles 1, 2 and 3 are currently provided with daily meals (see the 2013/2014 Annual Report on NSNP for more information available at www.education.gov.za)

the structures above to be non-critical spaces in school, it is important to notice the role they may play in either constraining or enhancing learners' learning, depending on the availability and quality of such spaces. In these schools, the tick-box strategies cannot be applied to evaluate the availability of these spaces because as much as some of them are available, they are mainly in a bad condition. Hence, there is also a need to conduct studies within schools, particularly in rural and farm areas, to gain understanding of how the availability or lack thereof and the quality of the three identified spaces by the government shape the processes of teaching and learning.

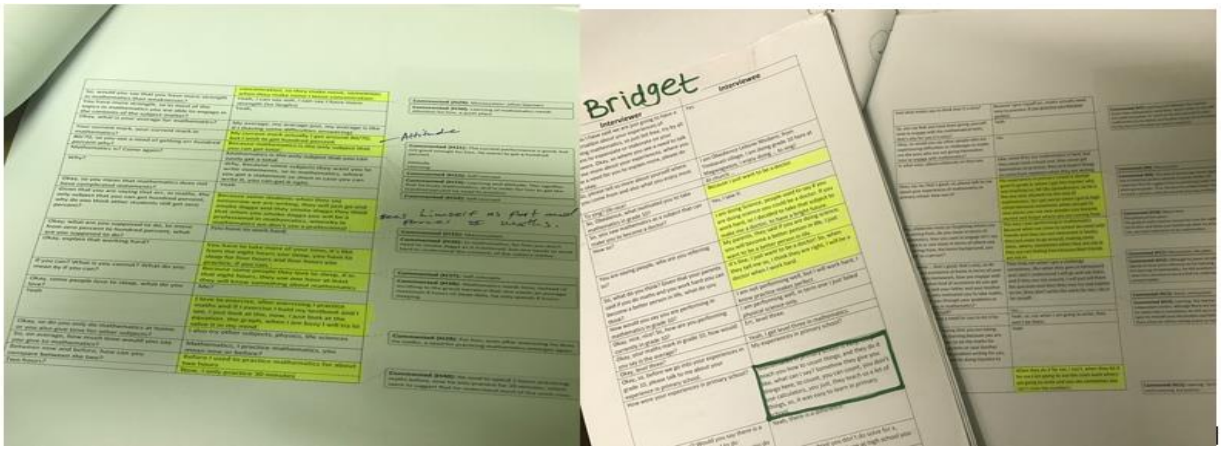
4.5. Data organisation and analysis

According to Marshall and Rossman (1999), data organisation and analysis refers to the process through which the researcher brings order, structure as well as creating meaning to the data collected. Various authors contend that in qualitative research, the data collection and analysis processes are inseparable (Strauss & Corbin, 1994; Veal, 2006; Tuckman & Harper, 2012; Atkins & Wallace, 2012). According to Stakes (1995) "there is no particular moment when data analysis begins" (p. 71). This means the data analysis process is about creating meaning from initial impressions during data collection and final compilations. Given this, I started analysing data after the first interview in order to identify patterns, and to facilitate further data collection. Data organisation and analysis processes are not linear in nature, but messy and time consuming. While this is the case, the process can also be an interesting and creative one (Denzin & Lincoln, 2000). In order to interpret and theorise data, I followed Creswell's (2009) six steps of data analysis, which helped me to identify general statements across categories of data for discussion. Although Creswell described the steps in linear order, in this study the process was not static; there were some recursive steps during analysis.

The first step is the organisation of data and preparation for analysis. In this study, this step involved the transcription of the twelve interviews verbatim and the summaries of the classroom observations were done. The transcription process involved tabulating the conversations between myself and the study participants in Microsoft Word (see Appendix 1), and the classroom observations were summarised and focused on the various forms of interactions that emerged in the classroom during learning. Since the methodology of the current study was critical phenomenology, it involved critically exploring Grade 10 rural

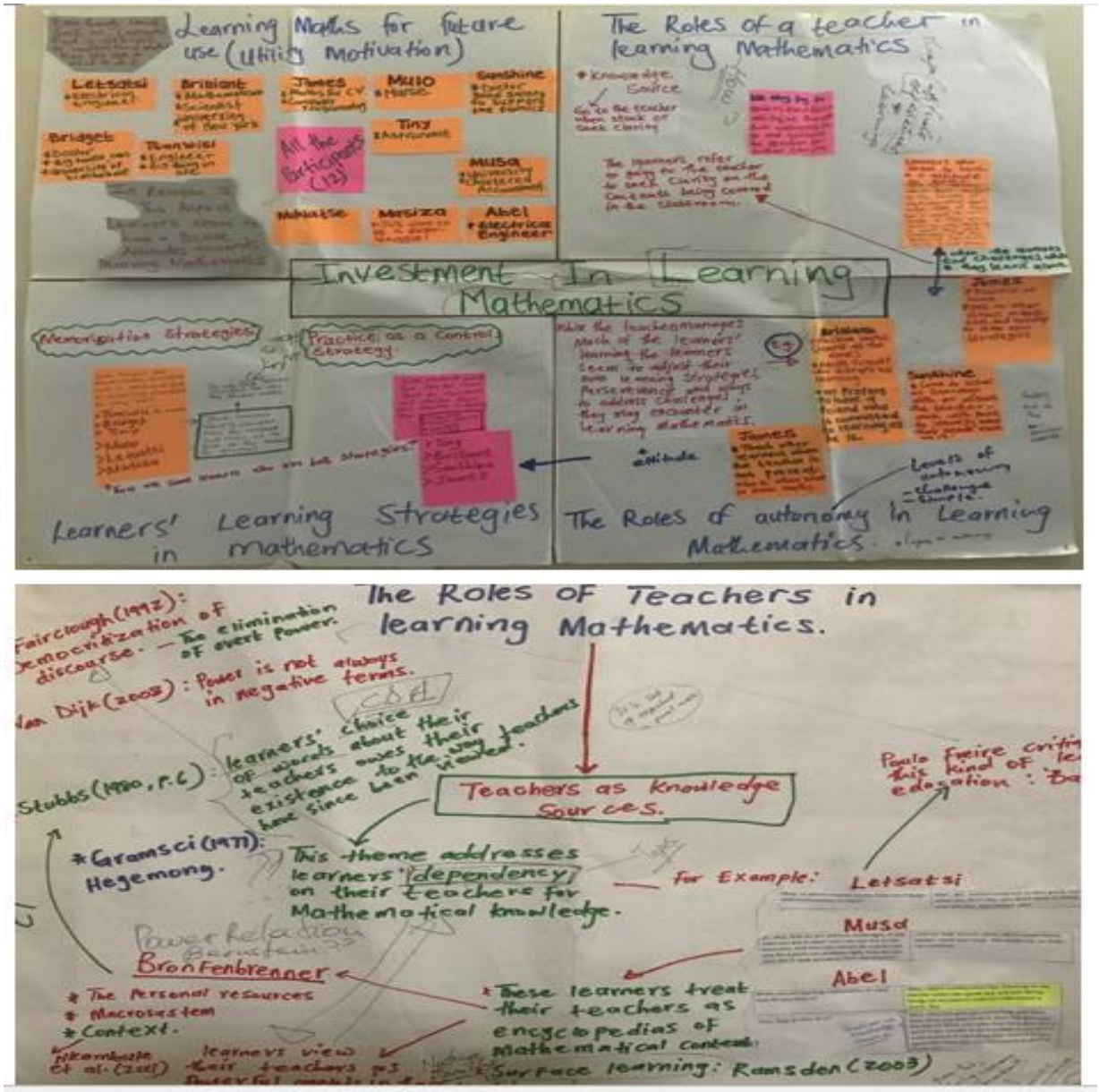
learners' experiences and attitudes towards learning mathematics, learners' statements had to be critically analysed which led to the second stage of data analysis.

Creswell (2009, p. 185) states that the second step entails reading through the data. For this step, I read and reread the interview transcripts, making notes in the margins of the transcript documents of the learners' choice of words, and I subsequently made a summary for each interview transcript based on the research objectives (see Appendix 2 for example). This step was followed in order to "obtain a general sense of the ideas, noting ideas and thinking about the general organisation of the data" (Creswell, 2012, p. 243). According to Creswell (2007), this process is referred to as 'horizontalization' of data, and photograph 4 depicts how I engaged with this step in the current study.



Photograph 4: Horizontalisation of learners' data

The third step involves a detailed analysis of the data (Creswell, 2009, p. 185). In this step, I followed the procedure described by Creswell; I organised the material by segmenting learners' statements and observed persona into categories. Thereafter, I labelled those categories using learners' used language. In the fourth step, which entails using the coding process to note patterns and themes for discussions, I identified the initial list of themes which after that were changed after further engagement with my supervisor. We noticed that rather than letting the data 'speak for itself' I was 'forcing' the data to fit into the identified theoretical framework detailed in chapter 3 (see Appendix 3). As Robson (2011, p. 468) aptly posits', in qualitative analysis, the researcher is required to have and maintain "clear thinking" throughout the analysis process, I then had to re-engage with the data. This involved going through each transcript again, making new notes in the margin and selecting the relevant parts from the raw data that best represented the themes and sub-themes.



Photograph 5: Selected parts of data represented on the charts

According to Best and Kahn (2006), the coding process involves selecting specific parts of the data that are relevant for the study and disregarding the data that is irrelevant, which do not particularly provide evidence for the themes identified, which is often known as 'dross' (Morse & Field, 1996). As depicted in photograph 5, the selected sections from the interview transcripts were cut out and pasted on charts, allowing me to identify overlaps and/or gaps in both the reviewed literature and the theoretical framework for the study. This process helped me to address the fifth step, which was about advancing how the themes' descriptions would be represented during discussions of the findings. The analysis processes detailed above resulted in three themes and sub-themes which are detailed in table 4 below.

Table 4: Themes and sub-themes for learners' experiences and attitudes to mathematics

MAIN THEMES	SUB-THEMES
Teachers' roles in learners' mathematics learning	▪ *If you don't understand, teachers will show you how to do it*
Roles of learners' autonomy in learning mathematics	▪ *Self-commitment and consolidation* ▪ *Self-direction and self-progression* ▪ *Peer collaborative learning*
The role of family in learning mathematics	▪ *Motivators of Mathematics Learning (MMLs)* ▪ *Guide in Mathematics Content (GMCs)*

Lastly, Creswell's (2009) sixth step involves creating meanings to the raw data, as Basit (2010) argues that "raw data have no meaning, and the act of interpretation brings meaning to raw, inexpressive data which is a necessary process" (p. 181). I observed this in the current study during the process of reorganising the data in relation to the three themes and sub-themes, and this allowed me to find connections among the themes and create meaning in relation to the focus of the current study, previous research, and Bronfenbrenner's Bioecological theory. The reorganisation of the data enabled the synthesising and interpretation of the descriptions the learners gave about their experiences of learning mathematics (Cohen et al., 2011). This was enhanced when I applied Critical Discourse Analysis in relation to the chosen theoretical framework to the themes and I was able to classify the identified themes and categories into Bronfenbrenner's framework. The information provided by the learners did not only confirm some of the components of the theoretical framework used, but also expanded others. Teaming Bronfenbrenner's Bioecological theory and Critical Discourse Analysis allowed me to establish helpful contexts for the kind of knowledge Critical Discourse Analysis extracts from texts (spoken, written, visual) (Fairclough, 2009; Janks, 2010).

4.5.1. The rationale for using Critical Discourse Analysis in relation to Bronfenbrenner's Bioecological theory

There are various possible qualitative analyses approaches: discourse analysis, narrative analysis and inductive thematic analysis, and this study used discourse analysis to complement the Bioecological theory discussed in chapter 3, specifically Fairclough's Critical Discourse Analysis (CDA). The rationale for using CDA with Bioecological theory is to complement each other during data analysis, and also to ensure in depth engagement with participants' responses which are complex. Brofenbrenner's theory is limited to understanding the multi-environmental influences on an individual's learning and development, while CDA "offers a sophisticated theorization of the relationship between social practices and discourse structures, and a wide range of tools and strategies for close analysis of actual, contextualized uses of language" (Lazar, 2007, pp. 4-5). While both the Bioecological theory and CDA analytical model acknowledges the centrality of social interaction in the teaching and learning processes, Fairclough's (1989) Critical Discourse Analysis framework moves beyond the central significance of dialogic interaction between an individual and an environment to explicitly setting out processes of analysis of language in use from the participants. This aspect is significant in this study because CDA does not only concentrate on *what* is said or represented, but also *how* things are represented through language, as it plays a crucial role in expressing individual perceptions, experiences and assumptions.

According to Luke (2002, p. 101) "a linguistic and text analytic metalanguage, no matter how comprehensive, cannot 'do' CDA in and of itself. It requires the overlay of a social theoretic discourse for explaining and explicating the social; contexts, concomitants, contingencies and consequences of any given text of discourse." Similarly, Pennycook (2001) contends that what texts 'do' in the world cannot solely be explained through text analytic language. Hence, in this study I used CDA to expand on Bioecological theory to understand the representations of participants' world that is partly linguistic-discursive, as meanings are historically and culturally specific and knowledge is created through social interaction (Jørgensen and Phillips 2004:4-6). If this is the case, it means participants' responses cannot be limited to the structures of the system, but are shape by multifaceted issues that CDA unearth and interrogate.

4.5.1.1. Fairclough's CDA Analytic Framework

Fairclough's (1989, 1995) CDA model[21] consists of three processes of analysis which are closely inter-related, and are tied to three dimensions of discourse that are inextricably related. The three dimensions are: the object of analysis, the human processes by which the object is produced, and the socio-historical conditions which shape these processes (Janks, 2010). To Fairclough, the above-mentioned dimensions each require a special kind of analysis: description (text analysis), interpretation (processing analysis), and explanation (social analysis). I chose this particular approach as it enables me to focus on the "signifiers that make up the text, the specific linguistic selections, their juxtapositioning, their sequencing, their layout" (Janks, 2010, p. 1). In relation to the choice of words that learners made during interviews, it is apparent that their "choice of language interlocutors make reflects their intentions, ideology, and thought" (Rahimi & Riasati, 2011, p. 107). The dimensions on which this analytic framework is based are depicted in figure 4.

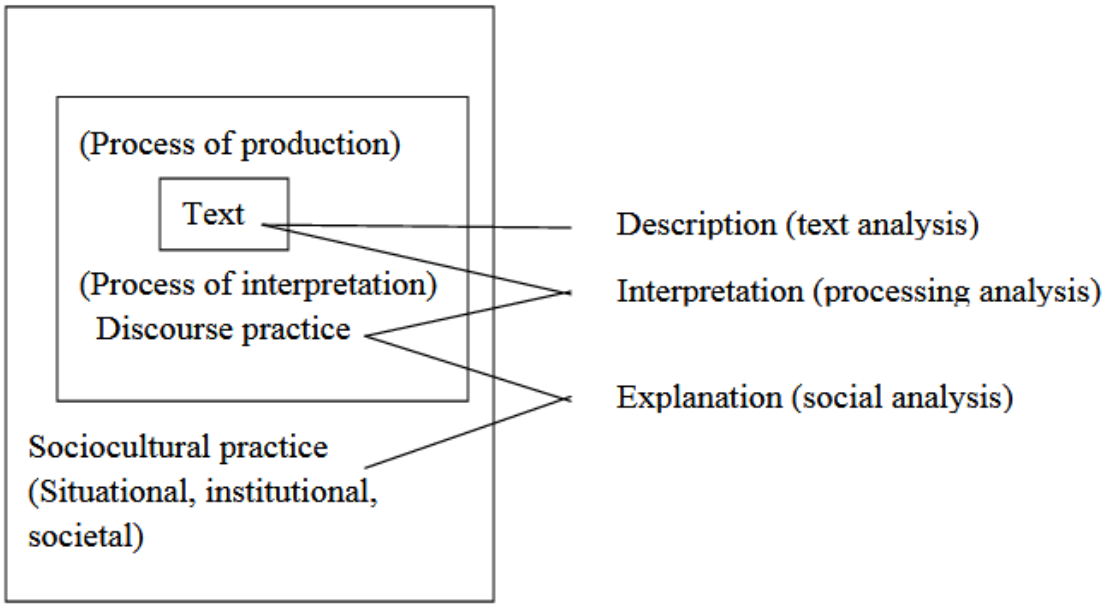


Figure 4. Dimensions of Critical Discourse Analysis (Titscher, Meyer, Wodak, & Vetter, 2000, p.152) (based on Fairclough's 1992a, p.73)

In the present study, this analytical framework informs the findings in the following ways. Firstly, the multi-layered analysis ~~is~~ integrates textual, processing and social levels of analysing learners' discourses about the experiences and attitudes towards mathematics and also concerning learning mathematics. Secondly, the comments made by the learners during

[21] See Janks (2010) for a clear demonstration of how to use Fairclough's model of CD Analysis.

interviews about their experiences in learning mathematics may provide more information than simply conveying what they said at surface value. Hence, CDA helps me to unearth social information they "conveyed inexplicitly" (Rahimi & Riasati, 2011, p. 107) about their experiences of learning mathematics and in turn their attitudes to mathematics. This is because participants' choice of words and prioritised meanings are never neutral, but owes their meanings "in a particular historical, social, and political condition and the meaning we convey with those words is identified by our immediate social, political, and historical conditions" (Fiske, 1994, p. 11). This, as also previously discussed in chapter 3, highlights that our social actions are shaped by multiple structures within the environments in which social relations emerge. CDA helps in "uncovering the relationship between language, society, power, ideology, values and opinions" (Rahimi & Riasati, 2011, p. 108). Similar to the Bioecological theory, the influence of various environmental levels on an individual's social actions seems to also be important in understanding how participants make use of language within broader social orders. This signifies that the aspect of language is very important in the construction of knowledge and 'reality', and is argued to be influenced by socio-cultural and political dynamics (Fairclough & Wodak, 1997). Thus, all the semi-structured interview transcripts in the form of written texts were analysed by using CDA in order to deconstruct these texts "to come up with their intended ideologies" (Rahimi & Riasati, 2011, p. 111) about the learning of mathematics. Thus, in order to unearth the linguistic evidence for the claims made from the discourse analytical work, texts are critically analysed. CDA together with the Bioecological theoretical framework allows me to understand the discursive manifestations of learners' choice of words, since discursive practices are inherent in various social structures, which are mainly constructed and "legitimized in and through language i.e., discourse" (Rahimi & Riasati, 2011, p. 111).

There is a need to denaturalise taken for granted assumptions in order to unearth the grand narratives of the broader social order, advantaging some individuals at the expense of others (see Janks, 2010). This relates to Stubbs' (1980) observations that "if people and things are repeatedly talked about in certain ways, then there is a good chance that this will affect how they are thought of" (p. 6). The social constructed status of mathematics, for example, may have dominated the ways people perceive it in different societies, in turn rendering other subjects substandard in advancing individuals' career horizons and leading a good life. Hence, it becomes important to deconstruct learners' experiences and perceptions in learning mathematics. The purpose of this study is to explore and interrogate Grade 10 rural

Acornhoek learners' experiences and attitudes to mathematics. It is possible that even if learners try to shift into new discourses, speaking of the importance of other subjects in their school curriculum, for example, the entrenched patterns of speaking about the nature of mathematics influence the choice of words learners used to speak about their experiences in learning mathematics (Janks, 2010).

4.6. Ethical considerations

Babbie and Mouton (2007) contend that during our interactions with other people and with other beings and the environment, ethical issues arise. That is, when engaging with an aspect that is likely to stir up conflict, arguments arise, so a researcher must always be sensitive to the ethical component in research. "In some cases, doing the right thing might involve placing the greater good above specific benefits that might accrue to me. In many cases, ethical choices involve a trade-off or compromise between the interests and rights of different parties" (Babbie & Mouton, 2007, p. 520). This calls for researchers to make ethical considerations of their choices and how these choices could potentially affect the people who are taking part in the study. The researcher is thus obligated to avoid certain acts which may be viewed to be morally impermissible or infringe on the rights of other individuals in society. In this part of the study, I introduce the reader to various ethical considerations that I adhered during the course of the study.

4.6.1. The protection of the learners' and their schools' identities

"The clearest concern in the protection of the subject's interest and wellbeing is the protection of their identity" (Babbie & Mouton, 2007, p. 523). Since I asked the learners to divulge information that is personal and which might not be known by other people such as their teachers, it is advisable that the identities of all the participants are protected. Regarding this, Babbie and Mouton (2007) further suggest two ways of ensuring that the identities of the study participants are protected, namely anonymity and confidentiality. Given that the participants in this study are Grade 10 learners, who are mostly minors (i.e. between the ages of 16 to 18) I considered all my participants to be vulnerable individuals (Shivayogi, 2013). Before the study could begin, the learners' parents were asked to consent that their children take part in the study. Also, the children assented that they were clear about all the information presented to them about the study and its objectives. Before the study could commence all the learners were assured of anonymity and confidentiality. Thus, within this

study, all the learners are addressed using pseudonyms, as indicated earlier. In addition, I also gave the two schools which the learners attend, school pseudonyms to conceal their actual names (Scott & Morrison, 2005).

4.6.2. Access to the schools and classrooms

Since this study is located within a larger research project, my supervisor asked for permission from the Mpumalanga Department of Education to conduct the study at the selected schools, and permission was granted. To gain access to the schools, I used the larger project's acceptance letters from the Mpumalanga Department of Education (MDE) to gain access to the schools and to work with the selected learners (See Appendix 4). I also applied for ethical clearance from the Ethics Committee of the University of the Witwatersrand and my proposal was passed before the study could commence. In addition to the request from the above-mentioned institution, I also wrote a letter to the school principals requesting permission to use their schools as sites for interviews (Appendix 5). As Creswell (2007) contends, in order for the participants to share information honestly and openly, the researcher should identify an environment that is comfortable for them, where they feel secure enough to divulge information. That is, I assumed that the learners would feel free to engage with me honestly during the interviews if they knew that there were people that they trusted on site, such as their teachers, so if they wished to withdraw their agreement to be participants in the study they could withdraw at any time without being afraid of victimisation or me insisting that they continue to take part in the study or even manipulating them. Although this study does not focus on teachers primarily, the preamble letter and letter of consent were also delivered by hand to the teachers whose classes I observed, detailing the nature of the study (Appendix 6). The teachers were assured that their classroom routines would not be advantaged or disadvantaged in any way and that they could ask me to leave the class at any time without any penalty.

4.6.3. Informed Consent

The preamble letter and letter of consent were delivered by hand to the principals detailing the nature of the study. Before interviews and classroom observations, I went through the consent form with each of the twelve learners and written consent was granted. Given that most of the Grade 10 learners are younger than the age of 18, which according to the South African Constitution are considered as minors, the participating learners took the consent letter to their parents or guardians to give consent that their children could participate in the

study (Appendix 7). This study took the overt ethical research approach rather than the covert. The overt ethical research approach involves the processes through which the researcher openly informs the study participants about the nature of the study and the specific reasons why they are conducting the study and how the information obtained from the participants is going to be used by the researcher and for what purpose (Scott & Morrison, 2005, p. 87). Thus, before I conducted individual interviews and classroom observations, I made it clear to all twelve learners who took part in the study and assured their parents that this research was for my masters' dissertation, however, that the information they provided may also be used for conference presentations and publications of journal articles in order to contribute to the literature on mathematics education research in rural contexts (Appendix 8).

4.6.4. Right to withdraw

Another ethical consideration I adhered to during the course of the study is the participants' right to withdraw from taking part in the current study. I notified each participant before we started with the interviews and before I conducted classroom observations that they had a choice not to take part in the study, and clearly assured them that their taking part in this study was purely voluntary. This meant they could withdraw their agreement to be participants at any time and for any reason (Babbie & Mouton, 2007). However, none of the selected participants withdrew their consent during the course of the study.

4.7. Ensuring the quality of the study findings: trustworthiness

There are issues that are considered important which maximise the trustworthiness of the study. According to Loh (2013) it is important for the research study to observe the criteria of making sure that the study is valid, reliable and is generalisable, as this is a prerequisite "for the research to be accepted into the pantheon of knowledge and to be received as suitable for use in various means and ways" (Loh, 2013, p. 4). Various authors (Loh, 2013; Shenton, 2004; Creswell, 2009; Babbie & Mouton, 2007) draw on four strategies for the establishment of trustworthiness in qualitative research as coined by Lincoln and Guba (1985), namely: credibility, transferability, dependability and confirmability.

4.7.1. Credibility

In any empirical research, it becomes important for the researcher to ensure that the study findings are a true reflection of the information provided by the participants. Regarding this, Anney (2014) defines credibility of the study as referring to "the confidence that can be

placed in the truth of the research findings" (p. 276). Anney (2014) further suggests strategies to establish credibility of the study: "prolonged and varied field experience, time sampling, reflexivity (field journal), triangulation, member checking, peer examination, interview technique, establishing authority of researcher and structural coherence" (p. 276). In this study, since the study was conducted within two schools for the entire month spent in Acornhoek, I spent half a day in each school daily in order to have a comprehensive understanding of the culture of participants and the contexts. Spending time at each school daily enabled me to gain insight into the factors within the schools that possibly shape learners' experiences and attitudes towards learning mathematics. Anney (2014) suggests that a researcher should use peer debriefing; at the end of each day while in the research field, we had about an hour of talking about the events at the schools together with my supervisor and my research colleagues. This helped me greatly in terms of how I could rephrase particular questions the following day in order to make the questions clearer to the learners. In addition to this, during the compilation of this dissertation, I frequently presented my ideas to my research peers and their criticism and contributions at times called me to task to refine my thoughts in developing the conclusions for this study.

In addition, another aspect that increased the credibility of this study was through the interview technique that I followed. As stated earlier, this study used a semi-structured interview technique which allowed for open conversations with the learners about their experiences of learning mathematics and this in turn enabled me to give thick descriptions about their attitudes towards mathematics and its learning. Further, another strategy I used to maximise the credibility of the inquiry is member checking. I went back to the learners who provided me with the information to check both data and the information and see if they correlated. Given that I did not transcribe the interviews the same day, I went back to Acornhoek to interact with the participants again and verify the data. This was to check whether they considered that their words or views about the subject under study matched what they actually meant to utter during interviews and during our conversations in the follow-up schedule. Also, member checking allowed me to have conversations with the learners about the observations I had made in the classroom, for them to explain to me why they had acted the way they did in the classroom the time I observed them learning mathematics. This further gave me understanding of the factors within the classrooms that shape their learning of mathematics.

4.7.2. Transferability

According to Babbie and Mouton (2007) transferability "refers to the extent to which the findings can be applied in other contexts or with other respondents" (p. 277). The strategies for ensuring transferability include providing "detailed descriptions of data" and using purposive sampling (Babbie & Mouton, 2007, p. 277). To ensure detailed descriptions, thorough descriptions of the data are provided. As outlined earlier, purposive sampling was used for this study because it promotes the variety of information provided by the participants about the subject under study (Babbie & Mouton, 2001; Babbie & Mouton, 2007).

4.7.3. Dependability

To address issues of dependability of this study, my supervisor acted as the inquiry auditor. The role of an inquiry auditor is to examine "the data, findings, interpretations and recommendations" (Babbie & Mouton, 2007, p. 278) of the study to establish whether or not they correlate. My supervisor examined the data that I collected, the findings, my interpretations of the information provided by the participants, as well as the recommendations I suggest in this study and she attested that they interlink. She also evaluated the coherence in the writing of this report. Given that she acted as the inquiry auditor, she evaluated whether the conclusions, interpretations of participants' responses and my recommendations can be supported by what the participants actually uttered during the interviews and my interpretations of the learners' actions during mathematics learning in the classroom. Two sets of criteria for inquiry audit are necessary for master's research, supervision and examination. Firstly, during our supervision meetings, my supervisor continually challenged me to think critically and deeper about each and every component of this study, to ensure that no information was treated at surface value. Secondly, before I could be accepted for master's candidature, the prerequisite was a proposal presentation and assessment. Through the presentations at the Wits School of Education PhD weekend, the lecturers and fellow students scrutinised my proposal and they challenged me where necessary and academically advisable to refine the focus of the study. In addition, my study proposal was sent to the internal and external readers who are both specialists in mathematics education and mathematics education research and my proposal was passed (see Appendix 9 for letter of candidature). The last form of audit is the final examination of the dissertation; this is to ensure that all the ideas presented in this study are academically sound and coherent.

4.7.4. Confirmability

The final strategy to ensure trustworthiness is called confirmability. Confirmability entails the correlation between the researcher's descriptions and interpretations of the information provided by the participants and what the participants actually uttered during the interviews. For Babbie and Mouton (2007, p. 278) confirmability refers to "the degree to which the findings are the product of the focus of the inquiry and not the biases of the researcher". To reinforce this statement, Anney (2014) posits that confirmability is concerned with ensuring that the researcher does not provide "misinformation, evasion and lies" (p. 279). "Confirmability also can be established using a reflexive journal" (Anney, 2014, p. 279). For the period spent in Acornhoek, I kept a reflexive journal which details all the events that took place in the research field and includes the 'ah' events that arose during data collection. In addition, sometimes when listening to the conversations from an audiotape some of the utterances from both the researcher and the participants may be inaudible. In order to ensure that I did not write "figments" (p. 279) of my own imagination as the researcher, I listened to the audio clips multiple times to ensure that the transcripts reflected the information provided by the participants precisely.

4.8. Chapter summary

In this chapter, I described in depth the process and methods that were used to collect, sort and analyse the qualitative data which was gathered by means of semi-structured, 'depth individual interviews' and non-participant classroom observations. This description included explanations and justifications of the choice of participants and data analysis techniques and processes for this study. This chapter also outlined the ethical considerations for this study. Chapter 5 presents in detail the findings of this qualitative research.

Chapter 5

THE DYNAMICS OF EXPERIENCES AND LEARNING OF MATHEMATICS IN ACORNHOEK:

DATA PRESENTATION, ANALYSIS AND DISCUSSION OF FINDINGS

I ask the reader to remember that what is most obvious may be most worthy of analysis. Fertile vistas may open out when commonplace facts are examined from a fresh point of view. – Lancelot Low Whyte

5.1. Introduction

In this chapter, I critically discuss the findings of the study, which explored Grade 10 rural learners' experiences and attitudes towards learning mathematics from interviews and classroom observations. As discussed in earlier chapters, learners' experiences and attitudes towards learning mathematics are shaped by their multi-level interrelations with various stakeholders in and outside the school context. While interpreting and discussing the findings that are reported in this chapter, I use participants' responses as evidence of their experiences and attitudes towards learning mathematics. Before I present and discuss the themes it is worth reiterating that the primary purpose of classroom observations was to supplement the information that was provided by learners during interviews. Before I engage in in-depth discussions of the findings, I present a summary of three major themes and sub-themes that emerged from the analysis of both interviews and classroom observations, which I presented in Table 4, chapter 4.

The first major theme is **'Teachers' roles in learners' mathematics learning'**. This theme refers to the interactions that learners have with their teachers in order to learn the contents of mathematics within the school, and consists of one sub-theme namely *'If you don't understand, teachers will show you how to do it'.* This sub-theme details learners' dependency on teachers to explain the mathematical contents until they understand. The second major theme is **'Roles of learners' autonomy in learning mathematics'**. The theme suggests that through the establishment of goals, learners' adjustment of their mathematics learning strategies, perseverance and the configuration of strategies to overcome challenges

in learning the subject, makes most of them in charge of their own individual learning. Although teachers are still needed in learners' learning, some learners believe that the learning of mathematics is not something that is being done to them by their teachers, but that they are actively involved in learning it for themselves. In this theme, three sub-themes were identified: *self-commitment and consolidation, self-direction and self-progression,* and *peer collaborative learning*.

In addition, the third major theme that emerged is **'The role of family in learning mathematics'**, which addresses the role played by the interaction between the learner and his family members at home to re-learn the contents of mathematics. Two sub-themes *Motivators of Mathematics Learning (MMLs)* and *Guides in Mathematics Content (GMCs)* were revealed. The first sub-theme within this theme looks at the role of family members as 'MMLs'. This focuses on emotional support the child's family members provide for a learner's learning of mathematics at home. The second sub-theme, GMCs, addresses the role played by family members and community members in assisting the learners to learn the contents of mathematics outside the classroom context.

5.2. Teachers' roles in learners' mathematics learning

Previous research studies have highlighted many factors within a school that influence learners' learning which include learners' individual characteristics, and the neighbourhood experiences (Westwood, 2008; Köğce, Yıldız, Aydın, & Altındağ, 2009; Duatepe-Paksu & Ubuz, 2009). The other factor is within the microsystem of the classroom, which is the teachers, and the nature of interactions during teaching and learning (Bishop, 1987; Lukhele, Murray & Olivier, 1999; Bronfenbrenner, 2005). From the findings, I identified learners' interactions with mathematics teachers to be a factor that shapes their experiences and attitudes towards learning the subject, addressing the last sub-research question. While the study is about learners and their learning of mathematics, it is unsurprising that the teacher was mentioned as playing a crucial role.

5.2.1. If you don't understand, teachers will show you how to do it

Within the education context, discussions about attitudes towards learning mathematics are typically learner-centred, and such discussions emphasise the teachers' role in the promotion

of learners' favourable learning experiences and attitudes towards mathematics (Nicolaidou & Philippou, 2003; Mourshed & Barber, 2007; Westwood, 2008; CDE, 2014). It is agreed that learners independently give meaning to the words and symbols of mathematics (Bergeson, 2000), yet learners' responses in this study illustrated that such meanings are derived from the teacher's pedagogical approach in the classroom. For example, Abel said that during mathematics learning, teachers *"give you something and then show you how to do it … if you don't understand it in class they show it to you again".* Similarly, Letsatsi stated that *"Mathematics is very good, but when you don't listen to your maths teacher, you cannot pass",* which presents learners' beliefs that a teacher's knowledge is a determinant of performance and learners rely on a teacher for content knowledge. While it is expected and understandable that learners depend on a teacher to introduce the concepts and content knowledge, however the way they do this may instils positive attitudes towards the learning of mathematics. When teachers avail themselves when needed, provide learners with information, and show them how to do mathematics, this offers a confident experience.

In addition to the above responses, Musa reiterated the dependency and accessibility of a teacher: "*I tell her [the mathematics teacher] that, 'Ma'am, here I don't understand, please I need your help.' She helps me, so that I can continue*". While Musa's response seems to also convey reliance on the teacher for mathematics knowledge, for him the teacher's willingness to explain concepts until he understands is linked to learning continuity. It appears that when the teacher acts as the 'fountainhead'[22] of mathematical knowledge and helps him to understand the subject matter contents, it enables him to continue learning, resulting in positive experiences and attitudes to mathematics. The three learners' actions during classroom observations supported their utterances during interviews. For example, Letsatsi sat quietly at the back of the classroom taking notes of everything the teacher wrote on the board, illustrating the need to listen to the teacher in order to get the knowledge so that 'he can pass'. From classroom observations, his teacher mainly used the 'show and tell' teaching strategy to teach the contents, leaving no room for learners to engage in problem solving. Thus, it appears that learners' beliefs about their teachers' roles in their learning of mathematics are influenced by their day-to-day interactions in the classroom. This addresses the link between the ways teachers teach the contents of mathematics and learners' attitudes towards the subject and its learning. This links with observations made by Ponte, Matos,

[22] Learners' responses suggest that they see their teachers as the original source of mathematical skills, processes and contents.

Guimaraes, Leal and Canavarro (1994) that, "Mathematics teachers organise the learning experiences of their students and consequently are in a critical position to influence their views, conceptions and attitudes" (p. 2).

Interestingly, this study finding suggests that even in cases where learners seem to struggle learning the contents of mathematics, their teachers' willingness and availability to help them understand the mathematical contents appears to help mitigate the development of negative attitudes towards learning mathematics. According to Bronfenbrenner (1979), it is important to take into account the reciprocity essential to the role each individual plays in the completion of particular activities during learning and teaching. He expressed it thus: "A role is a set of activities and relations expected of a person occupying a particular position in society, and of other in relation to the person" (Bronfenbrenner, 1979, p. 85). The example Bronfenbrenner provides to elaborate this reveals its relevance to this study's finding: "…when a teacher explains, the pupil is expected to listen" (p. 85). Thus, some of the information provided by the participants seems to suggest that in cases where teachers are able to fulfil their roles as mathematics teachers to elicit understanding of mathematical contents, skills and processes play a crucial part in the establishment and maintenance of both positive experiences and attitudes towards learning the subject.

Moreover, most of the learners that took part in this study seem to hold a belief that only their mathematics teachers are legitimate epistemological agents during learning and teaching processes. If Janks' (2010) statement, "Who we are and how we think is profoundly influenced by the discourses that we inhabit" (p. 55) is taken into consideration, it appears that learners' responses are shaped by their classroom experiences and the nature of interactions with teachers. Shulman (1986) posits that teachers should have particular levels of Pedagogical Content Knowledge, so that they can effectively engage their learners in the processes of meaning-making and enable learners' understanding. It was interesting the way learners spoke about mathematics learning experiences in relation to how they engage in learning through interactions with their teachers and the learning environment. The identification of teachers as significant others as well as the descriptions of how supportive they are in learners' learning, seems to contribute to learners' positive learning experiences and attitudes towards mathematics. This links with Bronfenbrenner's construal of the ecological contexts that surround the individuals, that learning takes place in the interactions

between the learner and their situated environment, a teacher in this study, and in the activities in which learners participate (1979; 1995).

Considering learners' silence about their own roles as learners in their learning of mathematics, I acknowledge that participants' responses could also be interpreted as merely receivers of information from their teachers, with the aim of reproducing a homogenous product at the end of the learning processes. This is especially true if participants' choices of words, for example, *"... they show me how..."*; *"she helps me, so that I can continue"* and *"when you don't listen to your maths teacher, you cannot pass",* illustrate the way in which these learners assume 'who' is in charge of their mathematics learning. Although this might be the case, learners' responses suggest that these experiences helped them learn mathematics and develop positive attitudes towards learning the subject. Research also shows that the quality of teacher-learner interaction during learning plays a major role in enhancing learners' understanding of the subject matter contents, most especially the feedback the learner is provided with, which is essential (Hattie, 2003; Steele, 2009). From learners' responses above, the teacher's role in their learning of mathematics is observed as a key element that enhances the promotion of learners' positive experiences and attitudes (Fennena & Sherman, 1978; Christou, Phillipou & Menon, 2001). Findings from Bergeson (2000) support learners' responses above; the author state that the teacher has mathematical knowledge and understanding that enables them to "see" mathematics concepts "in ways that learners are not yet ready to see themselves" (p. 57). This could be the reason Abel and Letsatsi appear to believe that learning cannot take place without the teacher present, because teachers were able to help them see and understand mathematics concepts in ways they did not think they could. While some learners depended on their teachers for mathematical knowledge and ensuring that learning continues, others managed to work autonomously in learning the contents of mathematics as supported by the discussions of their responses in the following section, representing the second theme.

5.3. The roles of learners' autonomy in learning mathematics

As mentioned earlier, the second theme that emerged from semi-structured individual interviews was the *role of learners' autonomy in learning mathematics*, and the sub-themes were: *self-commitment and consolidation, self-direction and self-progression,* and *peer collaborative learning.* I draw, in particular, on Little's (1991, p. 4) concept of autonomy,

which is "a capacity for detachment, critical reflection, decision making and independent action. It presupposes, but also entails, that the learner will develop a particular *attitude towards* the process and content of his learning" (italics added). This quote posits that autonomous learning is based on learners' self-evaluation and self-arrangement of learning the contents (Cao, 2013), in this study, the contents of mathematics. Autonomous learning entails that learners learn the contents of the subject matter independently, since "independence is the core quality of autonomous" learning (Cao, 2013, p. 13). Thus, in the current study, learners who strive "to make sense of the presented material by selecting relevant incoming information, organizing it into a coherent structure, and integrating it with other organized knowledge *independently of their mathematics teachers are autonomous*" (Meyer, 2004, p. 17 italics added). This links with Kuhn's (2007) assertions that the primary goal of modern education is to enable learners "to use their minds well in school and beyond" (p. 110), which possibly depends on learners' capabilities to work independently of their teachers that fosters critical thinking.

5.3.1. Self-commitment and consolidation

It is commonly understood that as learners learn the contents of mathematics, some also develop self-commitment to learning the subject, which usually enhances the engendering of positive attitudes and experiences in learning mathematics (Lave, 1988). There are numerous studies (for example, Romberg, 2000; Sabean & Bavaria, 2005) which suggest that when one spends time practising mathematics, such practice can enable them to master the skills and apply the knowledge efficiently. This is consistent with Bronfenbrenner's aspect of "person", in which he postulates that when learners regard learning the contents of the subject matter as personally meaningful, it helps to enhance their positive attitudes and therefore a greater likelihood that such learning will result in a satisfactory experience (1979; 1995).

From some learners' responses, they showed commitment to practising the contents taught by the teacher during learning in the classroom. Of interest in this study is that such commitment to re-learn the contents appears to help learners maintain information processing, and developing skills and interest in learning mathematics. For example, Tsan'wisi said, "*When I go home, I have to open that book of mine and practise that number that we have learned inside the classroom"*, suggesting responsibility for own learning of mathematics, as well as commitment to ensure that understanding is elicited through practise. Considering the choice

of words "…every time *I have to make sure that what I have learned, is in my brains, I have to do that* …" (Tsan'wisi), ensures that learning does not end in school but continues at home and re-learn for the purpose of understanding the concept(s). In Tsan'wisi's excerpt above, repetition the words "*I have to"* illustrates that he has made the practising of mathematics personal, and further suggests that he has taken ownership and responsibility for his own learning of mathematical contents. According to Olivier (1999) "Learning mathematics is not a matter of finding out what some other people want you to do under certain circumstance, it is a matter of personally constructing the knowledge you need to solve problems" (pp. 30-31). Similarly, Sunshine reinforced the importance of practice in mathematics *"I would be able to do good if I practise maths every day, if I practise it every day, I won't forget anything that we get from our teachers. So, I must practise every day so that I cannot forget the things that we do from January up to June"*. From this response, it appears that retention of mathematical knowledge learned previously is the primary goal that drives Sunshine to constantly practise the contents of the subject matter, and proposes a positive learning experience and consequently positive attitude towards learning mathematics. The words *"I must practise every day"* signify the learner's non-compromising self-commitment to consolidate the learned mathematical contents, which could be interpreted as an affirmative attitude towards learning the subject.

The classroom observation is evidence of Sunshine's attitude as she was able to recall or remember pieces of knowledge, skills and processes that the teacher had taught in previous lessons. The teacher was introducing learners to how to sketch the graph of hyperbolic functions, and given that the learners had been introduced to sketching linear and parabolic functions, Sunshine applied her prior knowledge on how to sketch graphs to explain how to plot hyperbolic functions, and most of her explanations were correct. Thus, her actions propose that personal attachment to autonomously practise the previously learned contents and skills promotes knowledge retention, and in turn, knowledge transfer. According to Sabean and Bavaria (2005) practise of mathematical skills and methods previously learned facilitates a deeper intellectual quality in learning the subject. This suggests continuous practise of mathematical contents and processes helped Sunshine to transfer knowledge. It was also interesting the way Sunshine explained the process before engaging with practising mathematics: *"Before you can practise maths, you need to exercise, refresh your mind, your body, and then you practise [mathematics]. Your mind needs to be clean, get all those things*

out of your mind and you will focus on mathematics, so you can do better". Sunshine believes that in order to make sense of mathematical contents during practice, she needs to exercise to enhance her alertness when she is engaging with the mathematics contents, and this helps her cement new learned ideas. This is supported by Viadero's (2008) suggestion that exercise helps put learners' brains in the optimal state for them to learn, think and recall the learned information better.

Romberg (2000) argues that meaningful learning is a result of purposeful engagement with the mathematics content knowledge, and I argue that participants' purposeful learning and autonomy resulted in meaningful learning of mathematics. The consequence of practising mathematics skills and methods is a positive attitude and deeper intellectual mathematics knowledge for the participants, and links with the positive learning experience in the classroom. In addition, it seems Sunshine's autonomy to practise mathematics daily is a "control strategy" in her learning. OECD (2004, p. 141) defined control strategies as ways through which learners "monitor their learning by, for example, checking what they have learned and working out what they still need to learn". Other research findings (Son & Metcalfe, 2000; OECD, 2004; OECD, 2010) suggest that the use of a control strategy in mathematics is linked to learners with negative attitudes and those who are anxious about learning mathematics. However, for Sunshine it appears that a positive attitude, possibly shaped by her socio-economic background, influenced a control strategy that will ensure success. Lambdin (2003, p. 11) states that "a teacher's goal is to help students understand mathematics; yet understanding is something that one cannot teach directly", suggesting a need for learners to be actively involved in their learning processes. Learners' utterances and classroom observations propose that those who appear to be personally attached to learning mathematics, as well as an understanding that constant practise can elicit understanding, seem to hold positive attitudes towards learning mathematics and they give the impression of having positive learning experiences (Kloosterman, 1988).

5.3.2. Self-direction and self-progression

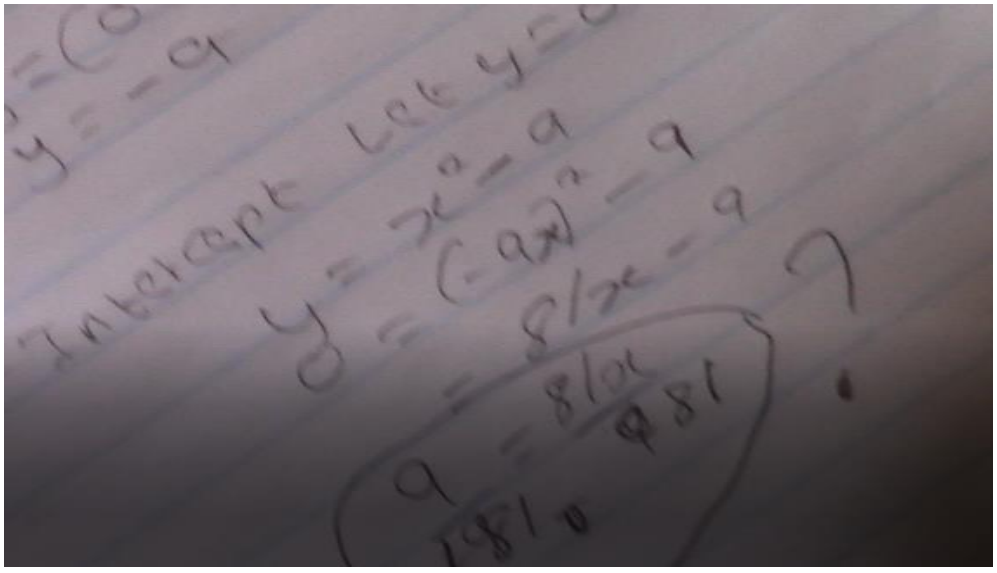
In this study, both learners' interest and the motivation to learn mathematics seem to promote self-direction and self-progression to show autonomy. While self-commitment and consolidation addressed learners' sense of responsibility to ensure that whatever the teacher has covered in the classroom is understood, self-direction and self-progression present discussions of learners' responses which propose that they do not merely re-learn the work

the teacher has covered in class, but also self-initiate the learning of new topics even before the teachers cover them in class. According to OECD (2004, p. 116), "Motivation and engagement can be regarded as the driving forces of learning", because lack thereof can also shape demotivation and disengagement. Thus, from learners' utterances during interviews, some of them preferred to be ahead of their teachers and, interestingly, wanted no engagement from the teachers in their learning of mathematics.

Brilliant presented an interesting autonomy in learning mathematics that suggests self-progression: *"I practise mathematics and get some information, even now in class, my teacher is teaching, she is behind me and I am ahead of her".* From this statement, it appears that Brilliant does not merely depend on the teacher for subject matter knowledge, but he also learns the contents of mathematics by himself, without the teacher's help. Along similar sentiment, James said: *"In mathematics, when ma'am is still in the last topic, when I get home I practise that topic and then I find the solution, from there I go to another topic and see that I am good".* Brilliant and James differ from the two participants in the previous section because for them practising the contents, skills and processes in mathematics is not merely about consolidating what their teacher has covered in class, but they also engage with new concepts on their own before they are introduced in class, the reason I foregrounded the aspect of self-progression at the beginning of this section. This addresses the importance of prior learning, as having a good sense of what you know can help you to be a convergent thinker and to be able to assess your capabilities in learning the contents (Schoenfeld, 1987). As such, learners' prior practice of mathematics contents can enable them to be able to ask questions in class in cases where there were some things they did not understand while practising (Svinicki, 1994). From the learners' responses above, it appears that these learners are able to self-progress to subsequent topics because they have prior knowledge that helps them to make sense of new knowledge that they encounter as they self-direct their learning.

In addition, Brilliant's and James' responses above suggest that they learn through exploration, which is inspired by control of the subject matter contents. The participants' learning of mathematics links closely with the notion of "deliberate practice" coined by Ericsson, Krampe, and Tesch-Römer (1993, p. 367), explaining how individuals tend to become experts in particular fields. According to their findings, experts are continuously engaged in countless hours systematically practising to perform a certain activity, and this is

noticed in the two participants that are discussed in this section. Deliberate practice for them revolves around identifying and learning the content that needs much work in mathematics, and can be taken to mean that they have positive learning experiences in mathematics, as well as positive attitudes to learn the subject. The learners' self-directed learning and self-progression as discussed in the earlier responses allude to Bandura's (2001) argument that "people are not only knowers and performers, they are also self-reactors with a capacity for self-direction" (p. 3). For both Brilliant and James, this could mean that the incentive motivator for self-directed mathematics learning and their commitment to possibly become proficient in the subject is their "anticipated self-satisfaction gained from fulfilling valued standards" (p. 3). Brilliant further emphasised the ability to understand mathematics *"... I can understand mathematics at any time ... my motivation is that I find mathematics so easy*", which demonstrates particular satisfaction that is gained from solving mathematical problems. Of interest is that the classroom observation contradicted his utterance that he could "understand mathematics at any time", as he appeared to have misunderstood how to determine the x-intercepts of the equation $y = x^2 - 9$ as shown in the photograph 6 below:



Photograph 6: Brilliant's misunderstanding during the lesson

Of concern with this observation is that Brilliant did not ask the teacher for clarity, and instead put a question mark next to the parts that he seemed to have misunderstood (see the above photograph). The response from the participant after being asked about his behaviour is that *"I understand it better when I do it by myself at home".* While this was interesting, however, it can be discerned that Brilliant seemed to have a negative attitude towards his

mathematics teacher and not the mathematics content knowledge and its learning, a possible reason why he did not ask the teacher for help when he had difficulties. This was noticed in the following response: *"Sometimes when the teacher is teaching, they do wrong equations, and when you say 'Ma'am you have made a mistake,' some will be angry at us too"*, which demonstrates the preferred self-directed learning. Although Brilliant's autonomy could be interpreted as egocentric, especially when a teacher is assumed to be an expert on the content, Brilliant's performance in mathematics is excellent. This was verified by the following response, "*My current mark, actually I get around 80/70, but I wish to get hundred percent … because mathematics is the only subject that you can get total"* suggesting both a positive experience and a positive attitude towards his learning.

Brilliant's and James' autonomy to learn mathematics correlates with Little's (2007) findings which suggest that autonomous learning is inextricably linked to experiences of learning *mathematics*[23] better and with success, which in turn is associated with learners' positive attitudes towards learning mathematics (Akinsola & Olowojaiye, 2008). In the earlier excerpts above, the two phrases "*my teacher is teaching, she is behind me"* (Brilliant) and "*when ma'am is still in the last topic"* (James) unleashes these learners' self-direction and self-progression in their learning of mathematics, and does not depend merely on their teacher for mathematical knowledge or to introduce contents and making of decisions of when to move on to the next topics. Thus, the findings suggest that there is a significant relationship between self-direction, self-progression and positive attitude towards learning mathematics, although for Brilliant the experience of learning mathematics was different.

The cases stated in the above discussions illustrate "the characteristic of the person who independently exhibits agency in learning activities" (Ponton, 1999, pp. 13-14). The above-mentioned learners' responses suggest that they are motivated internally to learn mathematics and influence of other people in their learning is less fundamental. Middleton and Spanias (1999, p. 66) state that learners "who are intrinsically motivated engage in academic tasks because they enjoy them". Thus, since intrinsic motivation is animated by pleasure and personal enjoyment, it can be linked to positive attitudes in learning mathematics (Middleton & Spanias, 1999; Mueller, Yankelewitz & Maher, 2011), as exemplified by Brilliant's and James' responses stated earlier. When considering of the Bioecological theory, personal

[23] Autonomous learning has been associated with language learning (Little, 1991/2007), but the current findings in this study suggest that autonomous learning is equally relevant in the learning of mathematics.

factors, in this case, learners' intrinsic motivation and sense of autonomy in their learning can be linked to the mechanisms that drive their learning of mathematics, which Bronfenbrenner called proximal processes (1995). The four participants' autonomy discussed thus far supports the notion that learners are both producers and products of the contents of their subject matters, which is consistent with the primary premise of the Bioecological theory detailed in chapter 3 (Bronfenbrenner & Morris, 2006).

5.3.3. Peer collaborative learning

The previous sections presented findings on learners' autonomy to learn mathematics at the individual level; other learners' responses, including some that responded in the above sub-theme, discerned that collaborative learning among themselves as learners, independently of their teachers, promotes positive learning experiences in mathematics, and in turn positive attitudes. For example, Sunshine said: *"...we help each other and where we do not understand we research to ensure that we always understand, we form a group and get help from other fellow learners so that we can understand all of us".* This response suggests that Sunshine and her peers have developed a participatory attitude towards learning mathematical contents, skills and processes. That is, Sunshine and her peers seem to exchange mathematical ideas, make plans to help each other learn and understand mathematics through proposing solutions to specific problems they encounter in learning the subject matter contents. James echoed similar sentiments, that there is a need for peer collaboration in learning mathematics to ensure that no learner is left behind, he said:

> *If you are able to do mathematics, we have to help each other so that we can achieve more, so we have to be having some group peers in order to do it together. When some don't understand then we work together, if there is a challenge we can resolve it.*

What distinguishes James and Sunshine is that James seems not to merely join his peer group to get assistance in learning the contents of mathematics, but to be a proactive change agent and help his peers to possibly understand the subject matter content better, as elicited by the phrase *"if you are able to do mathematics"* in his response. It is unsurprising that James is helpful, considering responses in the previous section which showed that James has some understanding of the content of mathematics, and perceives himself as a volitional learner who learns mathematics through self-direction and self-progression.

Thus, because he perceives himself as proficient in mathematics, James sees himself as a 'voluntary content guide' to his peers. The following response reinforces this,

> *Last year, I was chosen to be a group leader in mathematics, each and every Saturday I was going to other schools to learn mathematics and when I come back during the studies period then I was teaching mathematics to the other learners, and that improved my mathematics* (James).

According to Lin (2015, p. 13), "Peer scaffolding serves as a mediating tool to promote learners' ZPD and it has a valuable role to play …" for this study, in mathematics learning situations. This resonates well with statement made by Anthony and Walshaw (2009), that "partners or peers in groups can provide the context for sharing ideas and for learning with and from others" (p. 151). As discerned from James' response above, coming together to work in a group is a strategy that does not only help his peers to understand mathematics like he does, but also helps him to enhance his own understanding. Nonetheless, the repeated use of the pronoun "we", an entity that is context-dependent and suggests a need to ensure that everyone understands the contents of mathematics as learners, could signify the role played by 'collective agency' in learning mathematics (Wertsch, Tulviste, & Hagstrom, 1993; Wertsch, 1998). Human agency is usually understood to be a property of the individual (Bandura, 1989; Triandis, 1995) however; the discerned agency in the above responses seems to go beyond the normal conceptualisation of it being an individual property.

While these learners might be viewed to be taking charge of their own learning to merely consolidate and understand the contents of mathematics better, more than this, it can be uncovered that their autonomy to learn mathematics is possibly shaped by their views that "a teacher may not always be available to assist" (Cotterall, 1995, p. 220). To support this, Sunshine further stated that: "*Some Saturdays the teacher comes, some Saturdays we come on our own and practise mathematics".* This response suggests that Sunshine and her peers have established some attitude that when the teacher is present, she can help them learn the contents of mathematics; however, if she is absent, it does not mean that learning needs to cease. I also observed this when I went to Bash Secondary School on Saturday morning and found almost the whole class present, helping each other to understand the mathematics contents better. Gutierrez and Irving (2012) state that "When students work in small groups, they receive feedback more quickly than if they had to wait for the teacher" (p. 17), which is consistent with this study's findings detailed above. The learners' responses above demonstrate that learning collaboratively as learners appears to be an enjoyable learning

experience, and their unity and participation in small group learning seem to promote positive learning experiences.

Bronfenbrenner's work placed much emphasis on the significance of social interaction to enhance an individual's cognitive change. The role of social interactions is discerned in learners' excerpts above, and reinforces the specifications made by the Bioecological systems theory, that when a learner interacts with others within their learning microsystems, improved task engagement is a high possibility. This means that when individuals within a particular learning environment, in this study rural context, have shared goals for positive interactions and learning, it helps enhance their work ethos in the subject. This means that "hostility gives way when groups pull together to achieve overriding goals which are real and compelling for all concerned" (Sherif, 1956, as cited in Bronfenbrenner, 1979, p. 100). In relation to the learners' responses above, Bronfenbrenner's argument could be taken to mean that these learners develop positive attitudes towards learning mathematics and gain meaningful learning experiences from a relationship of mutual support amongst the learners.

5.4. The role of family in learning mathematics

While some participants acknowledged that the classroom, as the microsystem according to the Bioecological theory, is valuable, in particular their teachers in their learning of mathematics, others illustrated that home also played a crucial role in their learning. This theme is about how learning mathematics at home and interactions with family members influence the development of particular experiences and attitudes towards learning mathematics. The findings from the interviews suggest that there are two dominant roles that family members play in learners' mathematics learning: *Motivators of Mathematics Learning (MMLs),* and *Guides in Mathematics Content (GMCs)* which I discuss in detail below as sub-themes. This theme addresses the school-home and home-school interrelatedness in learning mathematics, which Bronfenbrenner calls the mesosystem. Bronfenbrenner (1979) suggests that the learning potential can be increased as a function of the supportive links that are available for the learner within different microsystems. The findings suggest that learners' experiences and attitudes towards mathematics are deeper and mostly associated with the learning environment, rather than from interacting with the contents of the subject matter.

5.4.1. Motivators of Mathematics Learning (MMLs)

Some learners' responses propose the role of family as the motivator for some learners to learn mathematics with positive attitudes. Some learners seem to get emotional support from the family members, and are encouraged to learn mathematics when they face challenges. Other learners were inspired to learn mathematics by family members who had pursued mathematics-related careers. The findings demonstrate that learners' positive experiences and attitudes towards mathematics thrive when family members constantly promote the learning of mathematics at home. This is illustrated by Bridget's statement:

> *at school I don't learn mathematics well, when I am at home with my uncle I am perfect because I enjoy it. He taught me many things I did not understand". "I don't ask questions in class, other kids laugh. They think you are stupid … They laugh and say you are stupid, so I don't think I can raise my hand in class and ask a question*.

This response addresses the importance of 'personal safety' within mathematics classrooms, as Bridget did not feel safe asking questions because of other learners' behaviour resulting in insecurity. Such behaviour promotes a negative learning experience, but not necessarily a negative attitude towards mathematics; it was the mathematics classroom that was unfavourable. The reasons for not asking questions, irrespective of not understanding, proposes a learning environment that makes some learners feel unaccepted, unwanted and disrespected. From the classroom observation, the participant was not asking questions during teaching and learning, nor interacting with other learners, thus reflecting a discomforting learning environment. This results in the development of 'nonchalant attitudes', and the learner becoming disengaged from participation during learning. Various studies have indicated that learners learn better when they view their classroom environments positively (see Teh & Fraser, 1994; Margianti, Fraser & Aldridge, 2001), which is contrary to Bridget's mathematics classroom experience and environment.

Home plays a crucial role in reinforcing positive attitudes towards learning mathematics, because some family members can instil a joyful learning experience and enhance understanding. This alludes to the role that the home-school mesosystem plays in helping learners learn better with positive attitudes (Bronfenbrenner, 1979; 2005). However, Bronfenbrenner's theory does not offer an explanation of what happens when one of the microsystems interacting with the learner is negative, as demonstrated in Bridget's response. The findings suggest that if there are negative learning experiences and attitudes developed towards learning mathematics in one microsystem (in this case the classroom), they can be

changed to positive experiences in another (the home). Learners with support and motivation from significant others did not only exhibit proficiency in the subject, but showed positive experiences and attitudes towards mathematics. Bridget's responses about home resonate with Lozanov's (1978, p. 258) principle of "joy, absence of tension, and relaxation" as essential human conditions for learning. It is clear that Bridget does not feel good about being in her mathematics classroom, but because there is a supportive climate at home she feels good about learning mathematics.

5.4.2. Guides in Mathematics Content (GMCs)

Learning at home has been overemphasised in previous research as playing an important role in ensuring that learners are motivated to take the initiative, and develop a good working ethos to actively participate in learning mathematics (Epstein, 2004; Msila, 2012). In this study, some learners' responses highlighted the powerful influence of the home environment on their learning of mathematics. Their responses suggest that their family members assist them at home to make sense of the mathematical content, skills and processes that were covered by the teacher in the classroom but resulting in misunderstandings by the learner. This relates to what Mestry and Grobler (2007) mentioned that when family members assist their children with homework continuously and consistently, it helps to enhance learners' performance in schools and also shapes learners' interest to actively participate in learning. For example, Tsan'wisi said:

> *My aunt helps me, she doesn't give me all of these answers, she shows me that you can do this, and do this. She will say, 'I will give you an answer for this one, but you will do this one on your own.' I have to do that on my own and she will never help me, she will never help me.*

Even though Tsan'wisi emphasised that his aunt gives him the opportunity to do mathematics himself, his choice of words *"she shows me" and "I will give you"* demonstrate that the aunt is helpful when he experiences challenges, as a way of mediating unknown knowledge. While family influence on learners' mathematical capabilities and the promotion of more positive attitudes has been argued to be essential (Voorhis, Maier, Epstein, & Lloyd, 2013; Mestry & Grobler, 2007), it might be perceived that the kind of support that Tsan'wisi receives from his aunt does provide him with an adequate opportunity to make sense of the mathematical contents himself. As the aunt gives him the opportunity to engage with other maths problems without assistance, it suggests some kind of scaffolding and the space to learn and make mistakes. With this in mind, it seems from Tsan'wisi's response above that

his aunt's availability to assist him with mathematical contents at home fosters a positive attitude towards learning the subject.

Tiny stated that: *"Maths is not difficult, get the right person who can teach you maths, like my father, he helps me when I am stuck in maths because he studied pure maths".* Similarly, Musa said: *"My brother at home gives me questions and I answer, and where I don't get answers good, he gives me corrections. He takes me and shows me how we do this here; I then have to redo the same questions that I did not understand".* These learners' responses demonstrate that the assistance they receive from their family members when they encounter difficulties in understanding the mathematical content promotes a sense of hopefulness in learning the subject. Both Tiny and Musa believe that in adverse circumstances when learning mathematics, the assistance from the father and brother respectively can help them clarify misunderstandings, which in turn appears to instil positive attitudes towards mathematics. These responses also show that in a rural context there are educated people to assist learners with learning, a reason some learners perform successfully. The responses show that the identified family members are Guides in Mathematics Content (GMCs), because they have some level of mathematics background. This means, for a family member to act as a GMC they should have some level of mathematical proficiency and rural families, especially parents, are always perceived to lack this proficiency (Ndlazi, 1999; Emerging Voices, 2005; Msila, 2012; Matshe, 2014). Epstein (2004) argues that family involvement and learners' attitudes and behaviour towards their school activities are directly proportional to each other. This means an increase in parental involvement in educational activities can play a role in shaping learners' behaviour during the process of teaching and learning in the classroom.

5.5. Chapter Summary

In the current contentious debates about learning and learner performance in mathematics in South Africa, it is essential to gain insight into learners' experiences and attitudes towards the subjects, especially rural learners who are often uncared for by the government. From interviews and classroom observations, I found that learners are explicit in their views of what enables them to learn mathematics, the specific learning strategies they use individually in and outside the classroom context. The information provided by the participants during interviews suggests that they learn mathematics in different ways because they have developed a unique relationship with the subject, as also seen in earlier discussions.

Some learners see a need to ensure that learning does not only end in the classroom during subject contact time with the teacher, but they continue to learn the mathematical contents, skills and processes either within a microsystem of peer groups, individually and/or at home with family members, which are all essential to develop higher mathematical proficiency. The learners acknowledged that at times learning mathematics could be a struggle, and emphasised the role of constant practice as fundamental to enhance the understanding of mathematics. Ongoing interaction with peer groups, the teacher and family members at home appeared to enhance the cogitation of new mathematical knowledge, confirm personal constructions and deconstructions of knowledge as well as clarify any mismatches in learning. This is consistent with Bronfenbrenner's (1977; 1995; Bronfenbrenner & Morris, 2006) conceptualisation of learning, that social interactions within learners' immediate context play a role in shaping their learning. The findings also show that the interrelation between the classroom and the home environment, which Bronfenbrenner termed the mesosystem, is essential to the continuation of learning mathematics.

Some learners' responses suggest that learning mathematics is not something that is being done to them by their teachers, but they are active constructors and re-constructors of mathematical contents. In relation to rural learners, the findings demystify that even within the same rural context, learners are subjective beings, as such they have different experiences and attitudes towards learning mathematics, reemphasising that rural learners are not only shaped by the contexts in which they live, but are also active agents in shaping their contexts. Further, this study's findings illustrate a need to move beyond the homogenisation of rural contexts and learners and start to consider their differences rather than their similarities to offer accounts of their learning within these rural communities (see chapter 2). That is, the realisation of the complexities embedded in each and every rural area, within itself and in relation to other rural communities, is essential in any attempt to gain insight into learners' learning within a particular rural context, to avoid deficit conceptualisations of rurality and rural education.

For some learners, in cases where they feel comfortable and confident that they have understood the contents of the current topic being covered in the classroom, they self-initiate to study subsequent topics. This demonstrates both positive experiences and attitudes towards mathematics. Some learners' responses illustrated their awareness that in order to learn mathematics well and develop rigour in the subject, one needs to be willing to constantly

'practise' mathematics and be determined to achieve greater levels of mathematical proficiency rather than being over-complacent. This addressed the role of agency in the process of learning. As Van Lier (2010, p. x) describes the nature of agency in learning processes to refer to "the ways in which, and the extent to which, a person is compelled to, motivated to, and coerced to, act" at the same time, "the person deciding to, wanting to, insisting to, agreeing to, and negotiating to, act". Thus, learners such as Brilliant and James have shown a willingness to self-regulate their own learning of mathematics.

In addition, learners highlighted the importance of ensuring that the teacher is always available and willing to offer support and clarify misconceptions they may have in learning particular mathematics content, skills and processes. By critically examining learners' comments about the roles of their teachers in their mathematics learning, it was uncovered that their dependency and reliance on the teacher for knowledge seems to play a significant role in gaining positive experiences and attitudes towards learning mathematics. This links with statements made by Bamwesiga, Dahlgren and Fejes (2012), that historically learners have learnt throughout their learning trajectories that the teacher is the main source of knowledge "who has all the power to determine their future" (p. 8). The implication for this is that learners regard their teachers as conveyors of mathematical knowledge, linking with behaviourist learning approaches, which are mainly regarded as outdated (Hmelo-Silver, Duncan, & Chinn, 2007; Major & Mangope, 2012). Whilst this is the case, it is essential to note that for some learners in this study, the 'show and tell' teaching strategies in learning mathematics seem to have positive gains in terms of learners' experiences and attitudes towards learning mathematics. The following chapter summarises the findings of the study and makes recommendations for future studies.

Chapter 6

BEYOND DEFICIT UNDERSTANDING OF RURAL LEARNERS' MATHEMATICS LEARNING

"What we find changes who we become." ― Peter Morville

6.1. Introduction

The overriding purpose of this study was to critically explore and interrogate Grade 10 rural Acornhoek learners' experiences and attitudes towards mathematics. Additionally, the study sought to understand factors that shape the experiences and attitudes towards learning mathematics. Taking into considering the purpose of the study, the main question for this study has been: "What are Grade 10 rural learners' experiences and attitudes towards learning mathematics?" To address this question, the study focused on three sub-questions:

1) What are Grade 10 rural learners' experiences and attitudes to mathematics?
2) How do learners' experiences and attitudes towards mathematics shape their learning?
3) What are the factors that influence learners' experiences and attitudes towards learning mathematics among Grade 10 learners in Acornhoek?

As discussed in chapters 1 and 2, the dearth of research in rural learners' learning in general, and the lack of research focusing on rural learners' experiences and attitudes towards learning mathematics in particular, motivated the conceptualisation of the current study to gain insight into factors that shape learners' experiences and attitudes towards mathematics. To date, the paucity of rural mathematics education research in South Africa has not been able to offer an account of rural learners' experiences and attitudes towards learning mathematics. Therefore, this study also examines how learners' experiences and attitudes towards mathematics shape their learning of the subject, in order to contribute to the existing knowledge in mathematics education and research.

In addition, the study used Bronfenbrenner's Bioecological theory (1977; 1979; 2005) as the theoretical framework. The theory allowed me to critically explore Grade 10 rural Acornhoek learners' experiences and attitudes from multilevel environments, going beyond the

microsystem of the classroom (see Chapter 3). In relation to Bronfenbrenner's theory, Fairclough's (1989; 1995) Critical Discourse Analysis was chosen as the analytical framework for the study. The CDA framework was used to analyse learners' discourses about their learning of mathematics, and also to reveal learners' constructed meanings which seem to be produced through learners' daily interactions within their situated environments (Foucault, 1989; Bronfenbrenner, 1979). Considering that participants used language to describe their experiences of learning mathematics, it was essential to recognise that their choice of words was shaped by their daily interactions in multi-level environments, and Bioecological systems theory enabled the understanding of the complex levels. Fairclough and Wodak (1997, p. 18) view language as "social practice" and in this study, it was used by the learners to represent their experiences of learning mathematics, which is never value neutral, as argued in Chapter 4.

In this final chapter, I present a summary of the findings from the study. This chapter begins by presenting a summary of the findings, in relation to the research questions as described in chapter 1. I then provide a discussion on the significance of the study, linking with the contentious debates on learners' mathematics learning, in particular rural mathematics learners both internationally and in South Africa. The limitations associated with this study and the study's implications are discussed. Finally, the chapter concludes by making recommendations for future research, stressing a need for more research with rural learners within rural communities in order to understand their experiences and attitudes towards learning mathematics, factors shaping these experiences and attitudes and how these shape their learning of mathematics.

6.2. Summary of the findings

One of the major findings was learners' views of the roles of teachers in their learning of mathematics. The learners believed that their mathematics teachers are the legitimate epistemological agents during learning. While learners' dependency on their teachers is expected, to a certain extent, to develop independent learning, the findings showed that learners' dependency on their teachers for mathematical knowledge promotes positive attitudes and helps learners to gain greater mathematical understanding. These findings are broadly in line with Bronfenbrenner's suggestion that interactions that learners make within their situated environment are the primary engines for their learning (Bronfenbrenner, 2001). Whilst Bronfenbrenner contends that these interactions are reciprocal between the learner and

the other persons, objects and symbols within their situated environment, the findings highlight one aspect that Bronfenbrenner is silent about. I noticed that the Bioecological theory does not capture the role of 'knowledge levels' during interactions, this means learners' ability to have some bidirectional interactions with their teachers and/or their peers relies on their current knowledge. When the child lacks knowledge of the subject matter, the interaction with the teacher can become unidirectional, and the learner can succeed in learning with the guidance from a skilled significant other.

Secondly, the findings strongly showed that some learners were autonomous in the learning of mathematics, and three types of autonomy were identified: *'self-commitment and consolidation', 'self-direction and self-progression',* and *'peer collaborative learning'*. These sub-themes address the role of learners' independence in learning mathematical contents and skills. Learners who fell under this theme showed partial or entire ownership of their mathematics learning, some processes which have been traditionally considered to be the responsibilities of the teachers. For example, learners who fell in the sub-theme *'self-commitment and consolidation',* showed that they take partial ownership of their work through consolidating everything the teachers have covered in the classroom. On the other hand, those who learn through *'self-direction and self-progression'* take total ownership in their mathematics learning, such as configuring learning methods to learn topics even before they are introduced by the teacher in the classroom, as well as evaluating progress in their learning. Further, learners who learn fell in the sub-theme *'peer collaborative learning'* illustrated that they gain meaningful mathematics learning experiences and develop positive attitudes towards the subject when they come together as learners independent of their teachers to cover the mathematical content. Thus, all three sub-themes reinforce the idea that learning is a process through which learners construct, deconstruct and reconstruct knowledge, rather than being mere receivers of the knowledge presented by their teachers inside the classroom (Cotterall, 2004; Bronfenbrenner, 2005; Little, 2007).

Thirdly, some of the participants showed clear roles played by their family members in their learning of mathematics, which in turn shape the promotion of positive attitudes and enhance meaningful learning of mathematics for the learners. In this study, learners with existing support and motivation from family members did not only show ability to learn mathematics, but showed positive experiences and attitudes towards learning the subject. As discussed in chapter 5, the findings showed that in cases where learners encounter unfavourable learning

experiences within mathematics classrooms, at home these could be countered through family support and motivation to learn by both the GMCs and MMLs. That is, the involvement of family in learners' learning of mathematics helps learners to engage in the learning processes at school with positive experiences. In relation to rural education, the findings are broadly in harmony with suggestions made by Moletsane (2012) that rural areas should not be viewed with deficit lenses. The findings illustrate that in rural areas, there are people who are educated and have the ability to assist learners with mathematics, a reason learners perform successfully and develop positive attitudes towards learning mathematics.

6.3. Significance and implications of the study

This study is significant because it contributes to the dearth of rural mathematics education research in South Africa, and also contributes to addressing the gap in literature on rural mathematics learning. In addition, this study is also significant because it explored learners' attitudes towards learning mathematics within a qualitative approach, whereas much previous research on attitudes fell into the quantitative research approach, as mentioned in chapters 1, 2 and 4. Thus, this study offers suggestive evidence for using qualitative approaches to determine learners' attitudes towards learning generally, specifically the learning of mathematics, by focussing on the way participants talk about their learning as well as their observed behaviours during learning. The contribution to the current knowledge made by this study is the illumination of rural learners' ability to take partial or entire ownership of many learning processes in mathematics, such as self-directing, selecting learning methods and evaluating their own learning progress. These have been conventionally regarded as teacher responsibilities, especially when in rural areas, schools and learners are viewed in negative terms. While rural families have been traditionally regarded as having limited educational attainments, this study revealed that there are some people within rural communities who have good knowledge of subjects taught in school, including mathematics, and are able to assist learners to understand the content better.

6.4. Limitations of the study

An aspect which might be considered a limitation is that I spent only three weeks at the research site, which resulted in not having adequate time to observe the context in depth to have subsequent interviews and classroom observations. However, because it is a master's dissertation, the period might also be considered enough to collect data. I should make clear

that I intentionally did not explore how learners' experiences and attitudes shaped their achievements in learning mathematics, due to space and time constraints for the study.

6.5. Recommendations for future research

This study underlines an overarching need for more in-depth study that seeks to unearth learners' experiences and attitudes towards mathematics, and its learning across the country to possibly gain understanding of the continuous underperformance in various local and international mathematics assessments. One of the avenues for future research would be research into the specific factors that influence the learning and teaching processes within rural mathematics classrooms, and in turn learners' achievements in the subject. In addition, while the qualitative study of attitude is not popular in the existing literature, this study recommends that interviews and observing behaviour and practices are some of the methods to be used to understand learners' attitudes towards learning through critical analysis of their choice of words when they describe such learning.

Another recommendation is that future studies should examine individual learner factors that reinforce learner autonomy in learning mathematics, particularly within rural schools considering the paucity of research aiming to examine such aspects. I posit that it is essential to unearth learners' beliefs about learning in general in order to enhance independent learning and foster critical thinking during learning. There is also a need to conduct studies that examine learners' experiences and attitudes towards learning mathematics, and consequently how these shape learners' academic performance in the subject. Furthermore, research should also be conducted with parents within rural areas to gain understanding of their perceptions of mathematics and its learning, because consciously or subconsciously they do play a role in influencing their children's learning of mathematics, as well as learners' experiences and attitudes towards the subject. And lastly, another area for further research is to examine peer collaborations in learning mathematics, to gain insight into the role this plays in shaping learners' learning and in turn their achievements in their academic activities.

6.6. Breaking the deficit understanding of rural mathematics learning

The dynamics of learners' experiences and attitudes towards learning mathematics within a rural context and schools have been made clear from the above discussion and throughout the study. This study provided insights into the rural Acornhoek learners' experiences and attitudes towards mathematics and its learning, as well as a variety of factors that shape these

experiences and attitudes. I believe that further research is necessary to unearth a variety of factors at play in reinforcing learners' attitudes towards mathematics as well as learning experiences, especially if the dream of providing equitable democratic education for all in South Africa, regardless of their geographic location, is considered. While conducting research with rural learners is slowly becoming popular, this research is the beginning for other researchers to start conceptualising research with rural learners within rural communities and schools. Researchers also need to take into account the dynamic interplay between factors within various environmental levels as discussed in chapter 3 and how they shape learning.

I am keen to emphasise that the aim of this study was not to criticise the Acornhoek learners or practices of the two schools, Bash and Dashboard, in their teaching and learning of mathematics or the wider school environments. Rather, I have sought to excite educational debates about learning within rural contexts in South Africa. Through teasing out learners' responses together with their observed classroom persona, I have realised the complexities and the subjective nature of learners' experiences and attitudes towards learning mathematics as discussed in chapter 5 and the current chapter. This chapter has also outlined the recommendations for future research, stressing the need for researchers to conceptualise research focusing on rural mathematics education, especially with learners to hear what they have to say about their learning.

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Appendices

Appendix 1

Interview transcript

Hlamulo	Sunshine
So, from our conversation yesterday, remember I told you about the study, I am looking at learners' experiences and attitudes towards learning mathematics in Grade 10, okay.	Okay
So, I will be asking you questions that have to do with your experiences, how you learn maths in class, how you learned maths previously, how you engage with mathematics, whether and how you work with your teacher and other students, and all the likes, so just feel free to answer any question.	Yes
So, you are doing mathematics?	Yes
Okay, so what made you to take mathematics as one of your subjects at school?	Because my career wants pure maths, I need pure maths to get on with my studies at university.
Okay, what do you want to do?	I want to be a doctor
You want to be a doctor?	Yes
So, what makes you think that you need mathematics in order for you to become a doctor?	Well, I made a research, so it needs pure maths, not literacy.
So, who motivated you to take	We get motivated before we get into the

mathematics in school?	class of maths, by our teachers.
So, your teachers are the ones who told you that you need to take mathematics in order to become a doctor?	Yes
How are you doing in mathematics?	It is very good, it is fabulous
Okay, nice, nice, so, would you say that mathematics is important in the society?	Yes, it is important
In what way?	If you know maths you can have many, pure maths has many careers to take, so, if you have, literacy, it does have jobs, but the jobs that are there are not paying very good, you can't get a very good salary, but in pure maths, like being a doctor, you get a good salary to support your family.
Who told you that maths, when you do maths you are going to get a job that is better paying?	Even in the research it's there, our teachers told us about everything about career paths.
Okay, please talk to me about your experiences of mathematics in primary school.	In primary school, I experienced many things in primary school.
Okay, how did you learn mathematics in primary school?	Well, we learned very good. With children, with our classmates, the teacher was explaining everything we were doing, everything we were writing, they would explain it so that we could get it from the beginning to the end
From the beginning to the end, so you see a need for the teacher to teach you mathematics?	Yes
So, would you say that you cannot do mathematics alone?	Yeah, I can do it alone, but with the help of our teachers
So, there is still a need for the teacher to be there in order for you to do well in maths?	Yes

If the teacher was not there, would you do better or good in mathematics?	I would do better.
How would you do it?	By practicing it every day, I would be able to do good if I practice maths every day
So, you see a need to practice maths every day?	Yes.
Why is it like that?	If I practice it every day, I won't forget anything that we get from our teachers and exams there are things that they give us, the first thing in January, and they come at June, so I must practice every day so I cannot forget the things that we do from January up to June.
Oh, that's good. How much time do you give for mathematics?	30 minutes (she laughs)
30 minutes? Okay, why do you give yourself 30 minutes?	(she laughs) I will be mad if I give myself more than 30 minutes
You will be mad; what do you mean you will be mad?	Well, if I practice maths for more than 30 minutes, I will learn many things that will confuse me, so if I give myself 30 minutes I will know that. After 30 minutes I, will leave what I am doing and I will come back again and give myself 30 minutes and continue.
How did you come to choose 30 minutes? Why not 25 minutes?	I think 30 minutes is better because when I look at the time, 30 minutes is what works for me.
You think it is sufficient for you to cover all the contents?	Yes
So, if you gave yourself let's say 45 minutes, do you think that would be different from 30 minutes?	Yeah, it would be different.
Why?	Well, maybe it's because I haven't given myself 45 minutes, but I don't know if I were to give myself 45 minutes how it

	would be.
Okay, why are you not giving yourself 45 minutes?	Well, I think it is too much and I think 30 minutes is well.
Okay, so, 30 minutes for you is fine and 45 minutes is too much?	Yeah, it's too much!
Given that you spend 30 minutes to do maths, and let's say 45 minutes is too much for you, how do you perform in mathematical assessment in class?	I perform very good.
Please give me the average of your performance?	Well, in my assignment I got 54%, and in my exam, I think I got 38, but it's not percent.
38 is not percent, okay, 38 out of?	Out of 50.
Okay, okay, that's good. Do you get any assistance at home in terms of your mathematical tasks?	No
How do you do mathematics at home?	I do it alone, I practice it alone and get more information.
Where do you get more information?	Well, I have some books, we were given by our teachers and some books our friends gave them to us.
So, the books are from teachers and friends?	Yes
Do you have extra material for yourself to engage with mathematics?	No.
That you have bought for yourself?	I haven't bought anything
Why haven't you bought anything or extra material for mathematics?	Well, maybe it's because I have no idea of the kind of things I can buy.
Okay, would you afford if I were to recommend a particular book, to say go and buy this particular book it will help you in terms of mathematics.	For myself I can't afford it, but by the help of my parents maybe I can

Can your parents afford a book that I could recommend?	Yes
So, they buy you extra material for other subjects?	Yes.
Why have you chosen to do mathematics?	As I have said, I have chosen mathematics because my career needs pure maths.
So, do you think mathematics literacy is not important?	It is important, but not to me because if I want to be a doctor maths literacy is not needed.
What do you understand is the difference between maths and maths literacy?	Well, the difference is that doing maths literacy it cannot put you to being a doctor, but pure maths, yeah, it can lead you to that.
Okay, oh no, that's interesting. So, what are your experiences of mathematics since you started high school?	Well, my experience, I have learnt many things, some of the things I didn't know about them, some of the things I know them from here.
Such as?	Such as the hype … what do you call this? Err, I forget this name, what's this name? these types of graphs called eish …
Which ones? You have hyperbolas, you have parabolas, you have the linear …	Yes, the parabolas, the straight line graphs, it was new to me this year.
So, you were never introduced to …	To these kind of graphs in the previous grades.
So, how are you finding it, given that it is being introduced in Grade 10 and it is new to you?	Well, as it is new to me, now I can understand it, how it works, how the steps are being followed.
Okay, so there are steps that need to be followed in order to understand?	Yes
Do you think the steps, those steps that you need to follow, if you do not follow them, you will never understand mathematics?	Yes, you will not understand because if you make a mistake in one step you will never get the right answers in the other steps.
What does that mean, what does that tell	Well, if you don't know, if you don't

us about mathematics?	understand at the beginning you can't understand up to the end. Because if you don't understand from the beginning you must get help, you must research about it, ask teachers, so that you can understand because if the teacher passes, you won't understand because you will be left behind.
Okay, so, you see a need for you to ask the teacher questions?	Yes, for the information that you do not understand.
So, if you don't ask, what would that say about you, as a maths student?	Well, if you don't ask for more information you will get it wrong all the time, you must not be stubborn, you must ask.
Okay, so do you ask questions from your teacher?	Yes, in class we do ask, one of my fellow learners always ask.
You ask the teacher?	Yes
Do you ask each other?	Yes, we even have a study group so we help each other.
What do you do in a study group?	Well, we come to school and we help each other, where we do not understand we research, everything that we do not understand, to ensure that we always understand all of us.
What do you mean by understanding?	Err, if there was a word, or calculations which we do not understand, we form a group and get help from other fellow learners so that we can understand all of us, and get into the right.
Okay, at the end you have much deeper knowledge about what you have covered in the classroom?	Yes
Is the teacher always there to facilitate those group discussions?	At Saturdays maybe, some Saturdays the teacher comes, some Saturdays we come on our own, and she doesn't come, maybe she is always busy sometimes, so we come

	on our own.
So, who take charge of err those sessions?	Us, all of us.
By all of you, do you mean even those that are struggling?	No, not those that are struggling. There are some that understand everything about maths, they know the calculations. So, the ones who understand everything help us to study and make us understand too, yes.
Okay, oh that's good. What challenges, if any, do you experience in mathematics?	Sometimes there are challenges, some of them are difficult, because you cannot do calculations that you do not understand. So, we do get difficult ones, but with our teacher's help, it helps a lot,
Okay, alright, so, how do you, or how did you solve the challenges in doing mathematics?	I solved it from help from home.
So, you need help from home?	Some few learners because some of them they understand everything about maths and some other teachers, not our teacher who teaches us.
So, why don't you go to your teacher to get help on what she has taught you in class and you go to another teacher?	Well, we go to our teacher, most of the learners you will find that they go to our teacher, the one who teaches us, and the office becomes full, so we go to another teacher.
Okay, well no, that's very good, so what are your strength in mathematics? What would you say are your strengths in mathematics?	My strength is that I work hard in mathematics so that I can achieve good marks.
Okay, what do you mean by working hard?	Well, every day I wake up very early so that I don't miss any class of mathematics. So that I won't be left behind in mathematics and I don't want to be absent at school because I will be left behind, because maths is every day.
Okay, so you don't want to miss even a	Yes! Even if I am sick I will wake up and be

single lesson in mathematics?	strong knowing that I will do it.
So, you wake up only for mathematics, that's why you wake up?	Not only for mathematics, because if I fail maths I won't be a doctor.
So, that's the reason why you wake up even when you are sick?	Yes!
Okay, what kind of skills then do you think this mathematics teaches individuals?	Err, skills?
In general, what skills does mathematics teaches you as an individual?	Well mathematics teaches me to be good, to be good in mathematics because there are many things that I don't know.
Okay, do you think maths is important in the society?	Yes, it is.
How is it important?	Well, it is important because like when you go and buy something, because you don't know how to count money, you can't know how much is your change, pure maths is also about numbers, about money, so, if you don't know how to count, you will not know how much you will pay, how much your change will be, so, you will always be robbed.
You will always be robbed?	Yes.
So, let's go back to that question of the difference between maths and maths literacy. Do you think the maths literacy learners they can't be able to let's say count, how much they were supposed to get for change …	Well, they can. There is no difference in money. In money there is no difference.
You are saying there is no difference there with regard to money?	Yes.
Where is the difference?	Well, the difference is that with us we deal with big, not big numbers, maths literacy they don't deal with numbers, but they deal

	with words.
They deal with?	The literacy ones they deal with words such as you have to tell us how much did this buy, tell us how, like that, so, we deal with small numbers, so to calculate using steps, so us is very different from them, we do solve for x, they don't do that.
So, with them is words, with you is numbers?	Yes.
What other areas of mathematics do you think you do that they do not do?	Some other things that they don't do?
Yeah!	Well, we do, err, there are many things that they don't do.
Such as?	(she laughs) I think there are a lot.
Such as what?	We do things like, like … can I just pass that?
Okay, please explain to me how you engage with mathematics when you learn alone?	Oh, when I learn alone?
I heard you said you learn with a group, you have a study group, sometimes you ask your teacher in class and all that, but when you are alone, let's say at home when you are learning alone, how do you learn?	Well, when I learn alone I learn some of the things that I don't understand, so I just take a paper and write the things that I don't understand and the things that I understand I continue with them so that the things that I don't understand tomorrow morning I come to my group to talk about the things that I did not understand so that we can help each other.
Okay, no, that's very good. Err, is there any specific section in mathematics that you love the most?	Yes
Which one is that?	Solve for x is always there.
Solve for x, why do you love solve for x?	Solve for x is always there in examination, I love it because it is simple. It is just solving

	for x.
So, you love topics that are simple?	Yes.
What about topics that are difficult?	The ones that are difficult (she laughs) are the ones that I practice more and more but the ones that are simple I don't spend much time on them, because I know there is no need to practice them, so the ones that are difficult are the ones that have long questions, long calculations, they are the ones that I practice more.
Which topics don't you like in mathematics?	I don't think there is a topic that I don't like.
Which topic or section of mathematics do you, or did you experience challenges in dealing with?	It will be, err, there is a question that is long, it has long calculations.
Which one is that?	I am still looking for the name.
Okay, what do you do in that particular section?	I practice and practice, sometimes …
What type of content do you deal with?	It's like lot of numbers, you must calculate until you get all the answers, you get one answer from the beginning, if you get the answer then you must continue with that answer, if you don't get the answer right from the beginning then all the steps you won't get it right.
Are you talking about simultaneous equations?	Yes! Eish, (she laughs), simultaneous!
Why simultaneous equations?	It is so because when you don't get the answer from the beginning, it is obvious at the end you won't get it right.
Okay, do you think simultaneous equations are related to solving for x?	Yeah
How are they related?	Yes, you are looking for, you are also

	looking for x.
Okay, given that you said you love solving for x, is there any case where you can solve for b?	(she laughs) yeah! There is no difference in that, they just put x. If they can put b, it is the same.
How are they the same?	You can use the methods that you use to solve for x in solving for b.
Okay, can you solve for t, using those particular methods or steps?	Yes
How so?	By doing the methods in solving for x, all the steps I use.
Okay, alright no, that's good. So, there are some learners who think mathematics is difficult, what do you think about mathematics? Do you think maths is difficult?	Well, can say it is not difficult. But, there are some parts that are difficult, only if you get help in them it will be easy.
Okay, so you need to get help from someone else?	Yes!
How often do you experience challenges in learning mathematics?	How many times? Maybe once or twice a week. Because some of them, if they give you difficult things, maybe twice or once a week.
So, when you get to the tests do you always know how to deal with particular sections for particular topics?	Yes, the ones that are difficult I start by them, on the free page like scribbler. Then I start by the difficult ones because the simple ones I end with them.
Why do you take err, that approach?	Well, because if I start by the easy ones I will forget the ones that are difficult because I must know all the steps for calculations. So, if I know the calculations of the hardest ones, it will be simple for me.
How do you practice mathematics?	I practice mathematics for, I use a calculator, a paper, a scribbler, a pencil. With my book and then I will take any number from a set of numbers and then

	write it down calculating for what is the highest, when I get it right is when I know I can put it down and then I practice more of the things that are difficult and then the ones that are easy.
So, what can you tell learners who thinks mathematics is difficult?	Sir?
What can you tell the learners who thinks mathematics is difficult?	Oh, I can tell them that mathematics is not difficult, only when you practice every day you are going to get more and more in knowing mathematics.
Okay, so, every day? You are saying that you practice it every day?	Yes.
Do you practice it when you get home, when you are in class or when you are outside during break, when do you practice mathematics?	Well, in free periods, our group come together and practice maths. And when I am home I give myself 30 minutes to practice maths.
Oh, okay. Interesting. So, during breaks, do you sometimes talk about maths? What do you talk about during breaks?	During breaks, sometimes we write our home-works so that we don't have a lot of work when we get home.
Okay, do you write maths home-works together?	Yes, we do that.
Are there some people let's say in your group who say this maths is difficult?	Yes.
And then, what do you tell them?	Well, I just encourage them and say let's carry on, and see if we can make it. So, if it is difficult we can get help from that group.
What motivates you when you experience challenges in mathematics to continue doing the mathematics problems, given that you do tell them to continue, what motivates you to continue even though it is difficult sometimes?	What motivates me is because I don't want to give up, I want to be a doctor, so if I give up I won't see my dreams.

Okay, so it is all about becoming a doctor? That's what motivates you?	Yes, yes!
Okay, please explain to me how you engage with mathematics in the class.	Well, I engage it by forming a study group, ask the teacher, every time when I write. They explain everything in class, sometimes the teacher can say you stand up and explain everything I have taught about.
So, you have to take them through step by step from what she has said?	Yes
What type of individuals does she pick on when she ask you to come and explain everything that she have taught in class?	About calculations, about how this step this step works, how the following step works, how did you get the answer, what do you do in a calculator, what do you press.
Okay, when learners then do she ask to come and do those particular steps on the board?	Well, sometimes she just call you by name and she say come and explain everything to me. And sometimes she will say, anyone who want to come and explain to me. A learner called Valencia will come in front and explain.
She picks randomly?	Yes.
So, when you are at home, how do you engage with mathematical tasks? Let's say you have home-work, how do you engage with those particular tasks of mathematics?	Well, I get information, sometimes the information will not be enough because of my mother, I stay with my mother, because of my mother she doesn't understand the pure maths so I get help from my next door's because they have children and sometimes some learners who stay in my community I go to them and get help.
So, it doesn't necessarily mean that you need a teacher, the teacher is there as the source of information, but after receiving that information you can still go to another person …	Yes
Even though your mother cannot help you with maths, you still go to your neighbour,	Because my teacher is not there with me at home, so I don't have a choice, I do to

your friends to help you understand the problem, why? Why do you have that drive?	them, my friends, my family and my community.
Okay, do you have access to internet?	Yes
Do you sometimes look at the mathematical problems, how they are solved at the internet?	Well at the internet I don't.
What do you do on the internet?	In the internet actually, I don't research on, I only research on physical science on the internet, but not for maths.
Why not for maths?	Well, because some of the maths you can look at the internet but some of the things are not. There is this app, called err, eish, I forgot this name of the app. That can help you with maths, everything you need, it can help you with maths.
Have you ever used the app this side?	No!
Why?	Because internet needs airtime, so I hardly have airtime, but sometimes I buy airtime and go to internet but this app I haven't downloaded it.
Why don't you download it?	Well, if I have airtime, data I will tell my friend to download it for me.
You are saying that you need internet?	Yes
How often do you have internet? How often do you need data so that you can go to the internet?	Maybe for a month I can buy for one week, it takes ten rands airtime.
So, do you buy it for every week?	Not every week.
Why don't you buy it for each and every week?	Because I don't have money to buy it for every week.
It is interesting what you are saying about the airtime, so you buy it only once a week	Yes

for ten rands.	
What makes you not to buy more?	It is not cheap, for a month it is R89.00 , so I can't afford it for a month, so I can only afford it for one week.
Interesting. So, how do you participate err in class during mathematics?	Well, I participate good.
What do you do?	Every time our teacher asks us questions, I will raise my hand and tell her the answer, the calculations, the steps that she is doing.
Okay, so what are your experiences of being taught mathematics in high school?	Well, my experiences is that I have good strength in what I have been taught and everything that is new, now I understand it every step, every calculation that our teacher taught us.
Oh no, that's good. So, here in high school, what is different between the way you learnt mathematics here and let's say in primary school?	Well, here is different a lot, yeah it is very different. In primary school, our teacher would be patient with you, and these numbers we are dealing with in high school and in primary are different.
Okay, how are they different?	Well, now I am learning pure maths, so in primary maybe, I am not sure maybe it is literacy and maths pure combined. So, is not everything I learnt about pure maths in primary.
So, what do you think is the relationship between what you have covered before Grade ten and you are currently covering now in mathematics?	Well, there are things that I covered in primary and Grade 9, but a lot of things are not in Grade ten.
So, can you make any links between what you have covered before and what you are currently covering now?	From Grade nine?
Let's say from Grade nine, things that are similar to what you have done before.	Yes, they are similar.
Which ones do you relate to what you have	Equations, graphs and solve for x, they are

covered in Grade nine?	there in Grade nine and you are also doing it in Grade ten.
So, the parts that are easy for you, would you say are the ones that have been introduced to you before you got to Grade ten and they are still easy for you, or are there things that are new that are difficult?	Well, the things that are new, they are not that difficult. For I experience it every day, and practice every day and learn more and more.
Okay, so, if you were a maths teacher, how would you teach maths?	Well, I would teach them and explain everything, come to school every weekend and ensure that all my learners get it right and explain what I am talking about, everything until they get them right.
So, it is about explanations, it is about coming in every weekend, it is about coming early and all that, that would make you or your students to understand mathematics.	If the learner bunks school or does not attend maths let's say every weekend, the learner will be left behind because he won't or she won't know everything in maths that I have taught about.
Okay, that's nice, you would make a good maths teacher hey.	(she laughs). Thank you.
So, would you ask if there is something you don't understand in mathematics, I know I asked you that question before? Let's say you are experiencing problems, either at home or at school, who do you ask mostly?	When I am here at school I ask my maths teacher, but when I am at home, friends and neighbours.
What, I know you say you aspire to be a doctor, where do you see yourself in the near future.	I want to see myself being more than just a doctor, helping people I think is the one. Helping people, children here at school, coming every, maybe five times a year, helping all the children, checking that everyone is healthy.
Why do you think you are concerned about the health of the other children that would be remaining here at school?	Well, South Africa is dying, many people are dying because of diseases, so, if I come maybe five times in the school, people will change and people will be healthy.
Oh, good. So, do you think, rather, what	To understand everything, the calculations,

role does mathematics and education play for you to achieve those goals?	I must understand everything, maybe before our teacher teaches, our teacher if she teaches us, if you don't understand anything, well you won't get it right.
What role does education play for you to come back, let's say in ten years' time, to help the children to stay healthy? Do you think education is necessary for you to achieve your goals?	Yes, it is. If I don't have education, you see, I won't be a doctor. You must be qualified in order for you to be a doctor and you need mathematics in order for you to be a doctor.
So, how do you perform in mathematics assessments?	I perform very well, because I pass my assessments.
Do you set levels for yourself, let's say for this test I want to get hundred percent?	Yes, but that is different because you will tell yourself that you want to get hundred percent and when the paper comes back you will find that you got fifty something percent or ninety something percent.
Okay, how does that then change the way you see mathematics, how does that changes the way you see mathematics, let's say you projected for yourself that I want to get ninety something percent, and then your script comes back and say you got ninety-four percent, how would that change the way you view mathematics?	Sometimes you don't get help from people and in your assessments you can't go to your teacher to write it for you, she will explain everything, but some of us we won't understand everything after she explained, so by the help of our people, maybe teachers, we wouldn't get hundred percent.
So, are you saying that even if you are getting help, you won't get hundred percent?	Some people who help you will get hundred percent, those who know perfectly pure maths, they can get hundred percent.
Would you say you are one of those people?	Oh, no!
Why not?	I wouldn't say I am hundred percent so, if I can't help a fellow learner to get hundred percent …
So, you are saying that you are not part of those that can get hundred percent?	Well, I am part of them.

Would you get hundred percent if you set a goal that you are going to get hundred percent?	Yes!
Would you get zero percent in maths?	No! (she laughs), never!
Why?	I know some of the things in our assessment, she teaches us, you can't get zero percent because some of the things she taught you about.
Okay, so, what do you say about learners who still get zero percent?	Maybe they are not serious or what! They don't ask for help, for information from the teacher, they are scared of her.
You said you have neighbours who are able to help you with mathematics?	Yes.
Would you say those students might not have people to offer extra help to them at home?	Yeah, maybe they don't get enough help at home, because some of our homes our parents did not do pure maths, so they can't help you with pure maths if they did maths literacy.
So, if you were to get let's say ten percent in mathematics, what would you do?	I would work hard until I get that ten percent.
I mean you already got ten percent, it is in a test and you get ten percent, that's your mark, what would you do, ma'am comes back and she gives you the script and you see that you got ten percent?	Haah! I would make sure that I study hard, and get more information, get help with what is hardest for me, if I don't understand everything I get help.
Oh, good. Is there anything that you would like to ask me?	Yeah!
Okay …	Anything that you have talked about?
Anything that you would like to ask.	So, okay, if I get this ten percent in a test, what things must I do in order to get hundred percent?
Okay, what do you think you should do in order to get hundred percent?	According to my point, my mind, I have to pull up my socks and get information, get

	information about the things that are difficult for me.
How do you approach let's say a topic in your textbook, let's say you are learning with your teacher, how do you approach a topic? How do you engage with a particular topic in mathematics?	Well, I must find out what the topic is all about.
Please explain more.	Well, I must find out what the topic is all about, get information, what does it talk about, something like that and get help from the teacher.
What is important for you to know in mathematics? Is it the steps that you are supposed to follow or is it the meaning of the topic that you are covering?	The meaning of the topic.
What do we mean by the meaning of the topic?	Well, if you know the steps and you don't know the meaning of the topic, well, maybe the steps you can get them correct if you know them. But, what is important is that you should know the topic, what it is all about.
Currently you are doing functions in Grade 10 right?	Yes.
What do you understand by functions?	Well, almost, not everything I understand. But, what I understand in functions is that we actually understand it when our teacher is doing it for us, but on our own, we don't understand it, what functions mean.
Okay, so, do you know what it means, the word function as an English word, what it means?	Well, maybe when I look in the dictionary and read everything what function means, but in my own understanding no.
Okay, which subject would you say is the most important in the school curriculum?	In this school it is maths, because all of us we are doing maths, even if it is different, all of us we are doing maths.
So, you are saying maths is the one that is	And then our home language and English,

at the centre of all the subjects?	because all of us do English.
Okay, so, do you think there is a relationship between mathematics, your home language and English?	Yes, not including home language, English and mathematics are related.
How, how so? Why do you think home language does not fit well with mathematics?	Well, in mathematics, we don't write in our home language, we use English only.
So, do you think if you don't have a background of English, then you can't be able to engage with mathematical tasks?	No!
How so?	When questions come you won't, you can't answer them because you won't understand what they want you to solve, because you won't understand the word solve in English.
So, I will ask again, let's say you were to get zero percent, what steps would you take to ensure that you get a better mark in the next assessment?	I would get help, get information, work hard, everyday come to school, make sure that I don't bunk maths periods.
So, do you think the things that you have covered before link with new topics?	Yes
How do they link?	My topics?
Yeah, let's say the things that you did previously and the things that you are doing currently.	They are different, but if you practice them every day, you won't forget the ones that you did previously.
Oh, that's very good. Anything you would like to ask me about mathematics, about school, about becoming a doctor?	I would like to ask about becoming a doctor.
Okay, what do you want to ask about being a doctor?	How many percentages must you get in maths in order to become a doctor?
Well, it depends from institution to institution, where do you want to go and do your studies?	At the university of Johannesburg.

University of Johannesburg, why university of Johannesburg?	Because maybe if I get bursaries, I will choose the University of Johannesburg because I have relatives in Johannesburg, who will support me when I am in Joburg.
Do you think it is the University of Johannesburg that is in Johannesburg?	No.
What other universities are there?	University of Wits.
What made you to choose UJ over Wits?	Maybe because I know the situation better in UJ than Wits, so I must do a research about these two universities.
Okay, do you UJ offers medicine?	I don't know.
Okay, how did you come to choose UJ before you even got the information?	Well, UJ is most talked about, good things, good education, yeah everything like that.
Okay, who talks about UJ with you guys?	Well, every children talk about UJ, my fellow learners talk about UJ, they say it is a nice University, it gives me good education.
Okay, what other Universities do you know in South Africa?	University of Cape Town, University of Pretoria.
Would you go to University of Mpumalanga?	No! (she laughs).
Why?	In my province, no!
Why not?	I don't want to study here in my province; I want to go out of the province.
Why do you want to go out of the province? What drives you to want to go out of the province?	I want to be there out of the province because some people are jealous; I don't want to talk too much with people.
What do you mean by jealous?	Well by jealous, people can get jealous especially when it comes to me, now that I want to be a doctor, when it comes to my seven years, when I am done with my seven years, they will become jealous because they will know that this girl she is becoming a doctor, she will do everything for her

	family, she will buy cars, nice house, they will start to be jealous of me.
What would they do? They won't take anything from you even if they are jealous.	Yho! They will.
What will they do?	Maybe they will bewitch me, I don't know.
In terms of engaging with mathematics, do you think sometimes you don't engage well in class because you are afraid of jealousy?	No! In class I am not afraid of jealousy.
Okay, how do you do things differently then?	The difference between the jealous in class and the jealous outside? Well, in class we are not many, but in the community there are many people, so some of us even though we don't have enemies, they start to be jealous so that they become our enemies.
So, your peers when you get a good mark in class, do they become jealous of you? Yes.	Yes.
What do they do?	Well, I don't follow them, whatever they say I never listen to them, but I can see that they are jealous.
So, what do you do?	I just watch them, I don't do anything.
Do you think the learners who are in the maths literacy stream, they are jealous of the maths pure learners?	No, they are not. They are not jealous.
Do you think maths is more important than maths literacy?	Err, yeah!
In what way?	Well, pure maths, maths literacy not like I am judging the ones who are doing it, but cannot lead you to be, whatever, whatever career you want, the big career, to get a big salary to produce everything for your family. But, in pure maths, if you get good marks, you can do a career you want, and every career that needs pure maths it does

	have a good salary.
What is the importance of mathematics in the society would you say?	The importance of mathematics, pure maths in our society?
Yeah!	Well, it is important because many people in our society, they did maths literacy and they are there at home sitting, they are not doing anything, they don't have jobs. And the people who did pure maths are them who are working; they are the ones who are producing food for their families. The ones who did maths literacy, most of them are doing nothing.
Oh, okay. That is very good, for you mathematics puts you in a better job market?	Yes.
Give me a list of the jobs that mathematics will take you towards.	It can be a scientist, it can be a doctor, in pure maths you can be, any career that you want. as long as you have pure maths, you can get it.
So, if a person gets hundred percent in maths, do you think that person can be a nurse or a teacher?	Yes.
In what way?	If that person is doing pure maths, yeah, he or she can be a teacher or a nurse because sometimes when you get good marks you can get bursaries to go to varsity and study for free for any career you want, even for that nurse, even for teachers.
So, mathematics is not only about good careers you say?	It is all about good careers!
Why do you say that?	If you don't have maths, pure maths, you can't be a doctor. You can't be many things, scientist. But when you are in pure maths you can choose any career.

Oh no, that's very nice. That is very good, so, you are comfortable in doing any mathematics, you are fine?	Yes, I am fine.
You never experience any challenges?	I do some challenges, difficult things, but I did get help and now I am fine.
That is very good. Thank you very much for your time neh.	Okay, thank you.

Appendix 2

Summary of the interview (Brilliant)

Brilliant appears to be a learner who likes mathematics, he sees a need to concentrate, work hard and practice mathematics. Of interest is that in everything he does, mathematics is at the centre. He aspires to be either a mathematician or a scientist, from the information he provided, it seems to suggest that he is working hard to understand mathematical contents so that he can do well in Grade 12, which consequently will allow him a chance to go to university to advance his career horizons. He wishes to go to the University of New York. His Grade 6 teacher incited his love for mathematics, and his father and brother motivated him to take mathematics in Grade 10. While this is the case, the data suggests that Brilliant has an intrinsic motivation to learn mathematics. This is exemplified by his commitment to practice the subject, even in cases where the teacher is covering a chapter that he already covered, he initiates his own learning by identifying a new topic and he tries to learn the contents on his own.

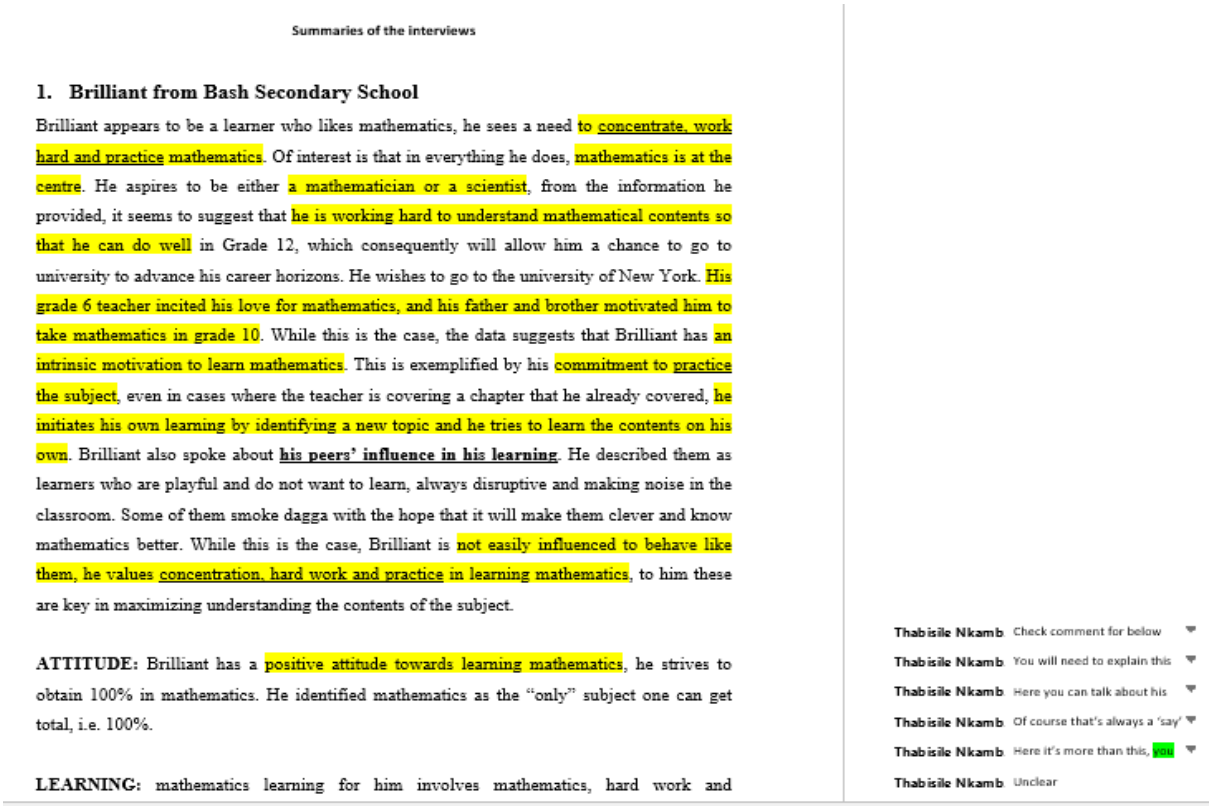
Brilliant spoke about his peers' influence in his learning. He described them as learners who are playful and do not want to learn, always disruptive and making noise in the classroom. Some of them smoke dagga with the hope that it will make them clever and know mathematics better. While this is the case, Brilliant is not easily influenced to behave like them, he values concentration, hard work and practice in learning mathematics, to him these are key in maximizing understanding the contents of the subject.

Brilliant has a positive attitude towards learning mathematics, he strives to obtain 100% in mathematics. He identified mathematics as the "only" subject one can get total, i.e. 100%. Mathematics learning for him involves, hard work and concentration. He does not like being disturbed when learning mathematics, although he prefers to work in a group, his iterations suggests that he is an individual worker. Because boys are playful and always make jokes when the teacher is teaching, he prefers working with girls because they are more focused than boys. He prefers to have a friend who is committed as him to learning, and despises those learners who just make noise and go to the toilet for no apparent reason. He does ask for help from the teacher, but after he has tried to solve mathematical problems for himself. At home, after exercising he practice mathematics, and when he is walking he thinks of what the teacher was teaching in class. For him mathematics enables him to solve his own personal as well as societal issues, it provides him with a lens to solve these problems.

Although not much was said about his experiences of learning mathematics particularly, Brilliant described an incident where he got 5% in Grade 9, and how he practices and work very hard to ensure

that he does not fail mathematics ever again. He also spoke about witchcraft, that he does not perform at a higher level in mathematics assessment as he would like to because his father told him to "cool down" since other may be jealous of him and use his brain. He said when he arrived at Bash Secondary School, they told him that he shouldn't think or act as if he is better than others because they will "so something" to him. Although Brilliant seem to be a good student, in that he practices mathematics more often and identifies areas that needs much work and try to solve the problems, this perception of witchcraft seems to shape the way he engages with mathematics assessment. Currently, Brilliant is getting 70/80% in mathematics, this might be the shaper of why he constantly practices mathematics, because he succeeds in learning the subject.

Appendix 3: Review of interview summaries and initial list of categories



Summaries of the interviews

1. Brilliant from Bash Secondary School

Brilliant appears to be a learner who likes mathematics, he sees a need to concentrate, work hard and practice mathematics. Of interest is that in everything he does, mathematics is at the centre. He aspires to be either a mathematician or a scientist, from the information he provided, it seems to suggest that he is working hard to understand mathematical contents so that he can do well in Grade 12, which consequently will allow him a chance to go to university to advance his career horizons. He wishes to go to the university of New York. His grade 6 teacher incited his love for mathematics, and his father and brother motivated him to take mathematics in grade 10. While this is the case, the data suggests that Brilliant has an intrinsic motivation to learn mathematics. This is exemplified by his commitment to practice the subject, even in cases where the teacher is covering a chapter that he already covered, he initiates his own learning by identifying a new topic and he tries to learn the contents on his own. Brilliant also spoke about **his peers' influence in his learning**. He described them as learners who are playful and do not want to learn, always disruptive and making noise in the classroom. Some of them smoke dagga with the hope that it will make them clever and know mathematics better. While this is the case, Brilliant is not easily influenced to behave like them, he values concentration, hard work and practice in learning mathematics, to him these are key in maximizing understanding the contents of the subject.

ATTITUDE: Brilliant has a positive attitude towards learning mathematics, he strives to obtain 100% in mathematics. He identified mathematics as the "only" subject one can get total, i.e. 100%.

LEARNING: mathematics learning for him involves mathematics, hard work and

Thabisile Nkamb Check comment for below

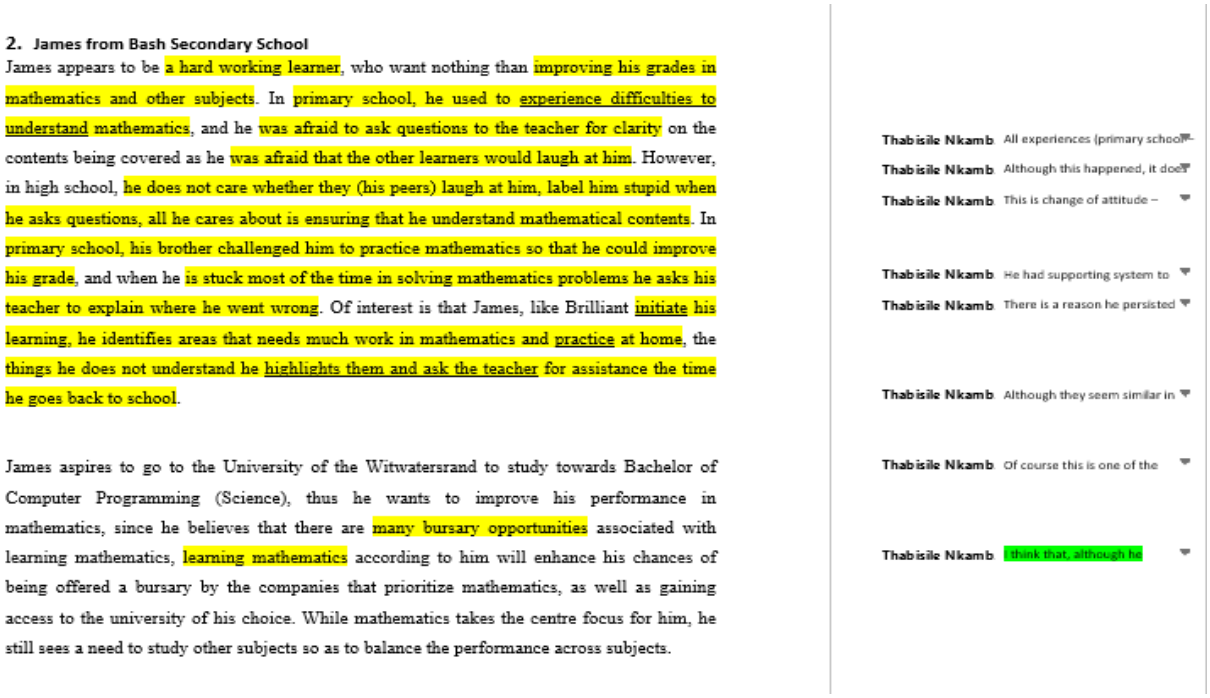
Thabisile Nkamb You will need to explain this

Thabisile Nkamb Here you can talk about his

Thabisile Nkamb Of course that's always a 'say'

Thabisile Nkamb Here it's more than this, you

Thabisile Nkamb Unclear



2. James from Bash Secondary School

James appears to be a hard working learner, who want nothing than improving his grades in mathematics and other subjects. In primary school, he used to experience difficulties to understand mathematics, and he was afraid to ask questions to the teacher for clarity on the contents being covered as he was afraid that the other learners would laugh at him. However, in high school, he does not care whether they (his peers) laugh at him, label him stupid when he asks questions, all he cares about is ensuring that he understand mathematical contents. In primary school, his brother challenged him to practice mathematics so that he could improve his grade, and when he is stuck most of the time in solving mathematics problems he asks his teacher to explain where he went wrong. Of interest is that James, like Brilliant initiate his learning, he identifies areas that needs much work in mathematics and practice at home, the things he does not understand he highlights them and ask the teacher for assistance the time he goes back to school.

James aspires to go to the University of the Witwatersrand to study towards Bachelor of Computer Programming (Science), thus he wants to improve his performance in mathematics, since he believes that there are many bursary opportunities associated with learning mathematics, learning mathematics according to him will enhance his chances of being offered a bursary by the companies that prioritize mathematics, as well as gaining access to the university of his choice. While mathematics takes the centre focus for him, he still sees a need to study other subjects so as to balance the performance across subjects.

Table 5. Initial proposed major themes and sub-themes

Initial proposed major themes	Initial proposed sub-themes
Effects of manifold relationships upon learning mathematics: enhancing or constraining?	*The microsystem of Grade 10 rural learners* *The mesosystem of Grade 10 rural learners* *The macrosystem of Grade 10 rural learners* *Illuminated factors within the exosystem of Grade 10 rural learners*
Time in learners' experiences and attitudes towards learning mathematics	*micro-time* *meso-time* *macro-time* *Anticipatory time: learning mathematics for future life*
Identity as mathematics learners	

Appendix 4

Mpumalanga Department of Education Approval Letter – larger research study

APPROVAL TO CONDUCT RESEARCH FOR DR T. NKAMBULE

education
MPUMALANGA PROVINCE
REPUBLIC OF SOUTH AFRICA

Building No. 5, Government Boulevard, Riverside Park, Mpumalanga Province
Private Bag X11341, Mbombela, 1200.
Tel: 013 766 5552/5115, Toll Free Line: 0800 203 116

Litiko le Temfundvo, Umnyango wa Fundo   Departement van Onderwys   Ndzawulo ya Dyondzo

Enquiries: A.H. Baloyi
Tel: (013) 766 5476

Dr T. Nkambule
2307 Oasis Security Estate
Cnr Pyp Avenue and Orange rivier Drive
Kempton Park West
1619

<u>RE: APPLICATION TO CONDUCT RESEARCH: DR T. NKAMBULE</u>

Your application to conduct research was received on 25 February 2015. The title of your study is: "Conditions of teaching and learning that facilitate and/or constrain learning in rural high Schools." The research objectives, significance and overall design of your study give an impression that the outcomes of the study will be useful and valuable in improving teaching and learning in rural schools. Your request is approved subject to you observing the content of the departmental research manual which is attached. You are required to discuss with the principals of the sampled schools regarding the approach to your observation and data collection as no disruption of tuition will be allowed. You are also requested to adhere to your University's research ethics as spelt out in your research ethics document.

In terms of the attached manual (2.2. bullet number 4 & 6) data or any research activity can only be conducted after school hours as per appointment. You are also requested to share your findings with the department so that we may consider implementing your findings if that will be in the best interest of the department.

MPUMALANGA
THE PLACE OF THE RISING SUN

APPROVAL TO CONDUCT RESEARCH FOR DR T. NKAMBULE

For more information kindly liaise with the department's research unit @ 013 766 5476 or a.baloyi@education.mpu.gov.za. The department wishes you well in this important project and pledges to give you the necessary support you may need.

APPROVED/NOTAPPROVED:

MRS MOC MHLABANE
HEAD OF DEPARTMENT

07/3/15
DATE

MPUMALANGA
THE PLACE OF THE RISING SUN

Appendix 5

Information sheet for principals

11 April 2016

Dear Principal

My name is Hlamulo Wiseman Mbhiza, I am a Master of Education by Dissertation Candidate at School of Education, University of the Witwatersrand. I am doing research on Grade 10 rural learners' experiences of and attitudes when learning Mathematics in Acornhoek, Mpumalanga Province. My research involves individual semi-structured interviews and classroom observations with 10 learners from two schools in Acornhoek. Video-recording and audio-recordings will be used during data collection. The interviews will take approximately 30 - 45 minutes and will take place after school hours. The learners who take part in the interviews may also be observed during mathematics period, depending on their willingness to be observed. I am requesting for your permission to interview and observe 12 Grade 10 learners from your school, to share any experiences and information on the research topic. The information will be used to understand learners' experiences of and attitudes towards learning mathematics. Your learners' academic work will not be advantaged or disadvantaged in any way. The learners can withdraw from participating in this study at any time without any penalty. There are no foreseeable risks in participating and you will not be paid for this study.

All the names and identities of the learners and of the school will be kept confidential at all times and in all academic writing about the study. Your individual privacy will be maintained in all published and written data resulting from the study. All research data will be destroyed within five years after completion of the project. Please use the contacts below should you require any further information.

Thank you very much for your help.

Yours sincerely,
Mbhiza Hlamulo Wiseman
457 Springbok Crescent, Eastbank, Gauteng
Cell phone: 0769019192 Email: wmbhiza@gmail.com

And

Dr Thabisile Nkambule
Head of Curriculum Division
School of Education
Tel: +27-11-717-3049 Email: Thabisile.nkambule@wits.ac.za

Appendix 6

Information sheet for teachers and consent form

11 April 2016

Dear Teacher

My name is Hlamulo Wiseman Mbhiza, I am a Master of Education by Dissertation Candidate at School of Education, University of the Witwatersrand. I am doing research on Grade 10 rural learners' experiences of and attitudes when learning Mathematics in Acornhoek, Mpumalanga Province. My research involves individual semi-structured interviews with 10 learners from two schools in Acornhoek. Video-recording and audio-recordings will be used during data collection. I was wondering whether you would mind that for me to come and do a classroom observation while you teach your learners. The information will be used to understand learners' experiences of and attitudes towards learning mathematics in Acornhoek. Your class routine will not be advantaged or disadvantaged in any way. You can ask me to leave the class at any time without any penalty. There are no foreseeable risks in participating and you will not be paid for this study. Your names (both yours and the learners) and identity will be kept confidential at all times and in all academic writing about the study. Your individual privacy will be maintained in all published and written data resulting from the study. All research data will be destroyed within two years after completion of the project. Please let me know should you require any further information.

Thank you very much for your help.

Yours sincerely,
Mbhiza Hlamulo Wiseman
457 Springbok Crescent, Eastbank, Gauteng
Cell phone: 0769019192 Email: wmbhiza@gmail.com

And

Dr Thabisile Nkambule
Head of Curriculum Division
School of Education
Tel: +27-11-717-3049 Email: Thabisile.nkambule@wits.ac.za

Teacher's Consent Form

Please fill in and return the reply slip below indicating your willingness to allow us to engage with some of your learners and observe your class when you are teaching for the study titled: **Exploring Grade 10 rural learners' experiences of and attitudes towards learning mathematics in Acornhoek, Mpumalanga Province.**

I, _____

Circle one

Permission to be videotaped

I agree that my class can be videotaped during classroom observations.	YES/NO
I know that the videotapes will be used for this project only	YES/NO

Informed Consent

I understand that:

- my name and information will be kept confidential and safe and that my name and the name of my school will not be revealed.
- I can ask the researcher to leave the classroom at any time.
- I can ask for my class not to be videotaped
- all the data collected during this study will be destroyed within two years after completion of the project.

Sign_____ Date_____

Appendix 7

Information sheet for parents and consent form

11 April 2016

Dear Parent

My name is Hlamulo Wiseman Mbhiza, I am a Master of Education by Dissertation Candidate at School of Education, University of the Witwatersrand. I am doing research on Grade 10 rural learners' experiences of and attitudes when learning Mathematics in Acornhoek, Mpumalanga Province. My research involves individual semi-structured interviews and classroom observations with 10 learners from two schools in Acornhoek. Video-recording and audio-recordings will be used during data collection. The interviews will take approximately 30 - 45 minutes and will take place after school hours. The learners who take part in the interviews may also be observed during mathematics period, depending on their willingness to be observed. I am requesting the participation of your child in the research project, to share any experiences and information on the research topic. The information will be used to understand learners' experiences of and attitudes towards learning mathematics. Your child's academic work will not be advantaged or disadvantaged in any way. Your child can withdraw from participating in this study at any time without any penalty. There are no foreseeable risks in participating and your child will not be paid for this study. Your child's name and identity will be kept confidential at all times and in all academic writing about the study. The child's individual privacy will be maintained in all published and written data resulting from the study. All research data will be destroyed within five years after completion of the project. Please use the contacts below should you require any further information.

Thank you very much for your help.

Yours sincerely,
Mbhiza Hlamulo Wiseman
457 Springbok Crescent, Eastbank, Gauteng
Cell phone: 0769019192 Email: wmbhiza@gmail.com

And

Dr Thabisile Nkambule
Head of Curriculum Division
School of Education
Tel: +27-11-717-3049 Email: Thabisile.nkambule@wits.ac.za

Parent's Consent Form

Please fill in and return the reply slip below indicating your willingness to allow your child to participate in the study titled: **Exploring Grade 10 rural learners' experiences of and attitudes towards learning Mathematics in Acornhoek, Mpumalanga Province.**

I, _____

Circle one

Permission to be audiotaped

I agree that my child can be audiotaped during interview focus or group interviews. YES/NO

I know that the audiotapes will be used for this project only YES/NO

Permission to be interviewed

I agree that my child can be interviewed for this study. YES/NO

I know that he or she can stop the interview at any time and doesn't have to answer all the questions asked. YES/NO

Informed Consent

I understand that:

- my child's name and information will be kept confidential and safe and that his or her name and the name of my child's school will not be revealed.
- My child does not have to answer every question and can withdraw from the study at any time.
- I can ask for my child not to be audiotaped and/or videotaped
- all the data collected during this study will be destroyed within five years after completion of the project.

Sign_____ Date_____

Appendix 8
Information sheet for learners and consent form

11 April 2016

Dear Learner

My name is Hlamulo Wiseman Mbhiza, I am a Master of Education by Dissertation Candidate at School of Education, University of the Witwatersrand. I am doing research on Grade 10 rural learners' experiences of and attitudes when learning Mathematics in Acornhoek, Mpumalanga Province. My research involves individual semi-structured interviews and classroom observations with 10 learners from two schools in Acornhoek. Video-recording and audio-recordings will be used during data collection. The interviews will take approximately 30 - 45 minutes and will take place after school hours. The learners who take part in the interviews may also be observed during mathematics period, depending on their willingness to be observed. I am requesting for your participation in the research project, to share any experiences and information on the research topic. The information will be used to understand learners' experiences of and attitudes towards learning mathematics. Your academic work will not be advantaged or disadvantaged in any way. You can withdraw from participating in this study at any time without any penalty. There are no foreseeable risks in participating and you will not be paid for this study. Your name and identity will be kept confidential at all times and in all academic writing about the study. Your individual privacy will be maintained in all published and written data resulting from the study. All research data will be destroyed within five years after completion of the project. Please use the contacts below should you require any further information.

Thank you very much for your help.

Yours sincerely,

Mbhiza Hlamulo Wiseman
457 Springbok Crescent, Eastbank, Gauteng
Cell phone: 0769019192 Email: wmbhiza@gmail.com

And

Dr Thabisile Nkambule
Head of Curriculum Division
School of Education
Tel: +27-11-717-3049 Email: Thabisile.nkambule@wits.ac.za

Learners' Consent Form

Please fill in and return the reply slip below indicating your willingness to participate in the study titled: **Exploring Grade 10 rural learners' experiences of and attitudes towards learning Mathematics in Acornhoek, Mpumalanga Province.**

I, _____

Circle one

Permission to be audiotaped

I agree that I can be audiotaped during interview focus or group interviews. YES/NO

I know that the audiotapes will be used for this project only YES/NO

Permission to be interviewed

I agree that I can be interviewed for this study. YES/NO

I know that I can stop the interview at any time and doesn't have to

answer all the questions asked. YES/NO

Permission to be videotaped

I agree to be videotaped during classroom observations. YES/NO

I know that I can leave the classroom at any time for any reason during classroom observation

YES/NO

I know that the videotapes will be used for this project only YES/NO

Informed Consent

I understand that:

- my name and information will be kept confidential and safe and that my name and the name of my school will not be revealed.
- I do not have to answer every question and can withdraw from the study at any time.
- I can ask not to be audiotaped and/or videotaped
- all the data collected during this study will be destroyed within five years after completion of the project.

Sign_____ Date_____

Appendix 9

Interview Schedule

Interview questions

1.What or who motivated you to do mathematics?

2.What is the importance of mathematics in the society?

3.What challenges, if any, did you experience in mathematics?

4.How do/did you solve the challenges in doing mathematics?

5.What are your strengths in mathematics?

6.What kind of skills do you think mathematics teaches individuals?

7.What is outstanding about your mathematics classroom?

8. (Please explain to me) How do you engage with mathematics when you learn alone?

9.Is there a specific section/topic you like in mathematics? Please talk about it/them briefly, why you like it/them.

10. Some learners think mathematics is difficult, what do you think?

11. What motivate you when you experience challenges in mathematics?

12. (Please explain) How do you engage with mathematics tasks in class?

13. When you are at home alone, how do you engage with mathematics tasks? Please explain

14. How do you participate in class during mathematics?

15. If you were a mathematics teacher, how would you teach it?

16. What are your learning experiences of mathematics?

17. Who do you ask if there's something you do not understand in mathematics?

18. What are your goals?

19. How do you perform in mathematics assessments?

20. Is there anything you like to ask me? Thank you for your time.

Appendix 10

Letter of candidature

Faculty of Humanities: Education Campus

Room 208/9, Administration Block, 27 St. Andrews Road, Parktown **Tel**: +27 11 717-3021/18 · **Fax**: 0865533480 or +27 11 717-3219 E-mail: maropeng.maake@wits.ac.za / hale.modau@wits.ac.za

PERSON NUMBER: 487440

Mr Hlamulo Mbhiza
457 Springbok Cresent
Eastbank
Alexandra
2001

08 June 2016

Dear Mr Mbhiza

CONFIRMATION OF CANDIDATURE FOR THE DEGREE OF MASTERS BY DISSERTATION (FULL-TIME)

I am pleased to inform you that the Graduate Studies Committee has approved your research proposal entitled: **Exploring Grade 10 rural learners' experiences and attitudes towards learning mathematics in Acornhoek classrooms, Mpumalanga Province.** You have now been admitted to candidature subject to corrections suggested by the two readers to the satisfaction of the supervisor and the focus of the study needs attention according to both readers. The external reader questions the focus on learners' attitudes while the internal reader hints that another objective should be added about how learners' experiences and attitudes shape learners' engagement and achievement in Maths. In the light of these slightly contradictory suggestions, the supervisor and the candidate should re-think carefully the focus of the study so that it becomes feasible and viable for an M Ed dissertation.

Please contact your supervisor(s) for readers' report.

I confirm that Dr Thabisile Nkanmbule has been appointed as your supervisor(s).
You are required to submit 2 bound and 1 unbound copies of your thesis to the Faculty Office for examination. The copies go to the examiners and are retained by them.

Your attention is drawn to the Senate's requirement that all higher degree candidates submit brief written reports on their progress to the Faculty Office once a year. Please note that higher degree candidates are required to renew their registration in January each year. Please keep us informed of any changes of address during the year.

Yours sincerely

Maropeng Maake

Maropeng Maake (Mr)
Faculty Officer
Faculty of Humanities: Education
cc Supervisor(s) Dr Thabisile Nkanmbule
Student file

Appendix 11

Ethics clearance letter

Wits School of Education

27 St Andrews Road, Parktown, Johannesburg, 2193 Private Bag 3, Wits 2050, South Africa. Tel: +27 11 717-3064 Fax: +27 11 717-3100 E-mail: enquiries@educ.wits.ac.za Website: www.wits.ac.za

03 June 2016

Protocol Number: 2016ECE018M

Student number: 487440

Dear Wiseman Mbhiza

Application for ethics clearance: Master of Education

Thank you very much for your ethics application. The Ethics Committee in Education of the Faculty of Humanities, acting on behalf of the Senate, has considered your application for ethics clearance for your proposal entitled:

Exploring grade 10 rural learners' experiences of and attitudes towards learning Mathematics in Acornhoek, Mpumalanga Province

The committee recently met and I am pleased to inform you that **clearance was granted**.

Please use the above protocol number in all correspondence to the relevant research parties (schools, parents, learners etc.) and include it in your research report or project on the title page.

The Protocol Number above should be submitted to the Graduate Studies in Education Committee upon submission of your final research report.

All the best with your research project.

Yours sincerely,

M Mabeta

Wits School of Education

011 717-3416

cc Supervisor - Dr Thabisile Nkambule