BARRIERS TO LEARNING MATHEMATICS IN RURAL SECONDARY SCHOOLS

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DECLARATION

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ABSTRACT

The Eastern Cape Province of South Africa is predominantly rural in nature. Many schools within the province are under-resourced in terms of the minimum school equipment such as school furniture, telephones, photocopiers, learner resource material (textbooks), electricity, water ablution facilities, audiovisual equipment and, in many instances, even educators. In the light of the above, it was decided to gain a deeper understanding of the barriers that learners face in learning mathematics in grade 8 in schools in the rural areas of the Eastern Cape Province. A mixed methods research design using both quantitative and qualitative methods was employed, in order to generate data to shed light on the research question. Biographical information of the learners and educators was gained. Six schools were selected and their grade 8 mathematics learners were used in the research. The learners completed a numeracy and mathematical literacy test as well as questionnaires regarding their attitudes to mathematics and literacy. Focus group interviews were also conducted with the participants for the purposes of collaboration of information derived from the test and biographical questionnaire. From the analysis of the data collected, several possible barriers were identified. Among these are that learners exhibit attitudinal barriers towards learning mathematics, they do not make serious attempts to solve problems once they encounter difficulty. The educators seem to lack the mathematics competencies to handle their teaching. They still teach instrumentally in the way they were taught, which could constitute a barrier to the learning. The educators' interaction with the learners takes place only in the classroom time and is therefore limited. A lack of a reading culture among the learners were found. Learners therefore experience difficulties in comprehending mathematical texts because of inadequate vocabulary and reading skills. Learners experience lack of support in their home environments. Basic and prerequisite numeracy skills do not seem to have been acquired at the necessary levels in earlier grades.

Various recommendations have been made for all stakeholders involved in the study – educators, caregivers, and the Department of Education in the Eastern Cape Province. The following recommendations were made for educators: they should make an effort to educate themselves on new trends in teaching methodologies. In this regard, educators should use a consistently open-ended teaching approach, accepting alternative views, leaving issues open, and encouraging independent enquiry and participation by means of learner-centred

activities. Specifically, educators must refrain from teaching as an attempt to deposit knowledge in the learners through direct instructions but rather adopt the constructivist perspective. It was also recommended that to improve numeracy competency among learners, educators should not just teach mathematics or depend entirely on mathematics but be conscious of the fact that although numeracy may be taught in mathematics classes, to be learned effectively, learners must use it in a wide range of contexts at school and at home, including entertainment and sports.

For caregivers, the following recommendations were made: Caregivers serve as a crucial link to their children's movement through the mathematics machinery and as such schools must find a vehicle to support and promote this partnership. Caregivers' involvement in learners' work will be a motivating factor for learners. Even if the caregivers themselves have no formal education, their mere concern and involvement in the learners' work will stimulate their interest and enhance performance.

The study also recommends to the Eastern Cape Provincial Government that there is the need to provide adequate infrastructure in rural secondary schools. Furthermore, there is also the need to provide the necessary educator and learner support materials and ensure that there are enough qualified mathematics educators in the schools. It was also recommended that appropriate incentives be given to the educators of mathematics to motivate them to higher performances.

OPSOMMING

Die Oos-Kaap Provinsie van Suid-Afrika is hoofsaaklik 'n plattelandse gebied. Die skole in hierdie gebied ervaar groot tekorte wat hulpbronne betref. Minimum toerusting soos meubels, telefone, audio-visuele toerusting, handboeke, elektrisiteit en in sommige gevalle selfs onderwysers voldoen nie aan die behoeftes in die plattelandse skole nie. In die lig hiervan is besluit om ondersoek in te stel na sommige hindernisse wat leerders in die leer van wiskunde in graad 8 in plattelandse skole in hierdie gebied ervaar. 'n Gemengde metodes navorsingsontwerp waarin kwantitatiewe sowel as kwalitatiewe metodes gebruik is, is aangewend om data in te win wat lig sou kon werp op hierdie vraag. Biografiese inligting van die leerders en die onderwysers is ingewin. Graad 8 leerders van ses skole het deelgeneem aan hierdie studie. Die leerders het 'n wiskunde toets afgelê sowel as 'n vraelys met betrekking tot hul houdings ten opsigte van wiskunde en geletterdheid ingevul. Fokusgroeponderhoude is ook met die deelnemers gevoer. Verskeie hindernisse is geïdentifiseer. Dit het geblyk dat die leerders se houdings ten opsigte van wiskunde moontlike hindernisse kon wees. Hulle sou nie ernstige pogings aanwend om probleme op te los wanneer hulle dit ervaar het nie. Die onderwysers het skynbaar nie die nodige kundigheid openbaar om wiskunde suksesvol te onderrig nie. Interaksie tussen die leerders en die onderwysers is beperk tot uitsluitlik klastyd. Daar is 'n gebrekkige leeskultuur geïdentifiseer. Onvoldoende woordeskat en leesvaardighede vloei hieruit. Leerders ervaar beperkte ondersteuning in die aanleer van wiskundige vaardighede van hul versorgers. Basiese en voorvereiste syfervaardighede wat in vroeëre grade verwerf moes wees, blyk nie in plek te wees nie.

Verskeie aanbevelings ten opsigte van hierdie bevindinge sluit die studie af.

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CHAPTER 1

SCOPE OF THE STUDY

1.1 INTRODUCTION AND BACKGROUND

The Eastern Cape Province of South Africa is predominantly rural in nature. It is a province endowed with scenic beauty, and an abundance of natural resources and untapped supply of human resources. Because it is predominantly rural, there are extremely long distances between towns and villages. It unfortunately also suffers from under-developed infrastructure and concomitant backlogs. These are a legacy of the apartheid past. Many schools within the province are under-resourced in terms of the minimum school equipment such as school furniture, telephones, photocopiers, learner resource material (textbooks), electricity, water ablution facilities, audiovisual equipment and, in many instances, even educators. Many of the school buildings are in disrepair. Table 1.1 shows the statistics gained from the Survey of the Register of Needs (Department of Education (DoE), 2000). This report highlights the lack of resources in South African and Eastern Cape schools.

Table 1.1: Lack of Basic Resources in South African and Eastern Cape Schools

Resources in Schools	South Africa	Eastern Cape
Without Electricity	42,9%	60,5%
No access to water	28,0%	40,0%
No telecommunications	35,5%	41,0%
No computers for teaching and learning	87,7%	Over 95,0%

Bot in Czerniewicz, Murray and Probyn (2000) also provides some statistics regarding the availability of resources. Although these statistics cannot be generalized as the study was conducted in only 900 schools in South Africa (a mix of rural, urban and peri-urban), the results do show trends in availability. These statistics are illustrated in Table 1.2.

Table 1.2: Availability of teaching resources

Resources	South Africa	Eastern Cape
Chalkboards	94%	85%
Chalk	95%	83%
Textbooks	72%	59%
Stationary	82%	58%
Dictionaries	46%	31%

(Adapted from Czerniewicz et al., 2000:24)

The Schools' Register of Needs Survey carried out in 1996 highlighted problems such as the lack of school buildings or their poor condition, the absence of telephones, power, water, toilet facilities, desks and chairs. Only 17% of schools were found to have a library, and only 31% of secondary schools have a science laboratory. Only half of the schools were adequately supplied with textbooks and two-thirds with stationary. These shortages are a matter of concern because international literature suggests that school libraries, textbooks and laboratories make important contributions to learning (Bot, in Fieldgate, 1998:129). During a follow-up survey by the Department of Education in 2000, it was found that some shortages reported in 1996 have showed improvement. Although a decrease in the number of educators was reported, there was an increase of 3929 educators in the Eastern Cape (DoE, 2000). Although the provision of facilities has improved there still existed significant provincial variations. The Eastern Cape still reported that 95% of schools did not have access to resources such as computers, media centres (libraries), furniture, specialised classrooms etc (DoE, 2000).

There are a number of inherited inequities in the schools system. These are reflected in the provision of facilities and infrastructure as well as human resources. Backlogs tend to be greatest in schools that used to fall under the former Department of Education, which served African schools. These backlogs are particularly severe in schools in rural areas. The predominantly rural Eastern Cape is one of the provinces with huge backlogs in their schools (Bot, in Fieldgate, 2001:129).

Lack of mathematics and science educators amongst others feature prominently in such rural secondary schools. With the introduction of the highly sophisticated and resource driven

curriculum 2005 in 1997 (C 2005), these backlogs have become more evident.
Although educator qualifications have improved during the 1990s, 36% of African educators teaching mathematics were un-, or under qualified. The majority (66%) of African secondary educators teaching mathematics had five years or less experience. The proportion of all African secondary educators who are teaching mathematics is quite uniform across provinces and constitute 16,5% (Hofmeyr & Hall, 1996).

Invariably, the mention of barriers to learning, calls to mind some kind of physical disability that prevents a learner to achieve his/her utmost potential. According to Tulloch (1993:112), a barrier is a fence or other obstacle that bars advance or access. It is an obstacle or circumstances that keep people or things apart, or prevents communication (class barrier, a language barrier), anything that prevents progress or success. Engelbrecht, Green, Naicker and Engelbrecht (1999:53) consider the following as the most critical barriers to learning and development which greatly affect effective learning: "socioeconomic barriers i.e. poverty and lack of resources, violence, a rigid curriculum negative attitude towards difference, inappropriate and unsafe built environment, lack of parental recognition and in adequate or inappropriate policy and legislation".

The researcher was motivated to carry out this study because of his visits to support educators and learners in rural schools. As Engelbrecht et al. (1999:53) argue, physical features, environment, poverty, and parental or family support create barriers that hinder the learning in rural schools. The effect of these is exacerbated by an inflexible or rigid curriculum, attitudinal barriers and inadequately trained educators. Educators have themselves little or no knowledge of the content of the mathematics they teach. A study, which highlights the problems facing grade 8 learners in mathematics in rural schools, should not only make the Department of Education (DoE) and all other relevant stakeholders aware of these problems, but should also assist the DoE to plan the use of resources appropriately, and to develop the rural schools to make them sufficiently attractive for educators to accept postings to these schools.

1.2 AIMS OF THE STUDY

In order to promote an interest in mathematics in learners in rural schools, this study aims to identify the nature of some barriers to the learning of mathematics in a selected group of Grade 8 learners in the King William's Town/Bisho district of the Eastern Cape. Identifying the barriers to learning mathematics in rural schools and finding appropriate interventions could make it possible for more learners to study the subject. Consequently, more learners would be encouraged to read towards careers in mathematics based disciplines which South Africa needs for her development. It is a well known discourse in South Africa that we do not have enough skilled people in science based fields.

There are many hypotheses about why learners battle with mathematics, but few of these have been researched in the contexts of rural schools in South Africa.

The research concentrates on grade 8 learners in rural schools in the Eastern Cape Province of South Africa. The research question therefore is: "Which barriers do grade 8 learners in rural secondary schools in the Eastern Cape Province of South Africa face in learning mathematics?"

1.3 RESEARCH METHODOLOGY

In this study, a pragmatic, mixed-methods design was used to collect both quantitative and qualitative data. Mixing quantitative and qualitative methods meant it was possible to benefit from their complementary strengths (Teddlie & Tashakkori, 2003:19).

Mixed methods research is able to answer research questions that other methodologies cannot. Mixed methods provide better (stronger) inferences. Mixed methods also provide the opportunity for presenting a greater diversity of divergent views (Teddlie & Tashakkori, 2003:15-16). The adoption of multiple methods in a single study adds rigour, breadth, complexity, richness and depth to any inquiry (Flick in Denzin & Lincoln, 2000:5).

1.4 LITERATURE REVIEW

A literature review was carried out to determine what had already been written on barriers to learning mathematics. According to Mertens (2003:143), literature reviews are excellent ways of gathering information related to the historical and contextual issues of importance to the population of concern. The literature search included quantitative, qualitative and mixed methods approaches. In addition several concepts were clearly defined. The researcher relied on books, newspapers, journals, and dissertations.

1.5 ETHICS AND CONFIDENTIALITY

A letter was written to the Department of Education, Eastern Cape (Addendum A), requesting permission to undertake the research and for ethical reasons, letters were sent to participants, requesting them to participate in the research (Addendum G). Anonymity was guaranteed in the questionnaires and it was indicated that any answer would be accepted.

1.6 SCOPE OF THE RESEARCH

The research was conducted as part of a master's programme at the University of Stellenbosch. The researcher lives in the King William's Town-Bisho area of the Eastern Cape, and is employed full-time as an academic co-ordinator for Mathematics Education in the In-service Education programmes of the University of Fort Hare, Alice. The research was carried out in the rural areas of the Eastern Cape.

Barriers to learning mathematics are a broad topic to research. In order to make the research manageable, only matters that concern the teaching and learning of mathematics in the rural context have been included.

1.7 TARGET POPULATION AND SAMPLE

The target population were all grade 8 learners and mathematics educators in selected rural schools in the King William's Town/Bisho District. Participation in the research was voluntary. All the learners who attended the schools of the researcher's sample were between the ages of 13 and 18 years of age. And most of the learners come from homes where primary caregivers had not gained more than primary education, and did not have access to electricity and running water.

1.8 DATA COLLECTION

Data were collected by means of questionnaires and focus group interviews. Mouton (2001:100) argues that data for a survey can be collected using either interviews or questionnaires. According to Cohen and Manion (1994:272) interviews as compared to questionnaires allow for greater depth than questionnaires, and they do not present the problem of poor return rates that questionnaires do. Cohen and Manion (1994), however, say that interviews are generally more expensive to organize, are likely to reach a limited number of respondents, and are prone to subjectivity and bias on the part of the interviewer.

1.9 RESEARCH SAMPLE

A total of 315 grade 8 Mathematics learners and educators at 8 selected rural schools in the King William's Town/Bisho district of Eastern Cape participated in the study. Participation in the study was voluntary.

1.10 RESEARCH QUESTION

The aim of the study was to explore the following question:

"What is the nature of some barriers to effective learning of mathematics in a selected group of grade 8 learners in the King William's Town/Bisho district of the Eastern Cape?"

1.11 IMPORTANCE OF THE STUDY

This study is important because it examines the possible barriers that grade 8 learners in rural schools experience in receiving effective teaching and learning of mathematics. It also investigates the extent to which these barriers may contribute to low achievement and learning gains. After the study has investigated the situation in the rural schools in King William's Town/ Bisho area and identify possible barriers, it will prescribe ways of improving the existing conditions which may lead to better understanding and achievement in rural mathematics classrooms.

1.12 DEFINITION OF CONCEPTS

The researcher will clearly define and explain all the concepts and the particular meaning of each concept that he will apply in the research.

Barrier: Something that prevents two people or groups from agreeing or communicating with each other for example their different social backgrounds or their languages.

A barrier is something that makes it difficult or impossible for something to happen or to be achieved not only between people, but also between learner and learning (Tullock, 1993:112).

Educator: At school level an educator is a person who gives intellectual, moral and social instructions to a learner or provides professional therapy or assists in providing professional services (Hornby, 1984:276).

Rural: The areas outside the cities, which usually lack the benefits of development and sophistication of the urban areas, are known as rural areas (Hornby, 1984:747).

Learner: Someone who is receiving formal education at a school is called a learner.

Secondary School Learner: A secondary school learner would be a child aged between 13-18 years.

Paradigm: A paradigm is a conceptual model of a person's worldview complete with the assumptions that are associated with that view (Mertens, 2003:139).

1.13 SUMMARY

The first chapter of the research provides the background to the investigation into the learning of mathematics in rural secondary schools in the King William's town school district of the Eastern Cape, Province in South Africa. It also noted the lack of resources in schools in South Africa and the Eastern Cape in particular.

In this chapter the researcher defined and explained the particular meaning of salient concepts used in this research.

The second chapter provides the literature review that relates to the research. The third chapter discusses the research design, methodology, analysis and results. In the fourth chapter, the findings are summarized, recorded, analyzed and discussed. The analysis includes noting the most salient findings, exploring the relationship between the findings and the literature and offering suggestions to educators.

In the final chapter conclusions are drawn, a summary of the research is provided, the main research findings are described, recommendations are made and the limitations of the research are outlined.

CHAPTER 2

LITERATURE REVIEW

2.1 INTRODUCTION

In this chapter literature relating to the theories of learning, the learning of Mathematics in particular and the barriers that hinder the learning of mathematics in rural secondary schools are reviewed.

According to the National Commission on Special Needs in Education and Training (NCSNET, DoE, 2001) and DoE Draft Guidelines for Inclusive Education (2002:130-135) report, learning difficulties do not only reside in the learner but also reside in the system of which the learner is part. In order to promote the right and equal access to basic education for all learners, it is essential to remove all barriers to education. The term "Barriers to Learning" is used to emphasize how educators and the education system need to approach and remove existing barriers. The NCSNET (2001:3) and DoE Draft Guidelines for Inclusive Education (2002:130-135) identified the following barriers to learning:

- **Attitude Barriers**

Fear and lack of awareness among educators and communities are significant barriers for all children, especially for children with disabilities. In South Africa, we are used to a segregated education system and many educators lack exposure to people with disabilities. In some communities, children with disabilities are hidden away for fear of the community seeing the child as some kind of punishment for past wrong doings of the family. On the contrary, the child can be seen as a 'gift from God' that must be protected and cared for but denied the opportunity to develop his/her own independence. Learners with HIV/Aids might also experience attitude barriers.

- **Inflexible Curriculum**

The style of teaching might affect the child. For example, a visually impaired child will not be able to benefit from visual aids in the classroom. The rate at which the educator introduces the curriculum content might be too fast for some learners who are struggling. And it might be too slow for others who become bored and lose interest in schoolwork. The subjects that are taught might also be a barrier because sometimes learners as not given a change to do the subjects they could do better in. The assessment process can also be a barrier. For example, a child who has difficulty with writing might fail his/her tests even though he/she has the required knowledge.

- **Language and Communication**

Teaching and learning often takes place in a language that is not the first language of the educator or the learners. Second language learners are often subject to low expectations and lack of support in learning a second language. Deaf learners learn most naturally through the medium of sign language but at times are compelled to learn in the oral method. Learners who have limited communication skills because of a physical or mental disability fail to benefit from their education because their communication needs are not met.

- **Inaccessible and Unsafe Environment**

The vast majority of sites of learning are not easily accessible to learners, educators and community members especially those who use wheel chairs. For example:

- Where access roads to schools are on steep inclines
- Where learners have to be dropped far away from school to complete the journey on foot due to lack of access roads
- Where there is youth violence in schools the fear factor prevents learners from regular attendance.

(DoE, 2002:4)

- **Lack Of Parental Recognition and Involvement**

Where parents are not included as partners in education provision they are less capable of supporting their children's learning. Absent parents, working parents, parents who are illiterate may not be able to support learning mathematics at home.

- **Lack of Human Resources Capacity and Development**

Educators who feel insecure about trying out new approaches and practices in the classroom might stifle learner's development.

Part of addressing the barriers that arise from the curriculum is ensuring there is flexibility in the learning and teaching process. Flexibility in the curriculum will promote greater accessibility to all learners regardless of their learning needs.

2.2 TEACHING AND LEARNING OF MATHEMATICS

2.2.1 The concept of learning in perspective

Chance (1999:19) defines learning as a change in behaviour as a result of experience. Learning is an endless, lifelong process that results from interactions with a multitude of situations (Brown, Collins & Duguid, in Brumbaugh, Ashe, Ashe & Rock, 1997:27). According to the NCSNET report, what is actually learnt, including Mathematics, is a product of natural selection by the learner.

According to Schoenfeld (1992:349) educators must be aware that learners bring misconceptions and misunderstandings to problem situations as their tools to work with, therefore educators need to access and adjust them. A very important task on the part of any educator who wishes to develop the mathematical thinking in any field is to gain access to the learner's intuitive and naïve knowledge. This is important since perceptions on certain subjects may prevent learners from taking up the challenge. For example, Brumbaugh et al. (1997:13) allege that "for many, mathematics is a dead subject that has not changed over the years. The mathematics learners (own words) see, appears to have been chipped onto stone tablets and handed down from a mountain." it is the responsibility of all educators of mathematics to change this impression.

2.2.2 Evolution of learning theories

Different theories based on different schools in educational psychology have been proposed to explain how learning occurs. These include the perspectives of behaviour psychologists, cognitive psychologists, gestalt psychologists and constructivists. Behaviour psychologists explain learning in terms of stimulus and response (S-R) theory. Learning occurs when the bond established between a stimulus and a response is reinforced in some way (Mwamwenda, 2004:171). Cognitive psychologists on the other hand, emphasize that insight, thinking, meaningfulness and organization of information are essential for learning to occur. The cognitive view maintains that a learner is capable of controlling his/her learning activity and organizing his/her field of operation and has an inherent capacity to learn (Mwamwenda, 2004:192).

Gestalt psychologists view learning as a perception and behaviour as a whole. According to them learning should be viewed holistically instead of being broken up into various components. The Gestalts argue that a given object is not understood by analyzing its components in isolation of one another. It can only be understood by looking at the global picture (Mwamwenda, 2004:204). For example, a series of dots are seen not as individual isolated dots, but as a pattern or configuration. Furthermore, individual musical notes are combined to produce a melodious and harmonious sound. According to Mwamwenda (2004:205), Gestalt psychologists argue that an organism cognitively formulates a number of hypotheses as to how the problem may be solved before it arrives at an insight into it. Once the organism has firmly decided which hypothesis should be used, it proceeds to use this to solve the problem.

However, a more recent way of thinking about learning is the constructivist approach, which sees knowledge as actively constructed (by individuals, groups and societies) and not simply transferred (Donald, Lazarus & Lolwana, 2002:100). Even though he did not see himself in this way, the prominent educational psychologist Piaget is thought to be one of the first learning theorists to advocate a constructivist approach to learning. Piaget believed in the importance of human interactions and physical manipulations in the acquisition of knowledge. The adherents of constructivism support the idea that children learn effectively through interactions with experiences in their environment. Constructivism has gained considerable attention in recent years in educational literature. However, there is no definite definition of what is meant by 'constructivism' (Duffy & Jonassen; Forman & Pufall; Kafai & Resnick; Nicaise & Barnes; Schwandt; Steffe & Gale in Brumbaugh et al., 1997:27).

According to Richardson in Reagan, Case and Brubacher (2000:108), "one cannot think of constructivist teaching as a monolithic, agreed-upon concept". There are fundamental theoretical differences in the various constructivist approaches. The debate is still on whether constructivism is best understood as an epistemology, an educational philosophy, a pedagogical approach, a theory of teaching or a theory of learning (Kaufman, Gennon & Brooks, 1996:234). But for now the writer will settle for the view of Fosnot in Reagan et al. (2000:109) who suggests that "constructivism is a theory about learning, not a description of teaching. No "cookbook teaching style" or pat set of instructional techniques can be abstracted from the theory and the constructivist approach to teaching. It may be helpful to keep in mind some general principles of learning derived from constructivism, however, as we rethink and reform our educational practices. Von Glaserfeld in Reagan et al. (2000:109) asserts that "… this view of constructivism confirms its status as an epistemology - a theory of knowledge and learning rather than a theory of teaching". As an epistemology, constructivism in reality calls for the rejection of traditional-orientated views of learning and the behaviourist model of learning. The individual's construction of his/her own knowledge is stressed.

According to Brumbaugh et al. (1997:28), behaviourism centres on a direct approach to instruction. This approach has been the dominant strategy for teaching mathematics for many years. The behaviourist approach essentially considers mathematics as a collection of skills. For them learning mathematics involves learning all the mathematical skills and mathematical knowledge. As Gagné (in Brumbaugh et al., 1997:28) puts it, a sequence of task could be established for a desired outcome. If the learner practised each required task as it was learned and developed, then that learner would be able to move on to the next step in the progression.

The constructivist assumption is that not only is knowledge constructed, but the learning process is also a personal and individual one. Learning is an active process and is collaborative in nature, and all learning is situated in the individual (Merril, 1992:102). Constructivism, therefore, offers a radically different view of the nature of the learning process. And from the perspective of a radical constructivist, knowledge is not something that can just be conveyed from educator to learner. Therefore, any pedagogical approach that presumes otherwise must be rejected. Freire (1970:53), for instance, spoke about undesirable 'banking' approach to education. In this approach, teaching attempts to deposit knowledge in the learners through direct instruction. This is evident in many schools as 'chant-and-drill' or 'talk-and-chalk' approaches, where learners are seen to be 'filled up' with knowledge (Donald et al., 2002:99). This approach does not give learners any sense of ownership or interest (Reagan et al., 2000:103). The learners must be given opportunities for critical thinking, discussion, exploration and presentation. Although when educators create such opportunities for learners, it inevitably makes many adults both in and outside school very uncomfortable and defensive, it is important to do so. Such issues are at the heart of growing up, and dealing with them publicly and critically is the essence of democracy (Reagan et al., 2000:103).

Freire in Reagan et al. (2000:80) also suggests that schools as social institutions are involved in the maintenance of the status quo. They, therefore, generally function to impose the values of the dominant culture on the dominated cultural groups in the society. Basic literacy skills, such as reading and writing, can sometimes become for the dominated groups acts of memorization and repetition rather than acts of reflection on meaning and critical translation into the child's own culture.

By contrast, the constructivist classroom creates an environment that encourages learning. The educator's role is to create surroundings where learners can make sense of mathematics as it relates to the real world. Vygotsky (1978:176), for instance, saw learning more like an apprenticeship. He stressed the major role language and symbols play in concept development. According to Vygotsky, thought and words form a vital living process. To him thinking and language develop one another. People do not only express what they think through language, they also use language to develop and refine their thinking (Gates, 2001:157). The theory of mathematics learning takes into account the social construction of meaning, which stems from the theory of the social origins of thought (Vygotsky & Leont'ev in Ernest, 1991:208).

According to the theory of the social construction of meaning, the child's knowledge and meaning are internalized "social constructions, the negotiation of meaning and engagement in activity". This theory sees children as needing to engage actively with mathematics, posing as well as solving problems, discussing mathematics embedded in their own lives and environment (ethnomathematics) as well as the broader social context (Ernest, 1991:208). As Steffe and Killian in Brumbaugh et al. (1997:26) explain, from a constructivist's perspective "mathematics teaching consists primarily of interactions between educators and children." This indirect approach to instruction effectively allows the children to learn in the context of meaningful activities. Constructivism has multiple roots in the psychology and philosophy of this century (Perkins in Brumbaugh et al., 1997:27). The emphasis of the constructivist classroom begins with the learners. The learner plays a major role in the decision-making processes as to what, when and how learning is to occur.

2.2.3 The development of mathematical concepts

Souviney (1994:34) defines mathematics concepts as the underlying patterns that relate sets of objects or actions to one another. An underlying pattern, for example, that defines the geometric concept triangle is: all closed figures that have exactly three straight lines.

Teaching mathematics concepts is a complex activity because each learner possesses a unique set of experiences and abilities that he/she brings to the learning environment. The educator's role is critical in planning and designing effective instructions for the whole class. There is a wide range of instructional methods available to the educators. Firstly, the educator must decide which theory of learning should inform his/her instructions (Souviney, 1994:34).

Usually educators select from various cognitive theories to determine their own personal approach to teaching and learning that works for them. The selected approach must satisfy the needs of different ability groups of learners in the class.

Anderson (1989, in Souviney, 1994:34) suggests there are two contrasting conceptions of learning that help to clarify the differences among theories of teaching and learning. Educators who align themselves with the receptive-accrual (behaviourist) view believe that learners learn by memorizing information verbatim. Failure to learn, therefore, is attributed primarily to lack of learner's effort or innate abilities. On the other hand, those who take a cognitive mediational (constructivist) view of learning believe that the learners' cognitive activity is the primary factor in acquiring knowledge. Learners learn by carefully re-evaluating their existing prior knowledge to facilitate the integration of new information. The success of the learners is dependent on prior knowledge and access to appropriate cognitive strategies (Souviney, 1994:35).

Simply pointing out the error in invented algorithms generally does not correct the problem because the error is structural rather than a misunderstanding about procedure or notation. Souviney explains as follows: suppose a learner incorrectly regroups across a zero placeholder and gets 307 - 129 = 188. Rather than explaining that when regrouping, 1 ten from 30 tens leaves 29 tens, a educator using a constructivist approach would offer the learner a counter example, such as 317 - 129 = 188. The educator would then ask the learner to verify that this answer is correct and whether both exercises have the same answer. The learner is left with the learner to resolve the conflicting results. A constructivist approach to instruction, compared to the traditional approach, expects educators to know much more about what their learners are thinking. By contrast, using the traditional approach to instruction, the educator infers what the learner thinks and knows mainly by evaluating the end product (Souviney, 1994:36). An answer, however, to an exercise offers little information on the strategies and procedures the learner adopted to solve the problem.

Constructivist techniques encourage the learners to "think aloud" for the educator while solving problems, writing reflexively about the use of manipulatives, and small-group problem solving can help learners reflect and evaluate what they are doing right and wrong.

Souviney (1994:37) asserts that educators who adopt constructivist methods do use direct instructions when it seems efficient to do so, sometimes involving the whole class. Generally the educators use direct instructions when they have established that the whole class is ready to consolidate what they have learned about a topic or to refocus learners when they appear to be off task or disruptive. If learners become too frustrated with their lack of progress, the educator may advise learners to put the problem aside and return to it later or make suggestions as to how to approach the problem.

Research on classrooms using constructivist methods has revealed that, compared to learner's traditional classrooms, learners in constructivist classes develop deeper understanding of complex mathematical concepts and principles, and are more likely to solve non-routine problems correctly, and are less anxious about learning mathematics (Cobb; Cobb, Yackel & Wood; Confrey in Souviney, 1994:37).

However, the implementation of a constructivist teaching approach is made difficult by the class size. Noddings (1992) observed that in a class of 30 learners, under the right conditions, some would perform "strong" acts of construction by reflexively abstracting new information from an activity. Others, however, will perform only "weak" constructive acts, waiting for others to draw conclusions about a problem at hand and subsequently accepting the results unconditionally (Souviney, 1994:37).

To overcome this problem, Confrey in Souviney (1994:37), suggests the following activities for effective constructivist teaching:

- "Promote intellectual autonomy and commitment in learners by valuing learners' theories and inventions.
- Develop learners' reflective processes by using learning logs.
- Construct learners' reflective processes by using learning logs.
- Construct learners' case histories by using portfolios or informed observation logs.
- Identify and negotiate tentative problem-solution paths with learners by requesting small-group reports and responding to learning logs.
- After solutions have been reached, revisit the solution path by having periodic whole-class discussions that focus on similarities and differences among solutions.
- Adhere to the intended goals and objectives of the lesson by limiting intrusions into mathematics class time and periodically refocusing learners' attention on the topic addressed."

2.2.4 Motivation: Intrinsic and extrinsic

Helen Keller in Sattler and Shabatay (1997:73) says: "That living word awakened my soul, gave it light, joy, set it free! There were barriers still, it is true, but barriers that in time could be swept away!" If motivated properly, any learner can learn mathematics. Children are not born as poor learners. However, the school, the learners and the community environment can combine to produce a learner experiencing barriers to learning (Escalante & Dirmann in Sattler & Shabatay, 1997:87).

Adair (1990:1) says a person is motivated when he/she wants to do something. A motive is not quite the same as an incentive. Whereas a person may be inspired or made enthusiastic by an incentive, his/her main motive for wanting to do something may be fear of punishment. Motivation covers all the reasons that cause a person to act. You can provide motives or incentives in one way or another; you can offer rewards or issue threats, or attempt to persuade. All these actual or potential influences may have an effect; however, Adair (1990:26) talks of the fifty-fifty rule as regards motivation. He asserts that 'fifty percent of motivation comes from within a person and fifty percent from his or her environment, especially from the leadership experience there.' What then is the motivation? According to Adair (1990:29), the main American dictionary in Adair (1990:29) defines motivation as 'to provide with a motive'. Motivation is closer in meaning to the older English concept of motivity: the power of initiating or producing movement. All these words - motive, motivation, motivity - come from the Latin verb "to move", or commonly some combination of inner impulse or productivity on the one hand and outer situations or stimuli on the other. When someone is motivating you then that person is trying to change the strength or direction of our motive energy. Therefore, as Adair (1990:30) argues, motivating others, should not be confused with manipulatory practices used by strong personalities to dominate weaker ones.

Motivation is a key concept in most theories of learning. It is closely related to arousal, attention, anxiety and feedbacks or reinforcement. For instance, a person needs to be motivated enough to pay attention while learning; anxiety can minimize a person's motivation to learn. Receiving a reward or feedback for an action normally increases the possibility that the action will be repeated. Weiner in Kyriacou (1997:27) points out that behavioural theories tended to focus on extrinsic motivation (rewards) while cognitive theories deal with intrinsic motivation (goals).

In most forms of behavioural theories, motivation was strictly a function of primary drives such as hunger, sex, sleep or comfort. According to Hull's drive reduction theory, learning reduces drives and so the motivation to learn (Wayne & Weiten, 1992:342). The extent of the learning acquired can be manipulated by strength of the drive and motivation. According to Kyriacou (1997:25), to answer the question 'what is motivation?' one needs to bear in mind a clear distinction between learning that must take place by an individual as a natural act of interaction with the environment, and the specific learning that is initiated by the educator. However, Piaget in Kyriacou (1997:25) says learning is the inevitable consequences of the individual's interaction with the environment. And the learning is dependent on the individual's biological disposition to adapting to the environment. Therefore, any educational experience which calls for the interaction of learners with some learning activity at hand will lead to some learning (Kyriacou, 1997:25).

Learners' academic motivations are a reflection of a number of influences - ranging from experiences in their upbringing to their experiences of success and failures at academic work in school. The home and parental encouragement is recognized as a major factor in influencing the level of pupils' academic motivation and achievement (Kyriacou, 2001:61). Furthermore, Steinberg (1996:54) found that parents and peers have the greatest influence over a learner's classroom performance. Based on his findings, he argued that academic excellence should be a national priority since parental and peer attitudes towards excelling in school had a far greater influence on learners' scholastic success than educators' or learners' intelligence quotient (IQ) score. For example, the performance of Asian learners tends to be much better in school than could be predicted by their IQ scores because of the expectations of their families and friends. On the contrary, learners from other minority populations perform below the level that would be predicted by their IQ score for the same reason.

Furthermore, the constructivist principle of practice regarding motivation is that the urge or need to learn and discover derives naturally from the process of human development. Motivation is an internally driven phenomenon arising from the need to actively adapt and develop progressively more effective ways of understanding and acting in relation to the word of information and knowledge (Donald et al., 2002:126).

It is difficult to motivate some children to learn at school. Some children lack the urge and the basic motivation is non-existent. This must be examined in the context of the system that the children function. What happens in families, classrooms, peer groups, schools, communities and societies can strengthen or weaken the motivation to learn (Donald et al., 2002:127). According to Raffini (1996:4), in the classroom, educators often try to control learners' behaviour with rewards or punishments. Although these two techniques may be effective for influencing and controlling learners learning and behaviour, they usually stifle self-determination. Piaget (in Raffini, 1996:4) believed that adults undermine the development of autonomy in children when they rely on the use of rewards and punishments to influence a child's behaviour. According to Piaget, punishment is an externally-controlled behaviour management technique that often leads to blind conformity, deceit or revolt in those being controlled. Rewards and punishments are very often the tools available to educators in motivating learners. These outdated methods can control many learners' behaviour. However, their indiscriminate use can seriously undermine learners' intrinsic motivation for the activities and the behaviours being controlled. Learners will learn for many reasons. But the more their learning is manipulated by rewards and punishment, the less they will internalize what is being learned (Raffini, 1996:1).

According to Raffini (1996:6) the more learners feel successful when performing an activity, the more intrinsically motivated they will be to persist in that activity. This presupposes that performance of the activity occurs within a context that provides for self-determination and the activity provides the learner with a continued challenge. Differences in learners' learning rates make the task of providing challenges to learners a challenge for the educator (Raffini, 1996:6).

Adair (1990:94) further states that the first and golden rule of motivation is that you will never inspire others unless you are inspired yourself. Only a motivated leader motivates others. Therefore, a educator who lacks passion and motivation for his/her job cannot motivate learners in his/her care.

Raffini (1996:3) also asserts that intrinsic motivation is choosing to do an activity for no compelling reasons beyond the satisfaction derived from the activity itself. Many psychologists believe that humans are intrinsically motivated to seek out and to master challenges. The lessons of research over the past twenty years into children's learning is that good teaching is good for all children (Thomas, Walker & Webb, 1998:145).

Further, an undue emphasis is placed on extrinsic motivation that possesses limited opportunities for the development of intrinsic motivation and deep processing of information by means of internalization. The result is a shallow approach to learning, an acquisition of superficial knowledge and a minimal authentic academic development (Botha in Engelbrecht et al., 1996:234).

2.3 BARRIERS TO LEARNING MATHEMATICS

According to Dednam (2005:199) all barriers influencing a learner's ability to master mathematical concepts and processes are linked. As they affect each other it is not always easy to pinpoint a specific one. Mathematical difficulties can be caused by intrinsic and extrinsic barriers. The extrinsic barriers include the family system, the school and environment. Intrinsic barriers refer to barriers within the learner that may hamper his ability to cope with mathematics. Furthermore, a complex and powerful ecological model involving different levels of systems in the social context developed by Bronfrenbrenner (in Donald et al., 2002:51) emphasizes that various levels of the systems interact in the process of child development.

According to Bronfenbrenner, child development should be seen as happening within four nested systems: the micro system, the mesosystem, the exosystem and the macrosystem. All these interact with the chronosystem (Donald et al., 2002:51). And children's own perception of their contexts is central to understanding how they engage with them. The environment does not simply influence the child. "Children are active participants in their own development. For example, if a child perceives his world as basically threatening he will be less likely to explore it" (Donald et al., 2002:53). Therefore, if a child finds the learning of mathematics as a barrier to his very existence, he will offer little engagement in the learning activity. The opposite will be true of a child who feels secure and confident in his ability to engage in new situations.

Barriers to learning mathematics include learners' and educators' beliefs with regard to how mathematics is taught and or learned. These impressions are developed by previous experiences in mathematics. The following anecdote is typical class learning mathematics: "Homework is reviewed with the educator doing some problems. Examples of the day's problems are worked or learners are assigned classwork related to the assignment of the day". This is a typical example of how many learners and educators think mathematics is learned. The educator demonstrates or models how to do the problem and the learners mimic what they see.

For years there has been an unofficial position that "nice girls" do not do well at mathematics. Thankfully, that attitude has changed (Brumbaugh et al., 1997:42). However, there is still pressure in some sectors of school society that places negative values on good performance in mathematics. Any such perceptions negatively influence the ambitions of learners. Gender should not be a deterrent. Perhaps it should be viewed as a challenge to educators. Many studies have shown that the educator is instrumental in creating a classroom setting that is conducive to learning and stimulates constructive learning (Brophy, 1990; Cheng, 1993).

2.4 SYSTEMIC BARRIERS

2.4.1 Absence from school and changes of school

Dednam (2005:199) says that regular absence from school and change of schools are also two of the most important causes of mathematical difficulties, as they cause backlogs in mathematical knowledge. Frequent absenteeism on the part of learners makes them miss out on lessons which leave gaps in their mathematical knowledge. These learners find it difficult to catch up. When changing school they may miss out on concepts that have been taught in their new school. Learners who have a backlog find it extremely difficult to keep pace with work. This situation is exacerbated if the educator is not adequately trained to offer the teaching and learning support, or for some reason, he/she lacks the know-how to identify and rectify problems.

2.4.2 Disposition of the mathematics educator

According to Brumbaugh et al. (1997:3), the "effective educator of mathematics" must be an effective educator as well as a competent mathematics instructor. Most studies have identified two qualities that "good" educators possess. The two qualities consistently identified are: warmth and a sense of humour. Unfortunately affective qualities are difficult to measure. The effective mathematics educator should be competent, as well as having the other prerequisites. If the educator is not competent or confident about teaching the subject matter, he/she will have difficulty in creating positive mathematical experiences best suited for the development of the learner. An effective educator continues to investigate new mathematical knowledge and effective teaching strategies. And as he does so, his thirst for new knowledge and strategies and excitement will be easily recognized by his learners.

All young children are capable of learning mathematics. They arrive in school with considerable capacity for abstract thought and potential for learning mathematics, but educators often fail to recognize, nourish and promote mathematical abilities, particularly those of the disadvantaged (Tang & Ginsburg, in National Council of Educators of Mathematics [NCTM], 1999:60). As a result, poor children's subsequent inferior performance in later school mathematics should be attributed more to their initial lack of ability (NCTM, 1999:59).

2.5 INTRINSIC BARRIERS OF THE LEARNERS

Dednam (2005:201) says learners experiencing difficulties in abstract thinking find it difficult to see the relationships between numbers and objects and are unable to measure unfamiliar units. The tendency is for the educators to teach the learners to manipulate the numbers, giving them the impression that they are "good at mathematics" though their understanding of the actual mathematical concepts is minimal.

2.5.1 Reading difficulties

Poor reading causes difficulties in reading mathematical combinations and construction of word sums. These learners get high marks for mental arithmetic and mathematical competence tests but struggle with mathematical processes and word sums as they cannot read and comprehend text (Dednam, 2005:200). Learners with reading difficulties also find it difficult to read numerals, for example, confusing sixes and nines, and reversing numerals and writing a seven back to front (Baroody & Coslick, 1998:4-16).

2.5.2 Emotional/Behaviour Disorders

Learners with emotional or behaviour disorders may be associated with communication disorders. These learners display temper tantrums, verbal aggression or withdrawal behaviours to respond to educators' commands or a peer's social invitation, or may use similar responses to express their feelings and ideas.

2.5.3 Attitude towards mathematics

The difficulties many learners experience in learning mathematics can be traced to a lack of confidence. Children learn the attitudes, prejudices and values of their parents, educators and peers. The negative attitudes many adults in our society have towards mathematics is as a subject that is difficult to learn and that it is a subject that only especially talented people can learn (Souviney, 1994:10). This hampers the children's motivation to learn. Further, Wakefield (1997:233) asserts that families that provide opportunities for children to share a treat equally, to make intelligent guesses and to play simple board and card games that require players to count, add, subtract and match are giving their children thinking challenges that develop their number sense. Children who come to school without this kind of previous experience encounter problems when mathematics programmes assume that mathematical relationships can be taught directly by the educator in accordance with the curriculum rather than being constructed by each child according to his or her level of previous knowledge.

2.5.4 Learners who have external locus of control

Such learners feel that what happens in their lives comes from outside and so have no contribution to make and feel helpless when trying to learn mathematics (Donald et al., 2002:101).

2.5.5 Anxiety

These learners feel anxious about engaging in most situations where they have to be involved socially, emotionally or scholastically. A way of trying to escape this anxiety might be to avoid engaging in these situations. Such learners will not attempt the mathematics problem for fear of making mistakes, especially if the educator's expectations are high (Lerner, 1993:205).

2.5.6 Distractibility/Attention Deficit-Related Problems

A short attention span can make it difficult for learners to follow all the steps needed to complete a mathematical problem. Others leave the work uncompleted or they skip some steps. They often ask the educator to repeat the explanation or for help (Dednam, 2005:201). It has also been observed that:

"Learners have difficulty filtering irrelevant sensory information. They have attraction to 'novel' environment conditions. They have restriction to activity when experiencing excessive stimulation (in attention) and initiation of sensation-seeking activity when insufficiently stimulated (distractibility)" (Barkley, 1998:80).

2.5.7 Impulsivity

Some learners tend to act without considering the consequences of their actions. They seem to have difficulties with inhibiting their behavioural responses to stimuli. They are also likely to respond at the moment rather than delaying their responses in order to consider their actions. They have emotional outbursts or reacts based on feelings not facts. They perform poorly on tasks requiring planning (i.e. tests) (Lerner, 1993:209).

2.5.8 Disorganisation

Some learners misplace or lose belongings and have difficulty handling materials with multiple pieces. They have messy desk appearances and difficulty completing tasks and tests within a set time framework. There is also a tendency to overestimate time intervals and display a haphazard, illegible penmanship (Barkley, 1998:80).

Apart from the above-mentioned factors that may pose mathematical difficulties, there are other secondary skills that contribute to mathematical difficulties. Some of these difficulties identified by Dednam (2005:201) are motor, audio and visual related.

2.5.9 Other intrinsic barriers

Concerning motor related skills, Dednam (2005:201) observed that lack of gross motor, visual motor and motor skills especially at pre-school level may adversely affect learners' performances in mathematics at a later stage. In addition to this, she also asserts that deficiency in fine motor coordination, tactual kinesthetic and visual motor integration can also impair the learning of mathematics.

In terms of auditory problems learners' ability to differentiate between numbers which sound almost the same or count correctly in higher order encounter problems in learning mathematics. The same can be said for the difficulty of handling addition and subtraction operations simultaneously.

There are also visual difficulties. Dednam (2005:201) contends that difficulty in coping with basic concepts in mathematics such as relating a digit's position in a number such as 12 to its value poses problems for learners. She calls this "visual perception difficulties". Also identified by her is the learner's inability to differentiate between the mathematical operations such as + and **-**

Other learning problems that Lerner (1993:209) identifies are what she calls "passivity" and also "mathematical readiness". These learners probably lack confidence in learning mathematics because their past learning experiences were often dismal exercises in failure and frustration. These learners do not believe they can learn mathematics, they do not know how to go about the task of learning. As a result they become passive and dependent learners (Lerner, 1993:209).

2.6 PARADIGMS REGARDING THE LEARNING OF MATHEMATICS

In Maree's (1992:32) writings on problems in learning mathematics, he alludes to the fact that everyone involved in teaching mathematics should adopt a holistic approach to teaching it. He cites Kuhn's definition of a paradigm as a set of beliefs which is accorded a status of being so fundamental that it does not need any testing to prove its authenticity. He also used the following paradigms to explain the learners' inadequacies in the learning of mathematics:

2.6.1 Developmental paradigm

The **developmental paradigm** is of the view that children reach a stage in their development where they are able to master mathematical concepts. This by implication will not afford the child the opportunity to acquire those mathematical skills if the child has not reached the necessary developmental stage. For the child to be in a position to understand various concepts in mathematics curriculum the child should be in a position to carry out essential mathematical skills for each grade level.

2.6.2 Self-learning and self-discovery

Maree emphasizes **self-learning and self-discovery** as prerequisite tools to master new concepts in the learning of mathematics. It becomes the educator's responsibility to provide the necessary materials and support structures for the learners to achieve (Copeland in Maree, 1992:33).

2.6.3 Dyscalculia paradigm

The **dyscalculia paradigm**: There are some learners who do not have the ability to learn mathematics. The learners' success in non-mathematical disciplines does not by implication indicate success in mathematics learning.

2.6.4 Dyspedagogia paradigm

There is the **dyspedagogia paradigm** which is the view that the mistakes learners make in mathematics emanate from unsatisfactory teaching. Gannon and Ginsburg in Maree (1992:33) say the following in support of unsatisfactory teaching "some (problems in mathematics) are really teaching inadequacies, ... educators in training are seldom introduced to research on children's mathematical thinking ... successful teaching often requires alternative modes of explanation, more presentation" (pp. 410-411).

2.6.5 Behaviourist paradigm

The **behaviourist paradigm** sees problems in mathematics the result of learned behaviour. Learning mathematics is an external activity solely planned by the educator. Therefore, mistakes in mathematics are unwanted behaviour which has been learned. And efforts should be made to unlearn them through drills and constant practice. Educators/psychologists should teach learners the basic skills and principles in mathematics rather than dwelling on the analysis of learners' mistakes.

2.6.6 Medical paradigm

The **medical paradigm** argues that problems in mathematics emanate from chemical or organic malfunctioning of the learner. The learner's inability to achieve is attributed to poor genes or physical defects inherited from the parents. Not much can be done to remedy the defect.

2.6.7 Psychoanalytic paradigm

There is the **psychoanalytic paradigm** which describes problems in mathematics as a symbolic or subconscious behaviour. Once those barriers preventing the learner from achieving to his/ her utmost potential are removed, an achievement on a higher level will ensue. Visser, Morgan, Dees and Dees (in Maree, 1992:33) argue that the problem of mathematical anxiety testifies to this paradigm.

2.6.8 Cultural paradigm

There is the **cultural paradigm** which posits that it will be naïve to assume that mathematics is culture free (Woodrow in Maree, 1992:33). Some educators believe that mathematics is meant for certain groups of people - mostly whites/westerners (Christine in Maree, 1992:33). That bias also exists in the content of mathematics textbooks, in the sense that the books are western-oriented (very little or no reference is made to non-western groups and their life styles in mathematics textbooks) (Hudson in Maree, 1992:34).

2.6.9 Curricular paradigm

The **curricular paradigm** contends that mathematics texts are usually outdated; yet mathematics is a rapidly growing field (Steen in Maree, 1992:34).

2.6.10 Social paradigm

The **social paradigm**, according to Maree (1992:34) deals with "[p]oor educational background, domestic instability, insufficient parental counselling, poor adaptation to changed learning and educational circumstances all lead to under achievement (Grossnicke, Reckzeh, Leland & Ganoe, 1986). Unless these factors are adequately accommodated, learners cannot be expected to achieve in mathematics.

2.6.11 Transactional paradigm

The **transactional paradigm** as a human activity is relative and dependent on other people (Maree, 1992:32). Like the systems theory (Donald et al., 2002:47) this sees disturbances in the learner's relationship with others as affecting the learner's performance in mathematics. "The lack of parental involvement such as the father's lack of interest in his learner's mathematical achievement, families that underestimate the value of mathematics as a subject with a view to the future are typical contributory factors to underachievement in maths" (Maree, 1992:34).

2.6.12 Moral paradigm

The **moral paradigm** sees underachievement in mathematics as a deviation from the ethical and moral standards of a community.

2.6.13 Eclectic paradigm

Finally, Maree (1992:34) contends that there is the **eclectic paradigm** which says that any of the above-mentioned or unmentioned paradigms is valuable when evaluating the difficulties that any particular learner experiences in mathematics.

Therefore, Maree (1992:29) says that "Mathematics educators as well as psychologists in dealing with more 'technical' problems in mathematics as well as the treatment of emotional problems connected to mathematics, should take cognizance of these paradigms in an unbiased way".

2.7 THE RURAL LEARNER

In addition to the general barriers already mentioned, the rural mathematics learner is further disadvantaged by his environment. This environment is devoid of adequate educator and family support, inadequate physical and human resources and the curriculum.

The rural mathematics learner must be seen to be functioning in a system. Systems theory sees different levels and groupings of the social context as 'systems' where the function of the whole is dependent on the interactions between all parts (Donald et al., 2002:47). The rural mathematics learner is a system within a system - schools, family, community, educator, parents' peers and curriculum. Therefore, for the rural mathematics learner to function effectively, the relationship between the different systems must be cohesive at all times. If any part within the various systems is disturbed it will have a negative effect on learners.

According to Michayluk and Randhawa (1973:3) during the last few years, a considerable amount of material has been written about the rural learners and their situation that cause the rural learners to become disadvantaged, but little of it is based on research. Although adequate research design is lacking in many of the previous studies, they do tend to give the best picture available of the rural learners. The challenges that confront the learner in the rural areas are not limited to geographical location, but all factors such as socioeconomic status, aspirations and educational achievement are interrelated. These will affect their learning mathematics in particular (Maree & Molapo, 1999:374).

Many studies carried out on rural learners indicate poor performance in mathematics on their part compared with their urban counterparts. This is evidently clear in developing countries (Randhawa & Michayluk, 1973:1). This poor performance is attributed to negative factors such as the learning culture, poor environment, poverty, marital problems of parents, single parenthood, lack of educators and attitudinal problems that confront the learners (Michayluk & Randhawa, 1973:3). These are some of the barriers that affect rural learners most. However, educators in developing countries do not know whether to adopt strictly content-based teaching across the specified curriculum or to focus on specific topics that will ensure a higher percentage performance in the public examinations.

According to Sauian (2004:2), the mathematics curriculum in developing countries is often based on studies as well as the experiences of the developed world. Invariably, the syllabi of the former are often adopted from the latter. In fact, some scholars believed that there is an extraordinary similarity in the mathematics curriculum across the globe. For instance, Hawson and Wilson in Sauian (2004:2), claim that a canonical school mathematics curriculum was developed in Western Europe in the aftermath of the Industrial Revolution, and was adopted practically everywhere during the present century.

In most developing worlds today, the former mathematics education system was deeply embedded in the cultural and colonial heritage of the past. For example, in Malaysia, Singapore and Hong Kong they adopted the British system, the Philippines adopted the American system, while Vietnam and Cambodia adopted the French system and so on (Nebres in Sauian, 2004:2). Most countries have now revised and developed their own curricula though some of the contents still resemble the Western curriculum. The only variation is often reflected by the difference in socio-cultural background (Sauian, 2004:2).

In the developing world, there are differences in the level of mathematics education of the different countries. Each country has a different cross-cultural heritage, different medium of instruction, different level of educator training as well as different socio-economic positions (Sauian, 2004:3). Sauian in Sauian (2004:3) says the Chinese are well exposed to the urban-business environment as compared to the Malaysians who are traditionally rural people. This has resulted in a different perception of mathematics. In Indonesia, there is a significant difference in achievement in primary mathematics in rural schools compared to those in urban schools (Armanto in Sauian, 2004:3).

Hattie in Young (1998:211) shows that classes and schools differ in terms of their learning environment. This in turn influences student achievement. Hattie established that 20% of learners in supportive environments performed better than those in classrooms where learner support is lacking. But Young (1998:212) found that students in rural and remote schools appeared to be more satisfied with their schools. They felt educators and friends were more supportive and generally felt safer. However, science and mathematics achievement scores were not comparable due to lack of a prior achievement measure in the study. There were differences in achievement between students from rural and urban settings. Learners with emotional problems tend to perform extremely well at school when appropriate support structures such as effective teaching, motivation, monitoring of progress and providing feedback, reinforce learner's motivation and achievement across the whole ability range and across a wide range of school activities. However, when these support structures are not in place, such learners tend to have low self esteem and are not able to perform according to their potential (Kyriacou, 1997:3). Further studies done in Western Australia showed that rural schools were not disadvantaged by location, rural schools are disadvantaged by their self concept (Young, 2000:221). Learners in rural schools tend to have a weaker belief in their own academic ability to perform, irrespective of their actual ability.

The advantages of technological transformation and the provision of adequate resources enjoyed by urban learners are unfortunately denied their rural counterparts. Regardless of the lack of clarity on approaches and methods in addressing the educational needs of rural learners, there has been criticism of formal education systems in predominantly rural areas (Smith, 1984:13). The criticism emanates from the fact that education in rural areas seems irrelevant, alien and urban biased.

Griffiths and Howson (1974:13 in Maree & Molepo, 1999:374) warn curriculum specialists that producing a curriculum which neglects the nature of the society, the nature of its children, the nature of its educators or the nature of mathematics may actually produce a curriculum which is in some respects unbalanced, irrelevant or hard to implement. The under-resourcing of rural schools is also been a problem in first-world countries such as the United States of America (Maree & Molepo, 1999:374).

According to Reynolds, Cremers, Nesselrodt, Schaffer, Stringfield and Teedlie in Maree and Molepo (1999:374), the limited number of studies and reviews that have looked at rural school effectiveness has identified two major areas of differentiation between effective rural and urban schools, namely resources allocation and cohesiveness. Rural schools are generally characterized by scarcer resources than urban schools. Reynolds et al. found that rural schools usually have a smaller numbers of students. The students are more culturally homogeneous and so more likely to be cohesive. However, the opposite of this is true of South African rural schools where different tribal communities have been forced together with few resources. Instead of smaller, more homogeneous and cohesive classes, the classes are huge and include different cultures. This hampers cohesion.

Rural people have not been made aware of, and prepared for the changing patterns of life, which need a sound basis of mathematical (or scientific) knowledge. Resources have not been adequately supplied to enable rural children to cope with mathematics on an equal footing with urban children. Rural children, as a result, perform poorly in mathematics (Maree & Molepo, 1999:375). Sher in Maree and Molepo (1999:375), refers to rural community expectations when he states that, over many years, a powerful cycle of negative and self-fulfilling prophesies about rural education has become deeply entrenched in most under developed countries (like South Africa). A vicious cycle evolves: low expectations lead to inadequate resources and attention. This leads to unsatisfactory conditions, which in turn produce poor results, which lead to lower expectations, and so the cycle continues. Many educators have to handle huge classes. There are instances where two educators share a class of 270 students. These cases may be extreme. Nevertheless the overall ratio is too high for any meaningful mathematical achievement to take place.

2.8 MEDIUM OF INSTRUCTION

In South Africa it is often the case that rural children grow up in bilingual contexts. The home language is their major tool of communication in domains covering interactions, not to mention every day culture and values. Therefore, they use the second language to a minimal extent in situations where important topics are discussed and situations where conversation and linguistic requirements exceed their daily language use. Vygotsky (1978:117-118) asserts that acquiring technical decoding skills is most efficiently achieved when children are allowed to read material that reflects a word that is familiar to them in a language that they already know. However, Cooper (1993b) believes that "… in a supportive literacy environment children learn to read and write while enjoying the processes".

Rural black learners may have insufficient comprehension basically because of unfamiliarity with the text's cultural context. For example little distinction is made between blue and green in most African languages because these are perceived as background colours. Black, white, red and yellow are clearly distinguished because they are the colours of important objects like ripe fruit and cattle. The relevance of this to the teaching of mathematics becomes obvious when one examines various devices and aids used in the classroom situation for the teaching of mathematics, e.g. rods, coloured blocks and shapes (Michau, 1978:24). Segall, Campbell and Hershovitz in Michau (1978:24) found European groups more susceptible to the acceptance of rectangular and polygonal shapes than were the black people of rural origin tested. They attributed these differences primarily to whites living in a more "carpeted" environment.

In addition, Duncan, Gourlay and Hudson in Michau (1978:24) tested White and Black urban children in the Republic of South Africa in their third and seventh year of schooling found a definite correlation between "... the ability to interpret Western style pictorial material and the degree of acculturation to the Western mode" (Duncan, Gourlay & Hudson in Michau, 1978:24). One of the most striking deficiencies discovered in black children, particularly those of rural origin, was the inability to perceive three-dimensionality in pictorial material.

Apart from those who do not have the ability to do mathematics, learning problems that are experienced in mathematics classrooms can often be associated with reading problems. For example, learners develop concepts in arithmetic by means of the home language and transform them to the second language when their second language competence has sufficiently developed. According to Engen (see Booth, Nes & Stromstad, 2003:91), one restriction attached to bilingual subject instruction is that the pupil's home cultural experiences are ignored, communicating an implicit message that they are of secondary value. This may alienate the pupils from curriculum content and reduce motivation. In any case, the content of the curriculum may make it difficult for them to interpret, comprehend and articulate their own cultural backgrounds. It is the responsibility of the educator to determine the reasons for the learning difficulties and to design and/or structure individual programmes to help each of these learners.

According to Setati (2002:15), all previous studies have been informed by a notion of mediated learning, where language is regarded as a tool for thinking and communication. She also points out that mathematics knowledge and English language are social goals. They are seen to be a source of power and status. Both of them provide access to higher education and jobs. The dominance of English in politics, commerce and the media in South Africa is well known. English is seen as a key to academic and economic success and therefore being fluent in it opens doors that are closed to vernacular speakers (Friedman's study in Setati, 2002). Setati's study has revealed how the power of mathematics and English can work together in multilingual mathematics classrooms to reduce mathematical opportunities for procedural discourse. For substantial teaching and learning and engagement with conceptual discourse, the learner's main language is required.

2.8.1 The language of teaching and learning

The language of learning and teaching (LOLT) was a contentious issue during the apartheid era in South Africa. The legislation during that era contributed to the disadvantages that certain language and racial groups experienced: so-called Bantu education was experienced as inferior education. The new language policy in South Africa is designed to address the over-valuing of English and Afrikaans and the under-valuing of African languages, yet English continues to dominate in practice.

Bourdieu in Thompson (1992) says although English is the main language of a minority of the population, it is both the language of power and the language of educational and socio-economic advancement. It is therefore a dominant symbolic resource in the linguistic market. Learning in a second language cannot be the same as learning through the mother tongue. The language of mathematics consists of meanings appropriate to communication of mathematical ideas. Certain words, however, carry mathematical meanings that are different from the usual meaning in English (Mughisha, Sibaya, & Sibaya, 1996:33).

2.8.2 Mathematics as a language

Mathematics as a language seeks to express ideas of shape, quantity, size, for instance with precision (Mugisha, Sibaya & Sinaya, 1996:33). The mathematics that is taught in South African schools is deeply embedded in the cultural and colonial heritage of the past. Sentson (1994:111) argues that "the mathematics is based on an Indo-European culture and linguistic structure". The English used for mathematics does not carry the associations and connotations of an African identity. This complicates learning. Studies done by Michau (1978:23) on black learners of South Africa, have confirmed that there are differences and inadequacies with regard to mathematical conceptualization. Where there is no connection between the formal and informal knowledge the learners possess, it is difficult to understand (Wakefield, 1997:235). This difficulty increases when learning mathematics is done through a second language. The ability to solve a mathematical problem depends, among other factors, on the learners' command of the language of instruction. Where this is limited, the learners are compelled to memorise their work. According to Maree (1996:440), this promotes mechanical learning and application of mathematics, incorrect learning procedures and inadequate insights.

2.8.3 Understanding learners construction

Maher and Davis in Ward (2001:2) emphasize that educators must be able to understand learners' constructions that differ from their own. They recount the story of two learners and their educator who interpreted a problem differently. The problem involved two pizzas, each of which was sliced into twelve pieces. The problem asked what fraction of the two pizzas was eaten by seven learners if each ate one piece from each pizza. The two young boys used two pizzas as their unit and reported that 14/24 of the two pizzas was eaten. The educator who was using one pizza as her unit wanted them to answer 7/12 of a pizza. The learners' answer was not incorrect with respect to the presentation of the question, but the educator was using a unit different from the one the boys used, so she saw their construction as incorrect. She explained her correct answer, as she saw it, to them but did not give them time to use their manipulatives to build the new knowledge from her explanations. When given the same problem the next year, the boys used the knowledge that they had constructed and arrived at as the original answer (Maher & Davis in Ward, 2001). This example demonstrates that constructed knowledge was retained and the information received through direct instruction was forgotten. Communication between learners and educator is another essential aspect of constructivism. Had the educator in the example been attuned to the boys' explanations, she would have realized that theirs was also correct. Communication must be present for the educator to know how the learners' knowledge has been constructed. Educators need to realize that solutions are built from past constructions and therefore will probably differ from their own. They must be willing to accept this diversity as long as it is mathematically valid (Ward, 2001:2).

2.8.4 Language and environment

This is further supported by a research on young Brazilian children selling on the streets that show that they have very well developed mental arithmetic skills that have no relationship with school taught methods. The children's methods are very effective in their context (the streets) but do not seem to be useful to them when they meet more formal approaches in school (Carraher, Nunes & Schliemann, 1993). This suggests that language and environment play major roles in the learning of mathematics. However, for example, the dominant language in the Eastern Cape Province, isiXhosa, has not yet developed sufficient words or terminology for the technical terms in mathematics. The language of mathematics is confined to the classroom environment. The cultural world of the learner lacks mathematical terminology. The learners also do not get adequate practice in mathematical concepts outside the classroom.

According to Maree, Cooney and Hirsh, Brodie and Brodie in Sibaya et al. (1996:36) some words in mathematics have meaning that are unrelated to everyday use. Studies have shown that learners define "volume" and "function" as a sound and social activity respectively. In Maree's study (in Sibaya et al., 1996) the concept "volume" was linked to a knob of a television set. This testifies that one's everyday language interferes with understanding of mathematical concepts. However, the learners can improve their performance in mathematics if they use many learning strategies. In this respect, a constructivist approach allows learners to make mathematics ideas and concepts their own.

The conclusion reached by Sibaya et al. (1996:37), provided strong support for innovative approaches to the teaching of mathematics to learners whose language is a barrier to the learning of mathematics.

2.9 EXTRINSIC BARRIERS

Christiansen, Howson and Otte in Maree and Molepo (1999:374) stress the importance of mathematics as a foundation for advancement in technology by claiming that living a normal life at the close of the twentieth century, in many parts of the world, requires the everyday use of mathematics of some kind. Many urban South African residents have to a large extent been able to come to terms with a transformed life-style, because of the shift in mathematics teaching and learning in urban schools since 1976 (Maree & Molepo, 1999:374).

The learners' environment must be taken into account in the teaching of mathematics. Duminy (1983:37) brings to our attention the usefulness of the abundance of learning materials available in the environment. According to him the beginning of any presentation lesson's discussion, observation, enquiry, can be found in flowers and weeds, trees, farm animals, insects, birds, roads and footpaths, streams and dams, aquatic life, the weather, the stars and natural phenomena like frost, floods and drought. The environment of the rural learner, especially the black learner is full of traditional drawings and decorations on the walls and floors of buildings that are geometrical in nature (Mokhaba, 1993).

It is the duty of the curriculum and a rural mathematics educator to understand the principles and the techniques that would enable him/her to articulate and make use of the learner's home background, values and perceptions into the fundamental disciplines of mathematics. The curriculum designed for the rural communities should be relevant and useful to the rural learners rather than merely theoretical knowledge that have to be learned regardless of the need for socio-economic survival (Maree & Molepo, 1999:375).

2.10 CLASSROOM LEARNING CLIMATE

Randhawa and Michayluk (1973:5) assert that classroom climate is an interaction phenomenon. Therefore it is important that the developmental history of each group members' personality variables, cognitive variables, socio-economic status, sex and other variables that seem to interact with the behaviours of the participants of a certain environment be taken into account. There are also considerable differences between learners of all ages. These differences are very evident among learners who receive mathematics education for the first time. These differences become more apparent as the years go by. As Maree (1996) puts it, "not all children of the same age are equally ready to master mathematical concepts, skills, lessons or exercises and new work will not be mastered well by all learners in class." Educators must allow for individual differences and if they fail to allow this and continue to teach new material before the more basic concepts have been assimilated by all the learners, gaps will definitely develop in some learners. Children tend to learn mathematics in a singsong manner when the teaching is too rigid, formal and abstract. Rote learning helps learners to grasp the mathematics being taught. But it inhibits further learning. It gives the children the impression that mathematics can be mimicked. The learners get into the habit of using concepts without thinking or understanding them.

2.10.1 The outcomes of learning

According to Mayer in Lambert and McCombs (1998:371), the outcomes of learning can be divided into three main categories: no learning, rote learning and meaningful learning. If a learner has not learned, then one can expect poor retention and poor transfer of performance. If a learner has not learned in a rote way, then one can expect both good retention and transfer.

Educators who support rote learning believe that the "goal of instruction is to help learners learn the material as efficiently as possible or the educators' responsibility is to cover each of the topics in the curriculum" (Mayer in Lambert & McCombs, 1998:371). Briefly, the main aim of rote learning goal is to focus mainly on retention as the test of learning outcomes. On the contrary, when the goal of instruction is "meaningful learning", the evaluation of the learning outcomes comprise both retention and transfer. The supporters of a meaningful learning view maintain that "students need to apply what they have learned to solve new problems." However, the goals of rote learning outcomes are consistent with a curriculum-centred approach and goals for meaningful outcomes are in keeping with the learner-centred approach advocated by Mayer in Lambert and McCombs (1998:371).

2.10.2 Learners' performance and training of their educators

Previously, educators concentrated on content in the schooling business. That is, on what and how much must be taught in various academic content areas with less regard for the learning and the learners themselves. However, the approach to schooling has become learner-centred. That is because when learners are ignored, their continuous calls for help are also ignored. They begin to think school is irrelevant. They feel disconnected from their educators and peers or they drop out both mentally and physically because they just do not want to be there (Lambert & McCombs, 1998:499).

According to Sotto (1999:50), rote learning makes it possible to follow instructions exactly and obtain the required result but learn nothing. Children can stay in school for ten years and leave without having learned very much. They learn by drill and practice. They remember but remembering is not the same as understanding. Learning (real learning) isn't what happens when we are fed information. Sotto (1999:50) goes on to say that learning is not the same as remembering. In real learning we always try to make inferences. We say to ourselves, 'If I do this, then that seems to happen.' For example, consider the following two sentences. Which is easier to learn?

"When a boat faces directly into the wind, and its sails flap, it is said to be 'in stays'.

Up so in so up we in so than we so we."

The first sentence is longer than the second, and contains longer and more varied words. Yet most people would find the first sentence far easier to remember. If asked why, most people would say the first sentence has a meaning. A good deal of research has been done on this question. For example, Sacks found that people do not remember the exact words - or the sentence construction used to convey a message. What they remember is its meaning (Sotto, 1999:51).

2.11 HUMAN AND PHYSICAL RESOURCES

Human and physical resources are scarce commodities in South Africa. Therefore, the idea of creative teaching approaches for large classes needs to be developed. Holderness in Cherian and Mau (2003:4), says improvement in the quality of teaching in large classes depends on a number of interrelated factors. The physical state of the school building, the classroom environment and the availability of learning materials can all strongly drive the extent to which an educator can function efficiently, effectively and enthusiastically.

Holderness in Cherian and Mau (2003:5) points out that the evidence on the relationship between class size and education is inconclusive. He does, however, acknowledge that exceptionally large class sizes could seriously inhibit the quality of educational provision. Studies done by Yuanshan and Mau in Cherian and Mau (2003:18) indicate that the results on the relationship between class size and achievements are contradictory. The reports of some studies indicate that small classes were better, but other studies indicate otherwise. Yet other studies found that size made no appreciable difference. Studies on the relationship between class size and achievement involve many variables. For example, as research subjects, learners' ages, gender, grade levels, ability levels and socio-economic background may influence academic results. The ability, experience, educational or attitude of educators may also influence the relationship between class size and achievement.

The results of a study by Johnson in Cherian and Mau (2003:18) suggest that the learners' performance was better not only because of small classes but also because their educators were better trained. Also the results of a study by Cohen, Filby, McCutchen and Kyle (1983) indicate that apart from class size, educators beliefs, attitudes, knowledge and skills influence their instruction and learners performance.

Yuanshan and Mau in Cherian and Mau (2003:22), assert that in a large class, the communication between educators and learners may be a challenge because it is difficult for educators to observe and assess all learners' responses. For Chinese educators, the key solution is to prepare their lessons well in order to teach large classes and to engage their learners (Yuanshan & Mau, 2003). Most of the educators in China are well grounded in the subject knowledge and skills they teach. The Ministry of Education in China limits the teaching hours of educators and provides more time for them to prepare their lessons. Collaboration among educators is strongly encouraged. Some schools urge educators to prepare their lessons together and to help each other in handling difficulties in teaching.

Lam, Ma and Wong in Cherian and Mau (2003:19-20) investigated how mathematics educators adopted the national curriculum to large classes. They used ethnographic methods such as interviews and observation over four weeks in rural and urban elementary schools. In both schools, the educators followed the textbooks closely. They had a strong influence on how the subject was planned and delivered. Educators' decisions were based on professional knowledge, their educational beliefs and the public examinations. Lessons were organized and clearly communicated to the learners. Educators most often know each learner in their class and were able to call each learner by name. In this way, educators were able to personalize their teaching and develop a spirit of community, even in these large classes. Patet and Oke in Cherian and Mau (2003:33) argue that the dynamics of the large class provide an excellent opportunity for educators to scaffold learning effectively since much of the thinking is done in peer groups. The inability to spend one-on-one time with each individual in the classroom proves to be an asset. Thus the temptation for educators to do things for the learner is replaced with an effort to structure an activity to enable the learner to follow through his/her own construction of knowledge about the topic at hand. Parents or caregivers may be illiterate and therefore cannot provide the necessary scaffolds needed to support the homework. A scaffold is effective only if the external support is just enough for the learner to acquire his/her independence. Unnecessary support can undermine learning by making the learner completely dependent on the educator and so makes if difficult for the educator to withdraw from the situation (Diaz, Neal & Amaya-Williams in Cherian & Mau, 2003:34). Parents are expected to supervise homework. A well-designed homework activity does not only create a strong scaffold for a child's learning but also serves to strengthen the interaction and the bond between a parent and child. Whether in small or big classes, effective teaching depends partly on how well the given homework relates to the concepts that have been taught and how the homework has been used as the foundation for the rest of the instruction. In a large classroom, homework becomes one of the popular ways to ensure the quality of learning since there is not enough time during the classes to accommodate each individual's place (Patel & Oke in Cherian & Mau, 2003:35).

The argument that Bennett (1996) presents that it is no longer a matter of debate that large classes adversely affect learners and impose difficulties on educators applies only to the traditional manner of classroom teaching and learning, i.e. educator-centred learning. Learners' learning need not necessarily be confined to the areas within the school walls. Learners can engage in learning in other community settings such as museums, industries, public services and libraries (Lorentz & Sarason, 1979; Raywid, 1995). These opportunities are denied the rural learner.

Decreasing the class size does not necessarily ensure more effective teaching or a greater increase in student performance. The study conducted by Greenwald, Hedges and Laime (1996) shows that the educator's expertise is a more important factor in determining learner achievement. An open and flexible educator willing to adapt his instructions to accommodate the needs of his/her learners will be an effective educator irrespective of the class settings and type (Thaver in Cherian & Mau, 2003:121).

2.12 THE ROLE OF SCHOOL INFRA STRUCTURE IN LEARNING

Poor facilities handicap good teaching and affect the morale of educators and learners. Improving physical facilities is a good way to begin transforming schools. It may seem more logical to start school improvement exercises with the curriculum, but in reality starting with the school building as a launching pad also works well because the building is real and not abstract. The outcomes are visible (Cherian & Mau, 2003:169). A study conducted by Pallas and Pong (2001) on mathematics in nine countries, only in the United States of America (USA) were smaller classes found to be better for mathematics.

2.13 EFFECTS OF EDUCATOR'S CONDITION OF SERVICE ON TEACHING

In many parts of the world, educators are traditionally held in high esteem. The teaching profession today has a status that is elevated yet discounted. The desire to become a educator is considered a high calling. However, the salaries and benefits do not reflect society's recognition of the profession as one that needs complex skills and knowledge (Cherian & Mau, 2003:170).

2.14 EFFECTS OF POVERTY ON LEARNERS

Jolliffe in Charleston (2003:1) points out that in the United States, poverty in the non-metropolitan areas exceed that in metropolitan areas. Therefore, one might expect the achievement of rural learners to be lower compared to the national average. However, the best evidence available is based on the conclusions reached by national effort to develop new research about mathematics education in rural areas.

In 1996 and 2000, the mathematics scores of learners on the National Assessment of Education Progress (NAEP) in USA showed some non-significant negative differences from the national average at all grade levels tested. These non-significant differences are at times interpreted as showing practical significance, though there is no consistency in the pattern in the direction of the difference as regards positive or negative conclusions. However, two conclusions seem to emerge about NAEP results. Over 25 years of testing and irrespective of the locale definition, there has been minimal change - increase or decrease - in the mathematics performance of rural learners. Secondly, with few exceptions, recent performance of rural learners at NAEP grade levels differed from the national average. The observed non-significant differences are small. Sometimes they favour rural and small-town schools and have no practical implications. Studies conducted by Lee and McIntyre (2000) used NAEP 8th grade data for 1992 and 1996 to investigate state-level variability in rural versus non-rural mathematics achievement. According to the findings, a great deal of variation was evident at the state level. In seven out of 35 states non-rural learners' aggregate scores were "higher" than those of rural learners. The study concludes that "rural learners in states where they have access to instructional support, safe or orderly climate and collective support tend to perform better than their counterparts in areas where they do not" (Lee & McIntyre, 2000). However, in South Africa, education is a national competence and cannot be compared to that of the USA.

2.15 SUMMARY

This chapter highlights the barriers that mathematics learners may face in the rural secondary schools in the Eastern Cape Province. It is of special interest that researchers have come to different conclusions on the factors affecting rural learners of mathematics. The next chapter is designed to provide the reader with a clear account of the research paradigm, design, methodology and methods.

CHAPTER 3

RESEARCH DESIGN AND METHODOLOGY

3.1 INTRODUCTION

In this chapter the researcher focuses on the research design and methodology used. A clear description is provided of the research design and technique, quantitative research, qualitative research, mixed method research, the sampling method used, data collection methods (observation, questionnaires and focus group interviews) the advantages and the limitations of the methods and techniques used, and the data analysis and techniques. The context in which the study was conducted, including the physical resources and the general infra-structural development in the Eastern Cape Province and the research area in particular, will also be explained.

3.2 CONTEXT OF THE STUDY

In the examination of the barriers that Grade 8 mathematics learners experience in learning mathematics in rural secondary schools, there is a need to look at the demography of the research area.

The Eastern Cape Province is a land of undulating hills, endless, sweeping sandy beaches, majestic mountain ranges and emerald green forests. It is in surface area the second largest of the nine provinces of South Africa.

3.3 RESEARCH PARADIGM

According to Mertens (2003:140), there are three broad major paradigms in operation within the educational research community. They are the positivist/post-positivist paradigm associated with traditional research approaches such as experimental or quasi-experimental design and causal comparative and correlational research approaches, the interpretive-constructivist paradigm associated with many qualitative approaches such as ethnography, case studies and phenomelogical investigations, and the transformative-emancipatory paradigm.

The transformative-emancipatory paradigm is based on the assumption that all knowledge reflects the power and social relationships within society and that an important purpose of knowledge construction is to help people improve society (Banks in Mertens, 2003:139). Mertens (2003:139) places mixed methodologies (the use of quantitative methods as well as qualitative methods) within such a transformative-emancipatory paradigm. The use of both quantitative and qualitative methodology in the same study also places this within a pragmatic paradigm (Teddlie & Tashakkori, 2003:20). Some researchers believe that mixing quantitative and qualitative methods makes it possible to use their complementary strengths (Teddlie & Tashakkori, 2003:19). In this study a pragmatic, mixed-methods design will be used to collect both quantitative and qualitative data.

The adoption of multiple methods in a single study adds rigour, breadth complexity, richness and depth to any inquiry (Flick in Denzin & Lincoln, 2000:5). According to Mertens (2003:136), human society is a complex one involving issues of pluralism and social justice. Research methods historically were not concerned with the politics of human research and social justice. However, changing conditions inside and outside the research world have heightened the need to address these issues. Given the new dispensation since April 27th 1994 and the development of an inclusive education system in South Africa, the adoption of a pragmatic approach is appropriate since it generates transformative-emancipatory thought. Furthermore, the relationship between knowledge about diversity within communities and implications for social justice and equity for diverse groups provides another layer of understanding for researchers (Mertens, 2003:136).

The transformative-emancipatory ontological assumption is that there are diverse viewpoints regarding many social realities and those viewpoints must be examined within political, cultural, historical and economic value systems to understand the basis for the differences (Mertens, 2003:140).

According to Mertens (2003:144) steps adopted to solve the problem require the researcher to spend quality time with people and perhaps also to apply a mixed methods approach to solving the problem. These methods may include observation, interviewing, review of demographic and other statistical data.

3.4 RESEARCH DESIGN

According to Mouton (1996:175), a research design is an exposition or plan of how the researcher plans to structure the research goal that has been formulated. The major components of this plan include specifying the variables to be measured and their various levels, the number of groups and the method to be adopted in assigning the research subjects (research participants) to the various groups, the measurement instruments to be used and how measurements are made and the frequency of measurements (Saslow, 1982:71). It also includes an indication of how the data collected will be analysed.

In this study the researcher used qualitative and quantitative methods which include observation techniques, interviewing, a questionnaire, and focus group interviews. Both quantitative and qualitative data on the performance of learners on a numeracy and literacy questionnaire and in focus group interviews were gathered. The research design is thus a mixed-method design, utilizing both quantitative and qualitative measures in order to generate the richest possible data.

Mills in Berg (2004:7) says if humans are only studied in a symbolically reduced, statistically aggregated fashion, there is a danger that the conclusion – although arithmetically precise – may fail to fit reality. According to Berg (2004:7), qualitative procedures provide a means of assessing unquantifiable facts about actual people represented by their personal traces (such as letters, photographs, newspaper accounts, diaries and so on). As a result, qualitative techniques allow the researcher to share in the understanding and perceptions of the participants and to explore how people structure and give meaning to their daily lives.

The study employed focus group discussions to collect qualitative data while quantitative data was collected by means of questionnaires. In addition to these, observations of the researcher during the field work regarding the state of class settings were also used to generate relevant information.

In all, three sets of questionnaires were used – one set for educators and two different sets for learners. One questionnaire (addendum C), with open and closed questions, for learners reflects the type of knowledge and insight (prior knowledge) into mathematics that learners in grade eight should possess. This was meant to elicit information on their (learners') mathematical literacy and numeracy levels. The test items were suggested to the researcher by J.C. Murray (2005, personal communication), a lecturer and researcher in Mathematics Education. She consulted the mathematics educators of four high schools about their minimum requirements for grade eight learners joining their schools, and on the basis of that suggested the type of questions that needed to be included in the questionnaire. This was to ensure **content validity**. These minimum requirements are much lower than the National Curriculum Statement (NCS) assessment standards for grade seven learners. The educators stated that if these minimum requirements are not met by learners, they could not continue with high school mathematics in any meaningful way. The second questionnaire (addendum B) was a biographical questionnaire meant to collect information on the characteristics of the learners' families including:

- employment,
- social structure,
- educational history, and
- literacy level.

The questionnaire responded to by the educators (addendum D) with open and closed questions gathered information on such characteristics as:

- qualifications of educators,
- educators' major subjects at college and/or university,
- curriculum changes,
- educators' proximity to schools and learners,
- teaching strategy/new modes of teaching,
- membership of educator associations, and
- extra-mural activities of educators.

The focus group interviews (addendum E) yielded information on the learners' experiences of:

- reading, and
- learning mathematics.

The choice of the above measurement instruments were based on their advantages which are relevant to the processes of this study and the realisation of its goals. Being a relatively inexpensive way of gathering information, it enables a researcher to access large samples. It is an effective was to reach people in remote areas and can yield a high response rate (Neuman, 1997:272). Consequently information gathering using questionnaires is considered appropriate for the study.

The researcher is however aware of the challenges involved in using the questionnaire as an instrument of measurement. One of these challenges is that good questionnaires are difficult to design (Sanders, 1995:92). Another problem is that respondents may present inaccurate information about themselves. Several efforts were made by the researcher to overcome these challenges. These include using questionnaires that had already been used by the researcher, J.C. Murray (2005, personal communication). The use of focus group interviews to collaborate information derived from the questionnaire responses was also an attempt to enrich and complement the findings with qualitative data. In terms of the contention of Fraenkel and Warren (1990:402) low response rate of questionnaires could be minimised by sending the questionnaires to persons in authority to administer to potential respondents, grade 8 mathematics educators in this study were asked to administer the questionnaires to learners during break time. This approach also helped to eliminate the possibility of having incomplete answers to the questionnaire items.

In general, in this study, questionnaires proved to be more cost-effective than face-to-face interviews, which Neuman (2000:273) asserts can be expensive.

Focus group interviews were also used in this study for their inherent advantages to the research. A focus group may be defined as an interview style designed for small groups. Using this approach, the researcher sought to learn through discussion conscious, semi-conscious and unconscious psychological and socio-cultural characteristics and process among various groups (Basch; Lengua et al. in Berg, 2004:123). According to Denzin and Lincoln (2000:836) focus groups allow access to research participants who may find one-on-one, face-to-face interaction "scary" or "intimidating". Focus group data are group data in that they reflect the collective notions shared and negotiated by the group.

In this particular research, the focus group interviews allowed the researcher to interact with learners in an informal way that allowed discussions to take place, where appropriate, in their mother tongue, which is IsiXhosa. It also allowed the researcher to elicit information on other areas of the questionnaire where learners could not provide written responses.

3.4.1 Sampling

The study population consisted of all grade 8 learners in the 149 rural schools that are in the King William's Town district. Six schools were then 'selected' through purposive sampling. Each school, with its educators and learners, formed a group for the purposes of this study. Owing to the differences in the enrolment of learners in the various schools, the group sizes in the sample are not the same. According to Merriam (1998:12) purposive sampling is based on criteria determined by the researcher as to who is interviewed or what sites are observed.

The criteria used to sample the six schools were the proximity and accessibility determined by a radius of 25 km from the researcher. Within the grouping of schools, all educators and learners in grade 8 took part in responding to the questionnaires. This is due to the fact that the numbers of grade 8 educators and learners in the selected schools were relatively small and manageable as suitable sample sizes by the researcher. The table below depicts the participating schools, the number of participating educators and learners in each school and therefore the total sample size.

Table 3.1: Sample groups and group sizes

	School	**No of educators**	**No of learners**
1	High School 1	1	65
2	High School 2	1	52
3	High School 3	1	46
4	High School 4	1	52
5	High School 5	1	53
6	High School 6	1	47
	Total	**6**	**315**

For the focus group discussions the sampling of learners was done in a purposive manner, to ensure the inclusion of learners with the highest and lowest performance (using their proficiency in the English language) and to ensure an even distribution of learners in the intermediate range. The purpose of weighting the learners in this way was to avoid the possible skewed distribution that would have resulted from simple random sampling. All grade 8 mathematics educators took part in the one-on-one interviews.

3.5 RESEARCH METHODS

According to Bailey (1996:34) research methodology is the philosophy of the research process which includes the assumptions and the values that serve as a rationale for research. It also indicates the criteria or standard the researcher uses to interpret data and reach conclusions.

3.5.1 Data Collection Methods

The instruments used in data collection were:

- Literacy and numeracy questionnaire for grade eight learners (Addendum C)

- Biographical questionnaire for learners (with open and closed questions) (Addendum B)
- Educators' questionnaire (with open and closed questions) (Addendum D)
- Focus group interviews for learners (Addendum E),
- Structured interviews (Addendum F) and
- The researcher's observations of the state of classroom setting.

In order to be able to facilitate objective measurement of the characteristics of interest, the following relevant variables are operationally defined, together with their measurement instruments and the relevant scales of measurement.

Table 3.2: Variables and their definitions

Variable	Definition	Measurement instrument	Scale of measurement
attitude	willingness to tackle questions perceived to be challenging	biographical questionnaire and focus group discussions	positive; negative
prediction	recognition of patterns and abstract thought	learners' literacy and numeracy questionnaire	answered question correctly/unable to answer the question correctly
literacy	understanding mathematical text	learners' literacy and numeracy questionnaire	answered question correctly/unable to answer question correctly
mechanical	ability to solve problems that require simple and direct mathematical operations	learners' literacy and numeracy questionnaire	answered question correctly/unable to answer question correctly
educator competency in teaching mathematics	educator's ability to use contemporary method in teaching mathematics	educators' questionnaire	little/moderate/strong
reading culture	how often learners read outside school hours	focus group discussion	yes/no/only during school exams
educator's interaction with learners during lessons	opportunity for educators to provide individual and/group support to learners during lessons	researcher's observation	little/moderate/strong
caregiver support to learners	the ability of caregivers to help learners in school work and procuring basic learner support materials.	educational and employment status in questionnaire	able to/unable to

3.5.1.1 Literacy and numeracy questionnaire for grade eight learners

This questionnaire was administered to all grade 8 learners in the various schools by the researcher in the presence of their respective educators on different days between February 16^{th} to April 6^{th} 2005. The table below shows the specific dates on which the questionnaires were administered in the respective schools.

Table 3.3: Dates of learner questionnaire administration

No	School	Date
1	High School 1	22^{nd} February 2005
2	High School 2	21^{st} February 2005
3	High School 3	23^{rd} February 2005
4	High School 4	21^{st} February 2005
5	High School 5	24^{th} February 2005
6	High School 6	25^{th} February 2005

For the sake of convenience and to make sure learners were not exhausted before the administration of the questionnaire, school breaks during the morning sessions were used for the exercise in each school. Each exercise took approximately 40 minutes in the respective grade 8 classrooms. Learners were not offered any assistance from either the educator or the researcher. This is to enable the researcher to be able to ascertain their ability as they are in terms of the characteristics being measured. Learners' answers were recorded against the individual items on the questionnaire. The completed (or uncompleted) questionnaires were collected from the learners by the researcher immediately after the end of the 40 minutes allocated.

The researcher realises that the numeracy test (questionnaire) would have been improved if language editing could have happened before the test were administered. The removal of some linguistic ambiguities could have lead to different understandings by the learners, and thus possibly to different findings. As the fieldwork was already completed at the time, it was felt ethical to attach the original questionnaire as Addendum C.

3.5.1.2 Biographical questionnaire for learners

The biographical questionnaire was also administered by the researcher to all grade 8 students in the presence of their educators on different days. The administration of this questionnaire took place approximately a week after that of the literacy and numeracy questionnaire in each school. The researcher (and not the educators, unless required to interpret) offered assistance in interpretation to learners on request. Only the research offered this assistance in order to achieve uniformity in interpretation of questions. Learners' responses were recorded against corresponding items in the questionnaire which were collected immediately by the researcher after the time allocated. Total time allocated for this exercise was 15 minutes.

The researcher is aware of a possible problem of order effect that could be introduced into the responses of learners to the biographical questionnaire due to the fact that it was administered after the literacy and numeracy questionnaire. This is likely due to the fact that learners who believed they performed badly in the literacy and numeracy exercise might want to exonerate themselves by claiming negative attitude towards mathematics, or lack of caregiver support or fatigue from walking long distances to school. Order effect could have been minimised by counterbalancing for order effect but this was not done owing to time constraint.

3.5.1.3 Educators' questionnaire

The questionnaire for educators was self-administered by the 6 grade 8 mathematics educators in the respective schools. The questionnaires were given to the educators by the researcher on the day the learners responded to their literacy and numeracy questionnaires and collected by him when he re-visited the various schools to administer the second questionnaire to the learners.

3.5.1.4 Focus group interviews for learners

Focus group discussions were conducted in only one school which is High School 4 one hour after the administration of the biographical questionnaire. Only one school was chosen from among the six for this exercise as the researcher believes that the group equivalence possibly achieved based on their rural setting and common poor performance in mathematics makes it representative enough of all others. High School 4 was chosen specifically owing to its proximity and accessibility to the researcher. The discussions took place with the researcher and an assistant; no educators were present to enable learners to feel free to express their views. The purpose of this was to minimise the problem of reactive measures that could be caused by the intimidating presence of their educators. The difficulty the researcher faced was that 16 out of the selected group of 24 learners could not communicate fluently in English. To prevent domination during the session by any individual or group, each learner was encouraged, sometimes through prompting by either the researcher or his assistant, to participate in the discussion. As a result of language barriers, the assistance of an isiXhosa speaking colleague was obtained to translate the researcher's question so responses could be elicited from all the learners. For the sake of uniformity of interpretation, the researcher had a thorough discussion with the isiXhosa speaking assistant as to the meaning of the leading questions. Furthermore in order to reduce the possible effects of language barriers, the discussions were held in three separate sessions:

Group 1: Learners who did not need interpretation into isiXhosa

Group 2: Learners who used both English and isiXhosa

Group 3: Learners who spoke only isiXhosa

The discussions were based on pre-determined leading questions (Addendum E) which were prepared by the researcher. The exercise took place on the 28th of February 2005. The first focus group of eight learners used English exclusively throughout the interview. The second focus group of eight learners used code switching (using two different languages – isiXhosa and English) with both the interviewer and the learners slipping between isiXhosa and English throughout the interview session. Finally, the third focus group of eight learners responded only in isiXhosa and their responses were translated into English for the benefit of the researcher. As stated above, in this study the translation of the data was done by a colleague of the researcher who is fluent in isiXhosa, and who shares the same language and culture as the learners.

Since participants in such exercises become tired and bored during lengthy interview sessions (Berg, 2004:91), the interviews were limited to thirty minutes for each group of learners. The questions and verbatim responses were audio recorded together with written notes by the researcher (the assistant did not compile notes which means that only the researcher's understanding of what was said and interpreted was recorded in written form during the interview). Every attempt was made to prevent contact among the three groups before their respective sessions of the interview to preserve independence of the groups. This was done by keeping the third group in a separate classroom with an educator while discussion was taking place with the second group.

Here again, noting that the research design is within-subject and that the focus group discussion is the third measurement being done on the same learners, the possibility of order effect is acknowledged by the researcher.

3.5.1.5 The researcher's observation

The method of observation was used specifically to assess the classroom settings in the various schools concerning the ease of mobility of both educators and learners. The purpose of this is to ascertain to what extent the educators can move around during lessons to offer support and assistance to learners. It also gave indications of the ability of learners to interact with one another for mutual support where necessary during and after lessons. The settings prevalent during teaching periods were the very ones used during the administration of the various learner questionnaires.

3.6 METHOD OF DATA ANALYSIS

3.6.1 Analysis of qualitative data

The analysis of a qualitative data is a creative process, which is measured differently by different researchers and because of this, it is impossible to provide a "recipe" for analyzing data (Yin, 1994:11). Creswell (1994:154) also mentions that data analysis requires that the researcher be comfortable with developing categories and making comparisons and contracts. It also requires that the researcher be open to possibilities and seek contrary or alternative explanations for the findings. The researcher looks at a large amount of information and reduces it to certain conclusions from them. Patton (1987:144) also writes "analysis is the process of bringing order to the data, organizing what there is into patterns and basic descriptive units".

Audio taped interviews were transcribed verbatim into written format by the researcher. Recordings were retained for reference purposes. Constant comparative methods were used to analyze data.

Responses of the focus group interviews were analyzed using the following eight steps which Tesch in Creswell (1994:155) consider when analyzing data:

- Read through all documents.
- Select one document and read through concentrating on the underlying meaning.
- List the topic and cluster similar topics together.
- Select code for different topics and record these next to the topic in the document.
- Find the most descriptive wording for your topic and relate to each other.
- Decide on the final code for each category.

- Assemble the data material belonging to each category in one place and perform a preliminary analysis.
- Re-code your existing data, if necessary.

3.6.2 Analyses of quantitative data

Quantitative data were derived mainly from the learner literacy and numeracy, and biographical questionnaires. After the literacy and numeracy tests (Addendum C) the results were captured on MS Excel worksheets for analysis. The responses from the biographical questionnaire were also analysed using MS Excel worksheets.

3.6.2.1 Analysis of test results

The results of the test were presented in both table and chart forms. Since the sizes of the various groups (schools) were not the same the main descriptive statistic used were absolute and average proportions (percentages) of learners answering individual questions correctly. The results were initially presented for the combined groups of learners totalling 315. Thereafter, the questions were categorized into the following groups:

- mechanical questions'
- questions on fractions,
- questions on patterns, and
- word questions

Using tables and diagrams, the performances in the various schools were then compared with the aim of detecting any patterns and/or trends regarding learners' performances in the various categories. A 2 x 2 contingency table was also used to examine if some types of questions (e.g. word questions involving fractions) increase learners' coping difficulties.

3.6.2.2 Analysis of learners' biographical questionnaire (Addendum B)

The data collected was initially edited with the aim of eliminating unlikeable responses. Such responses include:

- learners' ages ranging from 5 years to 11 years
- distance walked to and from school, for example 140 km, 31 km, 35 km, 20 km.

Thereafter, tables and charts were used to organize the edited data. The resultant summaries were used to analyse information on possible environmental barriers to learning mathematics by the learners.

3.7 RELIABILITY AND VALIDITY

The argument and debate about **validity** and **reliability** has always been there from time immemorial. De Koning and Martin (1996:2) quoting Maxwell draw our attention to the fact that validity always relates to data or interpretation of data.

According to De Koning and Martin (1996:2) "Methods are appropriately or inappropriately used to obtain data. An inappropriate choice of methods or the misuse of methods can be a threat to obtaining valid data" The above argument is made clear by the use of words like 'trustworthiness' and ' credibility' as suggested by Patton (1990) and Pretty in De Koning and Martin (1996). Their argument is that the threats to validity and the ways we try to ensure validity differs from qualitative to quantitative methods.

This was the basic reason why the researcher further made use of focus group interviews in order to get data that is "trustworthy" and "credible" as it comes from the learners themselves with limited changes or misconceptions of questions being asked. The combination of methods does, however, result in a variety or range for data. Herman, Morris and Fitz-Gibbon (1987:133-134) put it thus, "Assessment of validity and reliability help to determine the amount of faith people should place in a measuring instrument … judgement of validity answer the question: Is the instrument an appropriate one for what needs to be measured?" Validity in this sense provides an indication of whether a measure is likely to be worthwhile or not in a given situation.

The mixed methods approach adopted by the researcher ensured credibility (parallels internal validity) (Mertens, 2005:302) subsequent to Creswell (2003:196). By triangulating methods the validity of the research is strengthened (Sandelowski, 2003:322; Onwegbuzie & Teddlie, 2003). The qualitative data was used to provide the context within which the quantitative data must be interpreted.

The researcher used member checks to ascertain the accuracy of the qualitative findings by visiting the schools to report back on the preliminary findings for the learners and educators to verify the researcher's findings.

Validity is determined by degrees and is a continuous process of gathering evidence and formulating an argument to support score interpretations Cronbach, and Khan in Phye, Robinson and Levin (2005:128) as discussed earlier in this chapter. This is what the researcher did in order to ensure credibility and hence validity.

The sampling is an additional measure of quality assurance. Consistency was maintained throughout the process of data collection because it is an important aspect of reliability.

3.8 ETHICAL CONSIDERATIONS

A letter was written to the Department of Education, Eastern Cape (Addendum A), requesting permission to undertake the research. This request was granted. The parents and/or guardians of the learners who participated were asked to fill in the appropriate consent letter (Addendum G). In retrospect the researcher realises that it would be more ethical to ask the learners themselves to give assent to participating in the research as well, and also the teachers who participated.

Anonymity was guaranteed in the questionnaires and it was indicated that any answer would be accepted.

3.9 POSITION OF THE RESEARCHER

Results could be subjective because they were related to the researcher's personal observations and feelings developed during the visits to the schools. The inability of the researcher to speak the local language of respondents was problematic. This condition was minimized by engaging the services of a colleague who is fluent in both English and isiXhosa. The researcher also encountered difficulty where he was not able to meet with the supervisors as often as he would have liked to, except correspondence by postal and electronic mail which in every respect is not better than face-to-face meetings. This also caused delays in the write up of the report.

The researcher chose to study grade eight mathematics learners because if he had worked with lower grade learners, the researcher's presence would intimidate the learners and they might present information to please the researcher which would not serve the intended purpose.

For consistency, the researcher made the same number of visits to the schools. Before the interviews were conducted, the researcher obtained each participant's permission (Addendum G) to record his/her responses and at the same time assured him/her of the confidentiality of his/her identity. The interviews were conducted in surroundings familiar to the learners in order to put them at ease.

3.10 SUMMARY

This chapter provided an overview of the research design and methodology used in this study. The research design and techniques used in this study, as well as the interview techniques used, were discussed in some detail. The data obtained will be analysed and discussed in Chapter 4.

CHAPTER 4

RESULTS AND FINDINGS

4.1 INTRODUCTION

In this chapter the data collected will be analysed. This chapter also discusses the characteristics and background of the learners, educators and parents. Special attention is given to the difficulties experienced by learners before the findings of this study are presented.

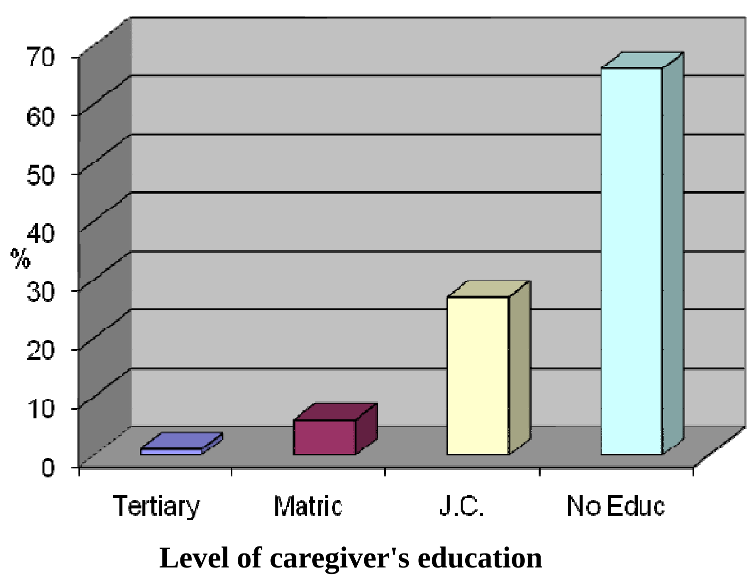
4.2 ANALYSIS OF LEARNERS' BIOGRAPHICAL DATA

The biographical questionnaire was used to generate data on learners' school and home environment, and their attitudes towards mathematics. The questionnaire was responded to by 315 learners from the six schools.

4.2.1 Educational background of caregivers

The educational background of the caregivers of the learners is represented by the Figure 4.1 below.

Figure 4.1: Educational background of caregivers



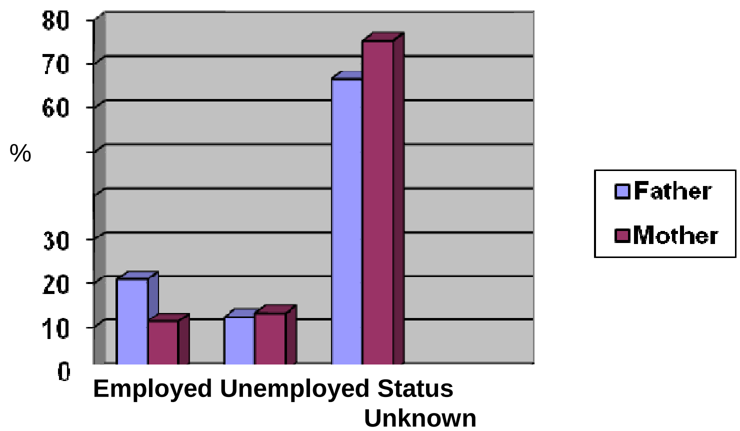
Of the 315 learners, 208 (66%) of the caregivers had no formal education, 85 (27%) of the caregivers had Junior Certificate (J.C.) equivalent to the present grade 10 level education, 19 (6%) of the caregivers had matric or grade 12 equivalent educational qualification and only 3 (1%) of the 315 caregivers had tertiary level education. It is generally accepted that higher education levels of caregivers foster a greater appreciation of education and ability to help learners learn. Patel and Oke in Cherian and Mau (2003:33) argue that parents or caregivers may be illiterate and therefore cannot provide the necessary scaffolding to support homework. Scaffolding is effective only if the external support is just enough for the learner to acquire his/her independence. Unnecessary support can undermine learning by making the learner completely dependent on the educator and so makes it difficult for the educator to withdraw from the situation (Diaz, Neal & Amaya-Williams in Cherian & Mau, 2003:34). Parents are expected to supervise homework. A well-designed homework activity does not only create a strong scaffold for a child's learning but also serves to strengthen the interaction and the bond between a parent and child. But the background of these parents is unlikely to promote such interactions. These results may be related to a study by Mbokosi, Msila and Singh (2004:301) on the effect of black parental involvement on the success of their children's education. Their study revealed that the black parents' role is crucial in the enhancement of learning success. Parents who play little or no role in their children's homework and study programmes may contribute to the poor performance of their children in the classroom.

The conclusion reached by Mbokosi et al. (2004), however, can neither be upheld nor disputed by this study because no comparison was made in terms of the performance of learners who stay with parents and or non-parents.

4.2.2 Employment status of caregivers

The figure (Figure 4.2) below shows the employment status of caregivers at the time of the survey. It shows that 21% of fathers were employed while 11,4% of mothers were employed. It also shows that the unemployment levels for fathers and mothers was 12,4% and 13,3% respectively. Unfortunately the survey could not produce evidence on the employment status of about 66.6% of fathers and 75,3% of mothers. A possible explanation for the 'response unknown' return could be that the learners did not understand the question or the learners might be living on their own. What is clear though is that, based on the information generated, a definitive statement cannot be made concerning the actual percentage of caregivers who are employed or who earn income. However, it is noted that high unemployment levels among caregivers have the potential to inhibit parental support in terms of such money-based basics as nutrition and learner support materials. Nevertheless, it should be noted that unemployed parents can offer support to learners in other forms such as guidance in making subject choices choosing friends both of which could either have positive or negative effects on a learner's performance at school.

Figure 4.2: Employment status of caregivers



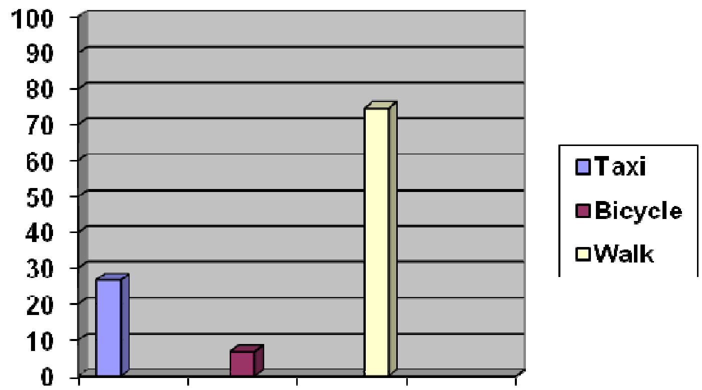
4.2.3 Modes of transport by learners to school

The distribution of the various modes of transport used by learners to school is shown in Table 4.1 and Figure 4.3, respectively.

Table 4.1: Transport to school

Transport to school					
Taxi		**Bicycle**		**Walk**	
No	**%**	**No**	**%**	**No**	**%**
84	26,7	21	6,7	235	74,6

Figure 4.3: Various modes of transport used by learners



The figure shows that 6% of learners ride on bicycles, 25% use public transport, and 69% of learners (the majority) walk the average distance of 6 km to their schools. This distance compares unfavourably with the average distance for learners in the province, which is 3,5 km (Tywakali, 2004). Even though this study did not investigate the relationship between the distance covered on foot to school and attendance at school, it could be a contributory barrier to learners' performance factor if distance causes erratic attendance or punctuality. This view is based on Dednam's (2005:1999) assertion that regular absence from school and change of schools are also two of the most important causes of mathematical difficulties as they cause backlogs in mathematical knowledge. Frequent absenteeism on the part of learners means that they miss lessons. As a result, there may be gaps in their mathematical knowledge which they find difficult to close. Learners with backlogs thus find it extremely difficult to keep pace with work. This situation is exacerbated if the educator is inadequately trained to offer the teaching and learning support or, for some other reason, lacks the know-how to identify and rectify these barriers to learning.

4.2.4 Family heads of learners

Head of family distribution is represented by Table 4.2:

Table 4.2: Head of family

Head of family	**Number**	**Percentage (%)**
Grandparents	154	49
Father	122	39
Mother	38	12
Total	**314**	**100**

In the case of these respondents, 154 grandparents (49%), 122 fathers (39%) and 38 (12%) mothers were heads of families. This shows that almost half of households were headed by grandparents. This could create a barrier for the learners because of lack of parental involvement in their learning. (The lack of parental involvement in their learning could constitute a barrier to learning.)

4.3 ANALYSIS OF TEST RESULTS

The results of the test are shown in its aggregated form for all participants in the Table 4.3 and Figure 4.4 below. The percentages in the table represent the 'percentages of learners who either answered a corresponding question correctly or incorrectly' while those in the figure represent only the percentages of correct answers to a given question.

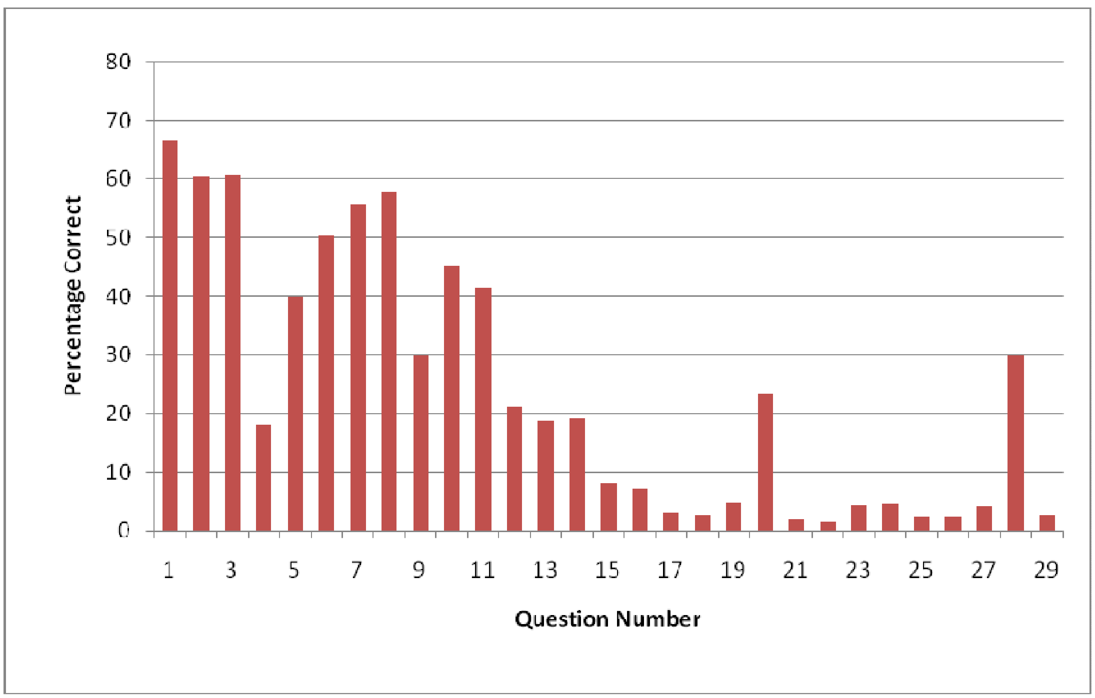
As a measure to determine the reliability of the test, it was considered appropriate to look at the internal consistency of the test by calculating the Cronbach coefficient alpha. Statistics yielded a Cronbach α of 0.89 which can be considered satisfactory or even high. Usually a score of 0.7 and higher is deemed satisfactory. Due to the high number of test items, the alpha value is high, which bodes well for the internal consistency of the test (M Kidd, 2008, personal communication). Three of the test items yielded a slight negative correlation with the total score which could mean that those items were problematic.

Table 4.3: Learners' responses to the Numeracy questions

No	Test Item	Correct Responses	%	Incorrect Responses	%
1	37 + 8	209	66.7	141	33.3
2	83 – 58	189	60.5	161	39,5
3	27 × 5	84	60.7	266	39,3
4	56 ÷ 3	56	18.0	294	82,0
5	798 + 312	122	39.8	228	60,2
6	238 × 17	155	50.3	195	49,7
7	810 ÷ 18	173	55.8	177	44,8
8	200; 250; 300; …; …; …;	180	57.7	170	42,3
9	900; 920; 940; 960; …; …; …;	126	39.8	224	60,2
10	2500; 2550; 2600; 2650; …; …; …;	139	45.3	211	54,7
11	"8 × 6 (context)"	127	41.6	223	58,4
12	"8 x 6 (context)"	66	21.2	284	78,8
13	"9 x 7 (context)"	60	18.8	290	81,2
14	"9 x 8 (context)"	59	19.1	291	80,9

No	Test Item	Correct Responses	%	Incorrect Responses	%
Which is bigger?					
15	1/2 or 1/5 of a cake? Why?	25	8.1	325	91,9
16	2/3 or 3/6 of a cake? Why?	22	7.3	32	92,7
17	3,47 or 3,6 or 3,3762? Why?	10	3.1	340	96,9
Find the next three terms of the sequences in numbers 18 and 19					
18	0,4; 0,6; 0,8; …; …; …;	9	2.7	341	97,3
19	3,8; 3,85; 3,9; …; …; …;	16	4,8	334	95,2
20	5,43 + 0,l	100	23.5	250	76,5
21	4/5 + 2/3	6	1,8	344	98,2
22	7/8 ÷ 3/5	4	1,5	346	98,5
23	20% of R500	13	4.3	337	95,7
24	"10m ÷ 2/3m (context)"	14	4.5	336	95,5
25	" 810 ÷ 50 (context)"	8	2.4	342	97,6
26	"R800 x 95/100 (context)"	8	2.2	342	97,8
27	"3 ½ km x 5 x 2 (context)"	15	4.2	335	95,8
28	37 ÷ 0,5	89	29.8	261	70,2
29	"3 x number – 2 (context)"	8	2.6	342	97,4

Figure 4.4: Distribution of correct responses



The above responses show very poor performances in mathematical operations involving fractions (question 15 – 23). It also shows very poor performances in word problems (questions 24 – 27 and 29). In order to be able to discern common traits in performances among schools, the aggregate figures shown above are dis-aggregated into group (school) performances and type of questions. The questions are divided into four groups namely:

- mechanical questions
- word problems
- fractions and patterns, and
- patterns.

These are analysed in the subsequent sections.

4.3.1 Mechanical questions

The Table 4.4 below shows the percentages of learners in each school who answered the mechanical questions correctly. Questions 1 – 7 are classified here as 'mechanical'. The figures are in percentages (the percentage of learners who correctly answered a particular question).

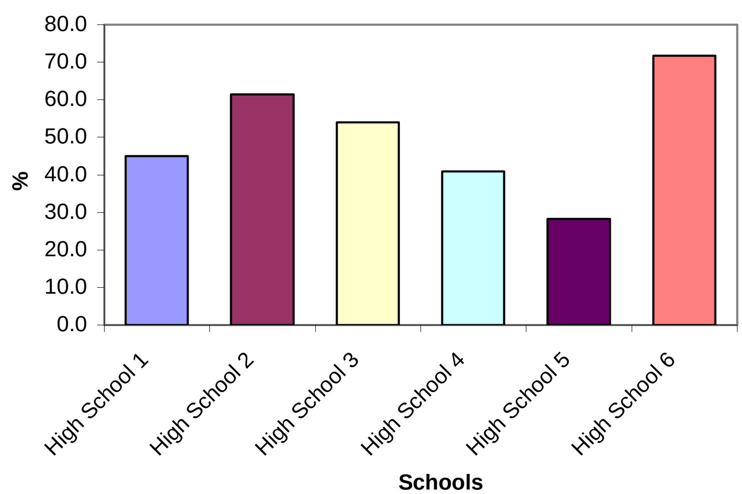
Table 4.4: Performance in mechanical questions

School	Question numbers							Sch Av
	1	2	3	4	5	6	7	
High School 1	76.9	61.5	58.5	18.5	23.1	30.8	46.2	**45.0**
High School 2	78.8	75.0	69.2	30.8	42.3	69.2	65.4	**61.5**
High School 3	80.4	65.0	65.2	13.0	41.3	52.2	60.9	**54.0**
High School 4	57.7	42.0	46.2	9.6	30.8	50.0	50.0	**40.9**
High School 5	17.0	34.0	37.7	0.0	37.7	35.8	35.8	**28.3**
High School 6	89.4	85.0	87.2	36.2	63.8	63.8	76.6	**71.7**
Subject average	**66.7**	**60.3**	**60.7**	**18.0**	**39.8**	**50.3**	**55.8**	**50.2**

The table shows that learners performed reasonably well on the mechanical questions (questions that required simple and direct mathematical operations) both by school and item. It is noted from the table (column 8 in the last row) that over 50% of learners answered all questions in this category correctly. A rather puzzling observation from the table is that question 4 (56 ÷ 3) could not be answered correctly. This observation goes for all the schools with not a single learner getting it right in High School 5. The inability of the learners in all schools to answer question 4 correctly is puzzling considering the fact that over 50% of them correctly answered question 8 which states 'calculate 810 ÷ 18'; many would consider question 4 to be relatively easier than question 8. The table also shows that relatively easy mechanical questions such as question 1 (37 + 38) could not be answered correctly by over 30% of learners in all schools. The same goes for the question on subtracting two-digit numbers such as 83 – 58 (question 2) where almost 40% failed to get it right.

The Figure 4.5 below shows the percentages of learners in each school who answered all the questions in this category correctly. Only two schools got over 60% of learners answering all the questions correctly with one school scoring as low as under 30%. With reference to the table above, it is noted that not a single learner from the lowest performing school in the figure could calculate 56 ÷ 3 correctly.

Figure 4.5: Performance in all mechanical questions by schools



Perhaps one can infer from the results as summarised in the table and figure that the inability to perform basic mathematical operations of addition, subtraction, multiplication, and division is a problem for a lot of learners in all six schools surveyed.

4.3.2 Word Problems

The Table 4.5 below shows the performances of the schools with regard to questions in this category.

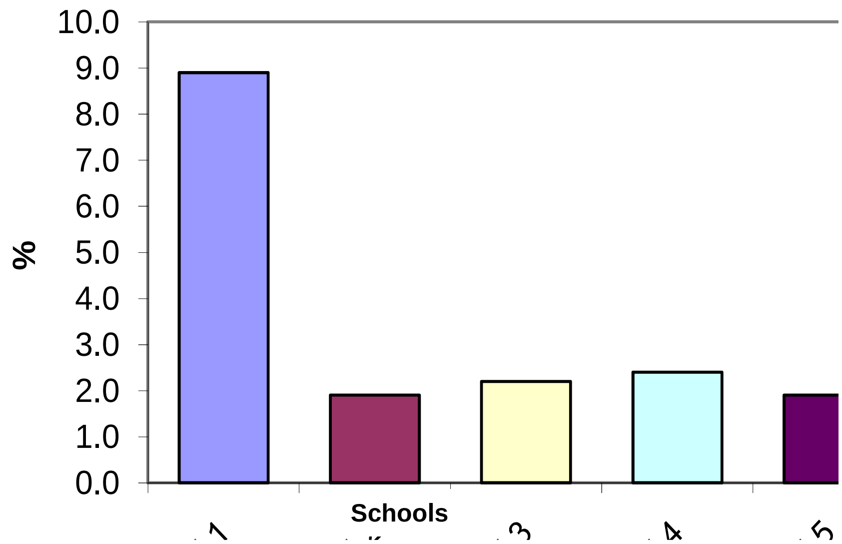
Table 4.5: Performance in word problems

School	Question Numbers				Sch Ave
	24	**25**	**26**	**27**	
High School 1	4.6	6.2	9.2	15.4	**8.9**
High School 2	3.8	0.0	1.9	1.9	**1.9**
High School 3	6.5	0.0	0.0	2.2	**2.2**
High School 4	5.8	0.0	0.0	3.8	**2.4**
High School 5	1.9	3.8	1.9	0.0	**1.9**
High School 6	4.3	4.3	0.0	2.1	**2.7**
Subject average	**4.5**	**2.4**	**2.2**	**4.2**	**3.3**

In word problems learners were unable to decipher the key operations involved in the problem, whether it was multiplication, addition, subtraction or division. The cell in the last column of the last row of the table shows that only 3,3% of all learners in the six schools answered all questions correctly. This inability to cope with word problems is evidenced in responses to the following problem (question 14) in particular: "A farmer plants 9 rows of pear trees in his orchard. Each row has eight trees. How many trees does he plant in his orchard?" The most common response (83,1% of learners) was 17 plants in the orchard. This answer shows an inability to make sense of the problem. Furthermore, no attempts were made by learners to draw diagrams or sketches to solve problems. If this had been done, they could have detected the flaw in their reasoning. Poor reading abilities also lead to difficulties in reading word problems. These learners performed better on mental arithmetic and mathematical competence tests, but struggled with mathematical processes and word problems as they cannot read and comprehend text (Dednam, 2005:200). Learners with reading difficulties find it difficult to read numerals, for example, confusing sixes and nines, and reversing numerals and writing a seven back to front (Baroody & Coslick, 1998:4-16).

The inability to cope with word problems is further highlighted by the Figure 4.6 below which shows the percentage of learners in each school who answered all questions in this category correctly. It can be seen that even the best performing school (High School 1) scored less than 10% of all participants answering all questions right.

Figure 4.6: Performance in all word problems by school



4.3.3 Fractions

The Table 4.6 below shows learners' performances in the questions classified as fractions.

Table 4.6: Performance in fractions

School	Question Numbers								Sch Ave
	15	16	17	20	21	22	23	28	
High School 1	6.2	3.1	4.6	13.8	4.6	3.1	1.5	1.5	**4.8**
High School 2	3.8	5.8	3.8	38.5	0.0	0.0	7.7	38.5	**12.3**
High School 3	8.7	13.0	0.0	34.8	2.2	2.2	2.2	26.1	**11.2**
High School 4	9.6	7.7	0.0	30.8	1.9	0.0	1.9	26.9	**9.9**
High School 5	7.5	3.8	5.7	17.0	0.0	1.9	1.9	26.4	**8.0**
High School 6	12.8	10.6	4.3	6.4	2.1	2.1	10.6	59.6	**13.4**
Subject average	**8.1**	**7.3**	**3.1**	**23.5**	**1.8**	**1.5**	**4.3**	**29.8**	**10.0**

From the table it can be seen that performances in this category is also dismal. An inability to add decimals was demonstrated by responses to the following example: Find the next three terms of the sequence: 0,4; 0,6; 0,8; ....; ....; .... The learners were unable to add on decimals and consequently, wrote them as whole numbers. There was the tendency to ignore the decimal commas in all cases examined. Thus 95,4% of learners ignored the decimal commas and wrote them as 4; 6; 8; 10; 12; 14; etc. This could also be explained by not only an inability to add decimals, but also an inability to recognise decimals.

Another evidence of the inability to cope with decimals is reflected in the response to the following question: "Which is bigger ... 3,47 or 3,6 or 3,3762 and why?" The response was "3762" because "it is bigger than 47 and 6."

The most common errors and misconceptions involving common fractions were held by more than 96% of the learners. They failed to add fractions by generating a common denominator or showing the operations diagrammatically. What most of them did was to either add or multiply the numerator or the denominator as shown below.

For instance, the following responses were offered:

$\frac{4}{5} + \frac{2}{3} = \frac{9}{5}$ or $\frac{6}{8}$ or $9 + 5 = 14$

$\frac{4}{5} + \frac{2}{3} = 68$

or $\frac{4}{5} + \frac{2}{3} = 7 + 7 = 14$

(numerator and denominator added up)

and $\frac{7}{8} \div \frac{3}{5} = \frac{10}{13}$

$\frac{1}{7} > \frac{1}{5}$ because $7 > 5$

$\frac{3}{6} > \frac{2}{3}$ because $6 > 3$ and also $3 > 2$

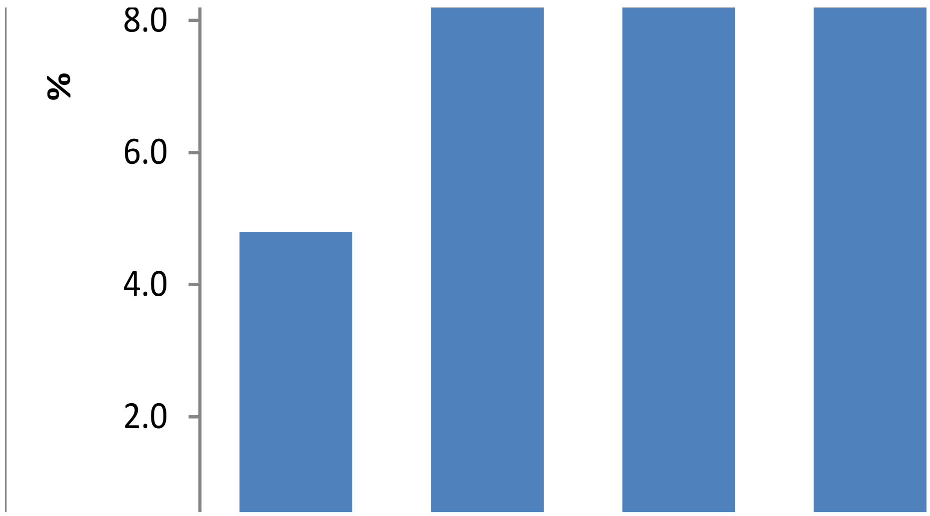
From the responses, the researcher found that the learners have many difficulties with fractions. Learners do not relate their concept of fractions to real objects (for example, sharing bread, chocolates, cake or money) but only to geometrical representations of shaded figures offered by their educators. The learners are unable to make sense of the idea of a fraction as part (and an equal part) of a whole.

To the learners, a fraction is another geometrical figure like all geometrical figures they encounter. The concept of fraction is completely related to area and shape, and is difficult for the learners to extend to real-life contexts like money, food, clothing, time and so on.

The researcher also realized that the learners find it difficult to understand decimal fractions. To understand decimal fractions, learners need to understand common fractions and the common fraction notation associated with them.

The performances per school in terms of the percentages of learners who answered all questions correctly in this category are shown in Figure 4.7 below.

Figure 4.7: Performance in all fractional questions by school



It is clear from the figure that all schools performed badly in the category. No school was able to score 15% in terms of all questions answered correctly.

4.3.4 Patterns

Table 4.7 shows the performances with respect of the questions categorised as patterns. Although all schools performed relatively better than the categories of 'word problems' and 'fractions', the level of performance is still low. For example in question 12, learners could not visualise the presence of tiles under the mat. Similarly in question 13 learners could not realise the pattern on the rectangular floor and thus failed to fit the tiles in. It is not surprising that learners fared worst in questions 18 and 19 since they contain fractions. As noted earlier in the preceding section, the concept of fractions is a huge problem for them. In question 29, learners again failed to realise the number of dots being added to the pattern both horizontally and vertically to be able to solve the problem.

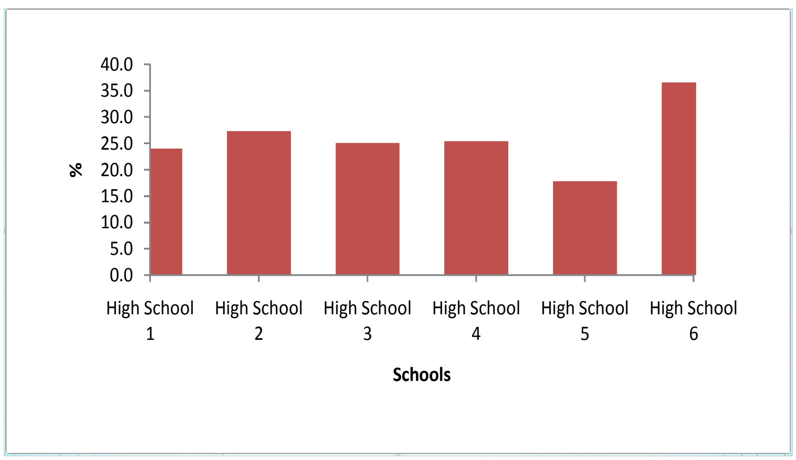
Table 4.7: Performance in patterns

Schools	Question Numbers									Sch Ave
	8	**9**	**10**	**11**	**12**	**13**	**18**	**19**	**29**	
High School 1	55.4	46.2	27.7	23.1	15.4	27.7	6.2	10.8	3.1	**24.0**
High School 2	67.3	40.4	51.9	42.3	28.8	13.5	1.9	0.0	0.0	**27.3**
High School 3	60.9	30.4	50.0	43.5	17.4	17.4	0.0	2.2	4.3	**25.1**
High School 4	59.6	32.7	44.2	48.1	21.2	19.2	0.0	1.9	1.9	**25.4**
High School 5	28.3	34.0	34.0	24.5	18.9	9.4	3.8	7.5	0.0	**17.8**
High School 6	74.5	55.3	63.8	68.1	25.5	25.5	4.3	6.4	6.4	**36.6**
Subject average	**57.7**	**39.8**	**45.3**	**41.6**	**21.2**	**18.8**	**2.7**	**4.8**	**2.6**	**26.0**

In response to the request to find the next three terms of the sequence: 900; 920; 940; 960; 980; ...; ...; ...; , the responses of about 75% of the learners were: 900; 920; 940; 960; 980; 10020; 10040; 10060. Even though learners recognised the sequence here, they showed the inability to write the numbers "one thousand", "one thousand and twenty", etc. in figures.

Figure 4.88 below confirms that on the average, the schools as groups performed better in terms of percentage of learners answering all questions in this category than in fractions and word problems.

Figure 4.8: Performance in all questions of patterns by school



4.3.5 Interaction effect between fractions and word problems

The Table 4.8 below shows the extent to which learners' problems increase when questions involving fractions are also expressed as word problems. The figures represent the average percentages of learners in all schools who answered questions in the specified categories (not fraction, fraction, not word problem, and word problem) correctly.

Table 4.8: Interaction between fractions and word problems

	Not Word problem	**Word problem**
Not Fraction	50.2	18.8
Fraction	8.1	3.3

The table shows that questions which are neither fractions nor expressed in word format were correctly answered by over 50% of all learners. The performance drops to 18.8% (2nd row; 3rd column) when the questions are expressed in words. Similarly, the performance drops to 8.1% when fractions are introduced into non-word questions. Finally performance drops to its lowest of 3.3% (3rd row; 3rd column) when fractions are introduced into questions expressed in words. It can therefore be deduced from this analysis that fractions and word format of questions interact with each other to deepen the difficulties experienced by the learners involved in this study.

It must be pointed out that the learners made similar responses. Perhaps this is a sign that learners copied from one other. This deduction is based on the fact that learners were seated so close to one another in the classroom that independent work was most likely impaired.

4.4 EDUCATOR QUESTIONNAIRE ANALYSIS

The Table 4.9 below shows a summary of some of the information collected from responses to the educators' questionnaire.

Table 4.9: Educators' questionnaire response

Educator	Sex	Yrs of experience	Highest qualification	subjects taught	Need for association	Distance from school	Medium of instruction
A	F	5	B.Ed.	Maths & Science	yes – share ideas but reluctant to attend workshops outside school hours	85 km	English. Also code switch
B	F	7	B. Ed	Maths & Science	yes – share ideas but reluctant to attend workshops outside school hours	20 km	English. Also code switch
C	F	10	STD	Maths	yes – share ideas	35 km	English. Also code switch
D	F	10	B.Ed.	Maths & Science	yes – share ideas but reluctant to attend workshops outside school hours	61 km	English. Also code switch
E	F	15	STD	Maths	yes – share ideas but reluctant to attend workshops outside school hours	47 km	English. Also code switch
F	F	12	STD	Maths	yes – share ideas	70 km	English. Also code switch

4.4.1 Educational background of educators

The table shows that the Grade 8 educators were all women with educator's qualifications in the humanities. None of them had a degree in Mathematics or Mathematics education. Their mathematical content knowledge was at grade 10 level (formerly Standard 8 or Junior Certificate). Among them, they had an average of almost 10 years' mathematics teaching experience. The table also reveals that they believe their membership of educator associations enrich their knowledge bases by providing them with the opportunity to exchange and acquire ideas from their colleagues.

The finding shows that the educators lack one of the qualities identified by Brumbaugh (1997:3) namely competency in mathematics. As discussed earlier in Chapter 2, it could therefore, be deduced that the educators lack confidence with regard to the subject matter and thus may constitute learning barriers themselves. It would seem then that educators need training and on-going support and encouragement in teaching and learning mathematics effectively in their schools.

4.4.2 Location of educators with respect to school

All the educators lived at some distance from the school. The educator nearest to the school lived 20 km away from the school. The rest lived about an average of 70 km away from their schools. Therefore interactions between educators and learners after the school day were non-existent. The rural mathematics learner is therefore disadvantaged by this environmental situation if it can be interpreted that the learning environment in the rural areas is devoid of adequate educator support. This could thus be possible contributory barrier to learners.

4.4.3 Teaching and assessment strategies

The Table 4.10 below shows the responses of educators concerning their teaching strategies.

Table 4.10: Questionnaire response on teaching strategies

	Responses by educators					
	A	**B**	**C**	**D**	**E**	**F**
I teach mathematics with the aim of getting all learners to pass the examinations	3	5	4	3	4	4
I teach the learners so that they understand mathematical concepts and then use the knowledge for life	1	1	2	1	2	3
I teach mainly using the revised National Curriculum Statement (RNCS) for mathematics given by the Department of Education	3	3	3	3	3	4
I teach according to the given RNCS for mathematics (not necessarily complete it) but use suitable local examples	4	4	4	3	3	3
I prefer context based teaching to content based teaching	1	2	3	3	4	3

Rating scale: Highly agree – 5; Fairly agree – 4; Agree – 3; Uncertain – 1; Disagree - 1

The table above shows that all six educators indicated that they teach learners with the aim of getting them to pass examinations. On the other hand two educators were not certain if they teach to enable learners to understand mathematical concepts and then use the knowledge for life. Pertaining to the use of the National Curriculum Statement (NCS) for Mathematics provided by the DOE, almost all educators with the exception of one seem not to be teaching according to its principles. This could mean that the educators are battling to come to terms with the National Curriculum Statement (NCS). It is also interesting to note from the table that one educator preferred content-based teaching to context-based teaching while another one was not certain which was her choice, meaning that only four educators actually preferred context-based teaching to content-based teaching. It could be deduced from the above analysis that majority of the educators may be having difficulty in implementing the new mathematics curriculum. The information gathered from the responses is valuable in that an educator's teaching strategy is an indication of an inhibiting factor in providing learners with an effective mathematics teaching and learning. The above results reflect that:

Teaching mathematics is a complex activity because each learner possesses a unique set of experiences and abilities that he/she brings to the learning environment. The educator's role is critical in planning and designing effective instructions for the whole class. There is a wide range of instructional methods available to the educators. Firstly, the educator must decide which theory of learning should inform his or her instructions (Souviney, 1994:34).

Usually educators select from various cognitive theories to determine their own personal approach to teaching and learning that works for them. The selected approach must satisfy the needs of the different ability groups of learners.

Anderson in Souviney (1994:34) suggests that there are two contrasting conceptions of learning. On the one hand, there are educators who subscribe to the receptive-accrual (behaviourist) view, who believe that learners learn by memorizing information verbatim. Failure to learn therefore could be found within the learner. On the other hand, there are educators who believe in the constructivist nature of learning. They are likely to reflect on their teaching styles and methodologies.

Further observation from Table 4.9 is that educators codes switch in order to comply with the Department of Education's (DoE) policy on multilingualism, which states that: "The advancement of multilingualism as a major resource affords learners the opportunity to develop and value their home language, cultures and literacies in our multilingual country and in international contexts, and a shared understanding of a common South Africa" (Department of Education, DOE, 1997:2).

According to Engen, in Booth, Nes and Stromstad (2003:91), one restriction attached to bilingual subject instruction is that a learner's home cultural experiences are ignored, communicating an implicit message that they are secondary value. This may alienate the pupils from curriculum content and reduce motivation. In any case, it will make it difficult for them to interpret, comprehend and articulate their own cultural backgrounds by means of curriculum. Therefore it is the responsibility of the educator to determine the reasons to design and/or structure individual programmes to help different learners.

On the question of what barriers to learning that the educators have identified the following have been identified as being common by the educators:

- language barrier;
- basic numeracy skills; and
- inability to read and understand text.

Setati's (2002) study has revealed how the power of mathematics and English can work together in multilingual mathematics classrooms to reduce mathematical opportunities for procedural discourse. Also for substantial teaching and learning and to engage in conceptual discourse, the learner's main language is required. However, English being international and the master model, it is not always possible to achieve this requirement. In South Africa, English is a language of power of socio-economic advancement and this makes English a valued linguistic resource in multilingual classrooms (Setati, 2002:15).

According to the data collected, the educators indicated that they use a combination of the following assessment methods in their various schools:

- group work;
- individual class work;
- assignments
- learners' portfolio for evidence of work accomplished;
- journals; and
- flexible approach to the use of textbooks.

4.5 FOCUS GROUP INTERVIEWS

The interviews were transcribed verbatim and then analysed using the data analysis technique generated by Tesch (Creswell, 1994:154-155). The following were noted: typical responses which ran through all three different focus groups to the question: "What do you feel when you do mathematics?" was for the first group, "I enjoy mathematics because I like it."

The second group found mathematics boring, especially when they perceived mathematics as an abstract commodity connected with only symbols x, y and z. In their opinion, mathematics needs 'someone who is fast and understands mathematics' (Learner's own words).

The third group felt happy because mathematics was "going to help them find a job". Another common response is that: "Mathematics is boring and the educator speaks only English in which about 70% cannot communicate"; "English is the medium of instruction".

This further affirms the responses of the numeracy and literacy questionnaires items administered by the researcher which deals with language competency.

All the 24 learners (100%) responded to the question: "What makes it difficult or easy doing mathematics?" by indicating that when the educator explains the mathematics problems, then it is easy. If she does not explain but just puts the problem on the board and says, "I will come later to explain the instructions," then it is difficult. It was also clear that another difficulty experienced by the majority of learners is concepts and abstract thoughts involving algebraic symbols like those represented by x's and y's.

When responding to the question, "Who helps you do homework?" only 4 out of 24 learners (16,7%) said they got help from their siblings at home. The majority indicated that they returned to the classroom the following day to ask their peers or educators. Most often, homework was not done or no attempt was made at all because parents or caregivers had no formal education to provide the educational support at home. And if the learners considered the problem too difficult, then none of them bothered to do it. About 60% of learners saw mathematics as the learning of rules and formulae.

The following questions were also put to the learners:

Do you like reading? Yes/No

Explain why you like reading or you don't like reading.

For how long do you read?

How many books do you read in a year?

From the responses of the first group of eight, the researcher concluded that learners do read. However, the learners acknowledged that they read many Xhosa books. They also read books on the learning areas other than mathematics but mostly their prescribed school books. Average reading during is about 30 minutes at a time. They did not specify the number of books read but said they read many. The second group read so they would know more stories.

They read especially during examination time. This implies that less reading is done except during examination time. The third focus group of learners also do some reading but mostly school texts. It can be deduced from the above responses that the reading culture of most learners in all groups seems to be confined to prescribed school books and only if they perceive them to be easy to understand. In addition to that most of the reading is done mostly during examination time.

An indication of learner difficulties that was common to all groups was the inability to cope with problems involving fractions. Almost all learners expressed discomfort with the concept of fractions and the comprehension of its basic principles. The inavailability of calculators was also cited as one of the barriers to doing mathematics by all groups.

In terms of Berg's principle therefore, I concluded that these responses are patterns and not coincidences. The themes that analysis using the constant comparative method yielded can thus be summarised as follow:

- The learners are not interested in mathematics and find it boring.
- The learners find the abstract nature of mathematics difficult.
- The learners see mathematics as necessary to finding jobs.
- The language of instruction is mostly English, which most of the learners cannot understand or speak.
- Little presence of reading for pleasure.
- Reading is regarded as an academic activity.
- Learners need direct instruction.
- Support is mostly gained from peers and educators, not parents or caregivers.
- Fractions pose many difficulties.
- Non-availability of calculators.

The findings in this study suggest that language competency in general may be a barrier to the attainment of higher levels of understanding mathematics. This is supported by the lower achievement in the word problems in the numeracy test. It must be kept in mind though that the numerical components of the word problems were of a higher difficulty level than the ordinary numerical problems and that this could also have contributed to the findings. The learners' interest in mathematics is less than desirable and instruction and effective teaching is very important for successful learning of mathematics.

4.6 FINDINGS FROM RESEARCHER'S OBSERVATIONS

The researcher's observation pertains to the classroom settings in which normal lessons take place in all schools under study. The Table 4.11 below shows the class sizes in the individual schools.

Table 4.11: Class sizes in various schools

School	No in class
High School 1	59
High School 2	49
High School 3	74
High School 4	68
High School 5	42
High School 6	58

Considering the fact that the recommended learner – educator ratio for high schools is 1:35, by the figures shown in the table, the schools are heavily overcrowded. In each school, the learners are seated in groups around a few desks (for the purposes of group work) with barely any space among the desks to facilitate movement by either the educator or the learners themselves. In fact in some of the classrooms, the educators had barely any space to stand and write on the chalk board. This situation severely limits the educators' ability to move around and offer help to learners. It also restricts learners' movements in the class. Even though evidence was not collected in this study on learner's independent work in view of this overcrowding, it may be fairly intimated that it could also be severely affected. A possible consequence of the situation could also be learners copying from one another.

4.7 SUMMARY

In this chapter the findings were summarized, recorded and analysed. The analysis involved noting the most salient findings and examining how the findings relate to literature. In the final chapter a conclusion is provided that summarizes the research, describes the main research findings and offers recommendations for further research.

CHAPTER 5

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

5.1 INTRODUCTION

This chapter provides a summary of the findings, conclusions and recommendations.

The aim of the study was to attempt to answer the following question: "What are the barriers that Grade 8 learners in rural secondary schools in the Eastern Cape face in learning mathematics?" The specific objective of the study was to identify the nature of some barriers in the effective learning and teaching of mathematics in a rural area of the Eastern Cape.

The study used quantitative and qualitative methods to examine barriers that Grade eight mathematics learners experience in learning mathematics in rural secondary schools in the King William's Town school district of South Africa. Data was collected by means of questionnaires, focus group discussions and observations.

The study examined on the following aspects:

1. Learners' competency in numeracy and literacy.
2. Biographical questions which yielded information on family structure, educational history and literacy levels of caregivers.
3. The educator questionnaire yielded information on their qualifications, their major teaching subjects, curriculum changes, the proximity of the educators to school and learners, and the membership of educator professional associations.

The most important findings of the study are summarized under the following headings, namely: Numeracy and Literacy competence, inadequate support from home and school, proximity of learners and educators from school and the background of educators, classroom setting and membership of professional associations.

5.2 SUMMARY OF FINDINGS

The following themes came to the fore in studying the findings as described in the previous chapter.

5.2.1 Numeracy and literacy competence of the learners

The results from the numeracy and literacy test revealed that learners in the research area lack number sense and understanding of mathematical text. It will be recalled that the educators surveyed in this study also identified the lack of numeracy skills and the inability to read and understand text as some of the learning barriers faced by their learners. Furthermore, the focus group discussion confirms that majority of the learners do no reading besides their prescribed school texts and in particular, find the reading of mathematics textbooks boring. It can be argued that if learners find mathematics textbooks boring and therefore shun away from reading them, then they will be impaired in their understanding and use mathematical language. From the findings, the researcher would want to infer that learning mathematics in the rural schools involved copying educator demonstrated skills and doing algorithms from the chalkboard with little attempt to enrich their mathematical language through further reading and playing with numbers. In the case of the learners in this research, relying sorely on the educator has its own ramifications in the light of the revelations from the educator questionnaire that few of the latter has training in teaching mathematics. It was also found out that some educators were struggling to cope with the National Curriculum Statement and as such might not be effective in their teaching of mathematics. If the same situation prevailed at the lower levels of the learners' mathematical education, then they are likely to be handicapped in their numeracy skills and understanding of mathematical texts.

Learning the language of mathematics is just like learning a language naturally: effective teaching requires immersion in a culture that speaks and uses the language. Children learn to read and write not solely because of their language arts instruction in school, but equally because of the reinforcement provided by other school subjects and their environment at home. Where reading and writing are not reinforced at home, the progress of learning is much slower (Steen, 1990:9-10). He further contends that numeracy is rarely stressed at school or at home. Parents, coaches, and educators of other subjects hardly make the effort to involve learners in activities that make use of mathematical or statistical methods. "No matter how effective mathematical instructions may be in school – and to be honest one must admit that it often is quite ineffective – it will have little lasting value unless learner motivation and experience is reinforced by extensive contact with mathematical, geometrical and statistical ideas in other environments" (Steen, 1990:10).

As pointed out earlier, the numeracy test revealed that number sense is not well developed in the learners and that they were lost with such numbers. This inability to write large numbers was evident in the responses they offered, for example to the following problems: " Find the next three terms of the sequences:

200; 250; 300; 350; ....; ....; ..... (success rate 51.4%)

900; 920; 940; 960; ....; ...; ...; ... (success rate 36%)

2500; 2550; 2600; 2650; ...; ...; ...; ....(success rate 39.7%)

This finding indicates that the learners had already developed gaps in the mathematical understandings during their primary school years, as the development of these skills are part of the curriculum in grades lower than grade 8.

Regarding fractions, both educators and learners indicated that it is a problem area. This is confirmed by the learners' performance in the test administered during the study. It is possible from the test result that learners who regard the tenths, hundredths, and thousandths as separate entities have had very little or no exposure to the idea that tenths can also be hundredths, and so on. That is why they could respond that 3,6 is bigger than 3,75. "Because tenths are bigger than hundredths" The learners do not realize that 0,6 is equivalent to 0,60.

The tests further revealed that the learners have misconceptions about multiplication and division. According to Muijs and Reynolds (2005:214), learners believe that multiplication makes things bigger, while division always makes things smaller. Therefore, the learners chose to incorrectly apply division or multiplication based on their perception of whether numbers needed to become smaller or bigger.

It would thus seem as though necessary skills that should have been attained during the Foundation and the Intermediate Grades in mathematics are not available to these grade 8 learners. This is a significant barrier to learning of Mathematics. Therefore, educators need to turn their attention to the findings of research into effective teaching practices in order to address the barriers regarding numeracy skills.

Although a certain percentage of learners will understand a mathematical concept despite a poor educator, most learners will only develop in an atmosphere created by caring and knowledgeable educators (Brahier, 2005:11).

5.2.2 Inadequate support from home and school

Parents or caregivers themselves are incapable of supporting the learners at home with their mathematics since more than 66% of them have no formal education. Consequently, the learners rely on their peers and educators for learning support. It is however noted that parent or caregiver support is not limited to helping a learner solve mathematical problems but also includes supervision during homework. It also involves providing nutrition, learner support materials and guidance to the learner. According to Bennett (1996:163) many research studies emphasize that learner achievement improves when parents participate in and support their child's academic environment. Parents should be linked to the schools at all levels of their children's education – their involvement should not cease at the bus stop or at the door of the school house.

However, there are several reasons why parents may not be involved in schools. Parents may view schools as unsupportive and unhelpful because they themselves have experienced failure in the mathematics classroom. Moreover, parents see their children's unsuccessful experiences as their own. Parents who dropped out of mathematics or school may not feel comfortable in the school environment (Bennett, 1996:164). Besides this, parents or caregivers who do not have regular streams of income may use all their time doing odd jobs and therefore have little time to spare in their children or wards education.

5.2.3 The distance of learners and educators to schools and the background of educators

When both the educator and the learners live far away from the school, learners do not have the opportunity to interact sufficiently with the educators. This could be a barrier to their effective learning of mathematics.

The educators' lack of specialized training in mathematics and mathematics education might make them feel that they are not sufficiently competent to teach Mathematics. They are compelled to teach Mathematics because they need to earn a living. In addition, their teaching roles are greatly constrained by having to work with very large classes and inadequate learning and physical resources.

5.2.4 Classroom settings

Learners are so cramped in the classrooms that there is the temptation or possibility of copying each other's work. When this happens, it inhibits their ability or chance of working independently. Educators are also unable to interact readily with individuals and/or groups. The manner in which seats are arranged, the proximity of learners to the educator and the position of the educator in relation to the class or group, all shape and influence the nature of the interactions within the classroom. Sommer's work in Hitchcock and Hughes (1989:182), demonstrates the relationship between levels of participation and the seating arrangement in the classroom. It may therefore be deduced that overcrowded classrooms are not conducive environments for effective teaching and learning.

5.2.5 Membership of professional associations

Membership of professional associations by educators is a great tool for educator development. The research findings have revealed that educators are interested in Mathematics associations because they provide them with a learning environment. Berg (2004:312) agrees that professional meetings can be edifying – not only for the content of the papers presented but also because these meetings can build confidence and a sense of competence. Yet some educators sometimes consider it a waste of their valuable time to have to attend courses and workshops during weekends and their time offs.

5.3 CONCLUSIONS

From the findings of the study the following barriers towards learning of mathematics were identified:

- The learners exhibited attitudinal barriers towards learning mathematics. They do not make serious attempts to solve the problems once they encounter difficulty.
- The educators lack the mathematics competencies to handle their classes. They still teach instrumentally in the way they were taught, which constitutes a barrier to the learning.
- The educators' interaction with the learners takes place only in the classroom time. The interaction between educators and learners is extremely limited.
- There is a lack of a reading culture among the learners.
- Learners experience difficulties in comprehending mathematical texts because of inadequate vocabulary and reading skills.
- Learners experience a lack of support in their home environments.
- Basic and prerequisite numeracy skills do not seem to have been acquired at the necessary level in earlier grades.

5.4 TENTATIVE RECOMMENDATIONS

The following are tentative recommendations that the researcher feels may benefit educators, parents, learners and Department of Education, Eastern Cape.

5.4.1 Recommendations for educators

- They could make an effort to educate themselves on new trends in teaching methodologies by making use of modern literature. Many schools are caught in a cycle of traditional ways of thinking and acting and so should be made aware of changing theories and new ideas that will accommodate the modern learner. They should also work collaboratively with senior mathematics educators to guide them through their work.
- Conferences and workshops are held regularly in the King William's Town/Bisho school district and would benefit the educators through sharing ideas with other colleagues in an attempt to revise out-dated strategies of teaching mathematics.
- They should use a consistently open-ended teaching approach, accepting alternative views, leaving issues open, and encouraging independent enquiry and participation. As Lewis and Stuart (1991) argue, lack of competence in English is a major reason for students' silence in class, and that it militates against the effective use of higher cognitive skills.
- They should use learner-centred activities, like discussion, research, reading and reporting to create an environment that is conducive to open and independent learning. A combination of different methods in a stable pattern will provide a good framework for teaching and learning.

Steen (1990:14) offers the following suggestions that would improve numeracy:

- "Don't teach just arithmetic. Numeracy requires a rich blend of statistics, geometry and arithmetic catalyzed by careful reasoning rooted in common sense.
- Don't rely on worksheets. Students learn best in active contexts featuring discussion, writing, debate, investigation and co-operation. Isolated facts on artificial worksheets reinforce the image of school mathematics as totally artificial, unrelated to real life.
- Don't ignore calculators. Children must learn many ways to calculate – manually, mentally and electronically – in realistic contexts that reflect the world around them. Calculators are part of that world and should be part of school mathematics.
- Don't rely only on school. Children are influenced as much by the entertainment and sports industries as by formal school instructions. There is much that those industries could do to promote both numeracy and literacy.

- Don't use just short-answer tests. Assessment instruments strongly influence the shape of instruction and learning. In numeracy, just as in literacy, formulation and expression are as important as "an answer." Tests should reveal how students think, not just what they know.
- Don't depend only on mathematics. Although numeracy may be taught in mathematics classes, to be learned effectively, learners must use it in a wide range of contexts at school and at home, including entertainment and sport.

Steen (1990:15) also says we cannot define or measure numeracy; we can only improve it. Especially in an age of computers, we really must take steps to improve the level of numeracy in all segments of society. With numeracy comes increased confidence and the ability to gain control over their lives and jobs. Numeracy provides the ability to plan, to challenge and to predict; it reveals the power of reason and unlocks the language of nature.

- Mathematics teaching should link the schools and the communities learners are from.
- Mathematics teaching must be based on real-life situations.
- Educators must refrain from teaching as an attempt to deposit knowledge in the learners through direct instructions. It would be more beneficial to adopt the constructivist perspective (Donald et al., 2002:99).

5.4.2 Recommendations for the caregivers

Caregivers serve as a crucial link to their children's movement through the mathematics machinery. Schools must find a vehicle to support and promote this partnership. Caregivers' involvement in learners' work will be a motivating factor for learners. Even if the caregivers themselves have no formal education, their mere concern and involvement in the learners' work will stimulate their interest and the learner's performance.

5.4.3 Recommendations for the Department of Education, Eastern Cape

The researcher's observations and visits to the schools clearly revealed that the infrastructure in rural secondary schools needs to be improved. The Eastern Cape Provincial Government should provide the necessary educator and learner support materials and ensure that there are appropriate mathematics educators in the schools.

Academically competent and skilful mathematics educators must be posted to rural schools. There should be free and decently-furnished accommodation for rural mathematics educators to entice them to accept posting to those areas. Mathematics educators must also be paid special rural allowances as incentives. Article 36, Limitation of Rights of the South African Constitution (1996) can be invoked to effect these recommendations.

Learners must be provided with free and compulsory Mathematics education. Remuneration of mathematics educators should attract prospective educators. These recommendations may seem too ambitious and expensive. However, big businesses operating in the country should see the importance of providing funding: the future of this country and its business interests depend on our schools being able to produce men and women who can use mathematics and mathematics-based disciplines.

If a mathematics educator is performing excellently and producing future mathematicians, he or she should be given sufficient financial reward to remain in the classroom and not be tempted to move into an administrative post. He or she can be promoted to the rank of a headmaster or subject advisor but remain in his/her school and in the classroom.

The only difference between a teaching headmaster and a non-teaching headmaster is an allowance (a little extra) that one receives for being head of a school. The remuneration for all headmasters will be the same except the one who is doing administrative duties will receive one notch over and above the teaching head.

The practice of promoting educators to fill positions which are unrelated to their subject disciplines should cease. There are instances in the field where educators who have majored in the humanities are heading Mathematics and Science departments. This practice demoralizes mathematics educators in the field as well as prospective ones. The point is what academic or professional support can such heads offer those teaching under them?

The Department of Education can consider building larger schools and provide accommodation to both educators and learners on campuses to cut down on learner absenteeism and truancy. They must also provide transport for the rural learners to be able to get to their schools on time. Everything should be done to encourage a reading culture. The availability of books cannot be over emphasized since it is a key factor in developing literacy. The highest achieving countries typically provide their learners with greater access to books in the home, in nearby community libraries, bookshops, and in the schools. Mobile libraries should be used to visit rural schools fortnightly where there are no nearby community libraries.

Essay writing competitions can be organized on a regular basis to encourage a reading culture in the schools. According to Warwick (1992:11), voluntary out-of-school book reading has a positive effect on learners' achievement levels.

Every building has a solid foundation. The foundation stone is laid before other structures are put in place, and finally the roof is put on the building. Therefore it will be a fruitless exercise to continue to dwell on matriculation intervention classes to increase the pass rate of the matriculation examinations without providing the necessary support in the foundation and the primary phases of learners' mathematics education.

There is a need to discourage a pervasive myth about the learning of mathematics. Mathematics is not only for a select few who are destined for mathematical careers. Every learner should study Mathematics of some kind at school. This has been addressed in part by introducing Mathematical Literacy as a learning area for grades 10, 11 and 12 and the fact that either Mathematics or Mathematical Literacy is compulsory up to grade 12.

To get everyone interested to know and speak the "language of mathematics", we must use games, pictures, stories, television adverts, etc. to get everyone, learners, parents and grandparents to speak the language of mathematics. This will help to stimulate interest in mathematics of the populace and future generations. Get the multinational big companies involved – after all, they stand to reap bigger profits from greater interest and competence in mathematics.

5.4.3 Recommendations for further research

This was a small scale study conducted in the King William's Town/Bisho area. Further research needs to be done on a broader scale to include more schools and more educators from greater rural background.

If more schools were to be added to the research, one would gain a more representative sample. A larger scale study will be more reliable and the results from such a research would have greater implications for educators on a broader level.

The researcher would recommend further research throughout South Africa in order to gather more conclusive results. Such a study would help in identifying what exactly is occurring in South African rural schools.

5.5 LIMITATIONS OF THIS STUDY

- The preferred language of the participants of this study was not necessarily the same as the researcher's mother tongue. This meant that a translator had to be used, and the meaning of some responses may have been altered in the translation process.
- The researcher realises that the numeracy test (questionnaire) would have been improved if language editing could have happened before the test were administered. The removal of some linguistic ambiguities could have lead to different understandings by the learners, and thus possibly to different findings. As the fieldwork was already completed at the time, it was felt ethical to attach the original questionnaire as Addendum C.
- The environment in which learners completed the written test was not ideal, and this could have impacted on the validity of the results.
- Invigilation by the researcher himself in overcrowded classrooms could have negatively affected the validity of the test results.
- The clustering of data was done from only three groups, which could have affected the validity of the findings.
- The fact that notes were being taken during the interviews could have been experienced as distracting. This could have impacted on the validity of the findings.
- The researcher did not obtain the learners assent in carrying out this study. At the time the researcher embarked on the study, it was not a requirement. If the researcher has to work with learners in a study in future, he will definitely ask for learners assent.

5.6 FINAL WORD

We live in a world in which mathematics is basic to most manufacturing and many other services. Addressing the barriers to learning and teaching of mathematics in rural Eastern Cape schools will hopefully continue to brighten the personal career paths of those who have to apply the skills. Dealing with the innumerable barriers that learners experience in learning mathematics, is a calling for all role-players in the education field and supporting these learners is an ongoing process which must have the highest priority in South Africa.

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ADDENDUM A – AUTHORISATION LETTER FROM EDO TO CONDUCT RESEARCH

Province of the Eastern Cape

DEPARTMENT OF EDUCATION
ISEBE LEZEMFUNDO
DEPARTEMENT VAN ONDERWYS

Private Bag X0032, BISHO 5605, SOUTH AFRICA

Reference: Enquiries: Mr A.T KOLITI Tel: 043-642 5866 Fax: 043-642 5896 Date: 24 NOVEMBER 2004

TO: MR LYT SAO
FROM: CES MANAGEMENT AND GOVERNANCE
SUBJECT: REQUEST TO CONDUCT EDUCATIONAL RESEARCH IN SELECTED HIGH SCHOOLS IN K.W.T DISTRICT
DATE: 24 NOVEMBER 2004

The above matter refers:
Permission is hereby granted to conduct educational research in the grade 8 classes as requested.
We hope that the findings and recommendations will benefit this district and these schools.
The selected schools will be as well informed by our office.
You are further directed to work closely with the EDOS of these schools as well.
Thanking you anticipation.
Yours faithfully

A.TKOLITI
CES-MANAGEMENTANDGOVERNANCE

ADDENDUM B –

BIOGRAPHICAL QUESTIONNAIRE FOR LEARNERS

QUESTIONNAIRE FOR GRADE 8 LEARNERS OFFERING MATHEMATICS IN RURAL HIGH SCHOOLS IN SELECTED SCHOOLS IN THE EASTERN CAPE PROVINCE

Instruction: Supply the correct information to the following questions in the questionnaire.

A. General Information

1. Name:
2. Sex: Male Female
3. Name of Location
4. Age last birthday
5. Educational background of parents/guardians

Parent	Junior cert.	Matriculation	Tertiary	Other
Father				
Mother				
Foster parent				

6. What is the occupation of your father?
7. What is the occupation of your mother?
8. What is the occupation of your caregiver?
9. How far is your home from your school? km
10. If you are 15 km from school what is your mode of transportation to school?
11. How many are you in your family?
12. Who is the head of your family?

B. Attitude towards mathematics

1. Tell me about your mathematics by completing the following:
When I do mathematics, I feel
When I have to do a difficult mathematics problem, I

I sometimes get sums wrong because

2. When you add any uneven number to any uneven number, what will you get?

Will you obtain the same answer always?
Explain why you think so

3. Three friends who share a flat decided to split a R70 food bill amongst them, taking into account the number of meals eaten at home. They agree to split the bill in the ratio of 2: 3: 5. How much does each pay?

4. A pair of shoes costing R300 is for sale at R225. By what percentage has it been decreased?

5. The annual electricity bill for heating water in a small home is R30 per month. The annual cost of heating the same home using solar heating is R20 per month. If a new home is built, the cost of installing an electrical heating system if R450 whilst the solar heating system cost is R750.

Complete the following table based on the above information.

Months (t)	0	1	2	3	4	5	6
Cost of electrical heating (A)	450	480	510	540	570	600	630
Cost of solar heating (B)	750	770	790	810	330	850	870

How much will be spent on electrical heating after 12 months? How much would be spent on solar heating after 12 months?
Which heating system would you prefer? Give reasons for your answer
Thank you very much

ADDENDUM C –

LITERACY AND NUMERACY TEST FOR LEARNERS

NAME OF SCHOOL: DATE:

NAME OF LEARNER: CLASS:

This information is for administrative purposes only. The school and the learner will not be identified.

INSTRUCTIONS TO LEARNERS

This exercise is for research purposes only.

Answer all questions. Write clearly in PEN not PENCIL.

Feel free to use any method you think is necessary. Any method used must be clearly written down or given as a drawing or sketch in the spaces provided on the question paper.

CALCULATE:

1. 37 + 8

2. 83 - 58

3. 27 x 5

4. 56 / 3

5. 798 + 312

6. 238 x 17

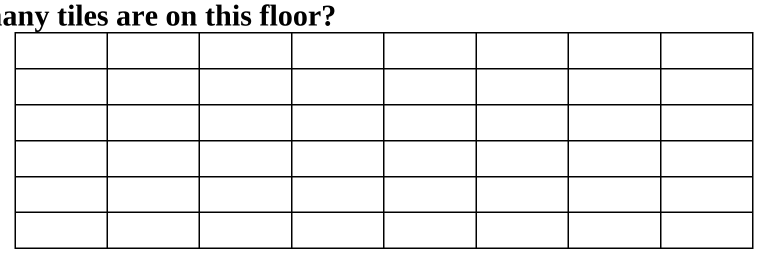
7. 810 / 18

8. **Fill in the missing numbers:**
   200; 250; 300; 350; ……; ……; ……; ……

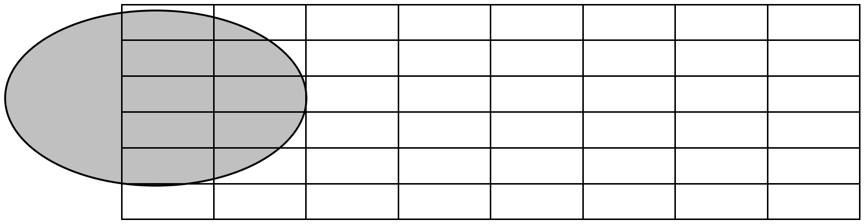
9. 900; 920; 940; 960; ……; ……; ……; ……

10. 2 500; 2 550; 2 600; 2650; ……; ……; ……; ……

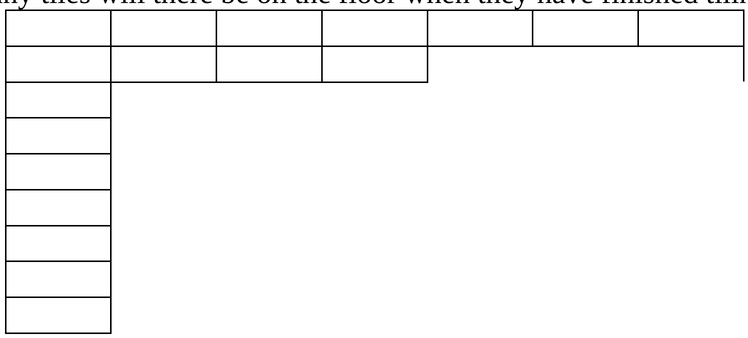
11. **How many tiles are on this floor?**



12. **How many tiles are on this floor (also under the mat)?**



13. How many tiles will there be on the floor when they have finished tiling this floor?



14. The farmer plants 9 rows of pear trees in his orchard. Each row has 8 trees. How many trees does he plant in his orchard?

15. Which is bigger: ½ or 1/5 of a cake? Why?

16. Which is bigger: 2/3 or 3/6 of a cake? Why?

17. Which is the biggest: 3,47 or 3,6 or 3,3762? Why?

18. Provide the missing numbers:
0,4; 0,6; 0,8; ……; ……; ……; ……

19. 3,8; 3,85; 3,9; .....; .....; .....

20. Calculate
5,43 + 0,1

21. 4/5 + 2/3

22. 7/8 / 3/5

23. 20% ofR500

24. Lulu uses 2/3 of a metre of material to make a T-shirt. She has 10 metres of material. How many T-shirts can she make?

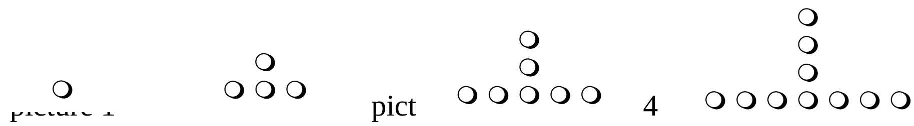
25. 810 people want to go to a soccer match. A bus takes 50 people. How many bus trips do we need to transport the 810 people to the match?

26. A radio costs R800. If you pay cash, you get 5% discount. John pays cash. How much does he pay for the radio?

27. Thabo walks ¾ km a day from his home to school. How many kilometers does he walk in 5 days?

28. Luya has to calculate 37 / 0,5. which of the following answers is correct?
740 74 7,4 0,74 0,074

29.



a) How many dots will there be in picture 5?
b) How many dots will there be in picture 10?
c) How many dots will there be in picture 20?

ADDENDUM D –

QUESTIONNAIRE FOR EDUCATORS

QUESTIONNAIRE FOR GRADE 8 MATHEMATICS EDUCATORS IN SELECTED SCHOOLS IN THE RURAL AREAS OF THE EASTERN CAPE PROVINCE

1. Name: .... Sex: ....

2. Number of years teaching grade 8 mathematics: ....

3. Complete the following:

Last Institution		
Highest Degree/ Certificate/Diploma awarded		
Year		
Major Subjects		
In-service training attended		
In-service training in Mathematics	**Topics discussed**	**Year**
	Awards given	**Year**

4. How do you evaluate in-service training for Grade 8 educators?

   (a) Annually

   (b) Once per Semester

   (c) Quarterly

   (d) Bi-monthly

   (e) Monthly

5. Do you fancy an association of Grade 8 educators?

   Yes / No.

6. Give reason(s) for your choice

   ....

   ....

7. What do you think should be some of the areas that should be discussed during meetings of such an association?

   ....

   ....

8. How close are you to the learners after school (if not living in the same location with learners)

   ....

9. Which teaching style in mathematics do you envisage to be the best?

   ....

10. Give reasons for your answer

    ....

11. Do you encourage a flexible approach to typical textbook problems?

    ....

12. Give reasons for your position

    ....

How would you consider the following case scenario?
Child A gets the answer of a sum correct but does not go through the various step for the answer. Child B on the other hand gets the answer wrong only at the end of the various steps and procedures.

13. Who do you think has performed better?..

14. Give a simple explanation for your choice ....

    ....

15. Is your mathematics teaching culturally biased or environmentally friendly?

    Yes / No

16. Elaborate ....

17. In solving problems do you encourage the learners to use your own strategy or their preferred strategies?

    (i) Mine (A)
    (ii) Learners' own strategy (B)
    (iii) Both A and B
    (iv) Not quite sure of the strategy

18. What is your preferred medium of instruction used in teaching mathematics?

....

19. If the medium (above) is different from the one been used in the school, how do you evaluate your medium of instruction?

(a) excellent
(b) very good
(c) good
(d) fair
(e) bad

20. Which of the following assessment styles do you adopt? Tick all applicable ones.

Group work	
Individuals	
Assignments	
Portfolio	
Journal	
Others (specify):	

21. How do you get your learners motivated? ....

....

22. How do you see the nationwide use of one mathematics textbook?

....

....

23. How do you see OBE in mathematics teaching?

....

24. Answer the following questions. On a scale of 1 to 5; where 5 denotes the highest agreement to a given statement.

5	4	3	2	1
Highly agree	Fairly agree	Agree	Uncertain	Disagree

	Rating Scale
I teach mathematics with the aim of getting all learners to pass the examinations.	
I teach the learners so that they understand mathematical concepts and then use the knowledge for life.	
I teach using mainly the revised National Curriculum Statement (RNCS) for mathematics given by the Department of Education.	
I teach according to the given RNCS for mathematics (not necessarily complete it) but use suitable local examples.	
I prefer context based teaching compared to content based teaching.	

What barriers do you think learners in Grade 8 experience in learning mathematics?

....

....

How do you address these barriers?

Thank you very much

ADDENDUM E –

FOCUS GROUP INTERVIEW QUESTIONNAIRE

FOCUS GROUP INTERVIEW: QUESTIONNAIRE

1. What do you feel like when you do mathematics?
2. What makes it difficult/easy in the classroom when you do mathematics?
3. Who helps you do mathematics?
4. What do you feel when you get a difficult mathematics problem to do?
5. Do you like reading? Yes / No?
6. Explain why you like or you don't like reading?
7. For how long do you read?
8. How many books do you read in a year?

ADDENDUM F –

RESPONSES FROM FOCUS GROUP INTERVIEW

FOCUS GROUP INTERVIEW: QUESTIONNAIRE (Responses)
GROUP 1(Interview conducted in English)
What do you feel when you do mathematics?
I enjoy mathematics
I enjoy because I like it.
What makes it difficult/easy?
When the educator does not explain the instructions
Difficult when the time is limited/small time period.
The educator does not explain how to do the problem
Just puts the problem on the board and says I will come later to explain
Concepts and abstract thoughts like variables represented by x, y, z, etc.
Easy when more focused on the problem and listen carefully.
Fractions
Who helps you do maths?
At home my brother
At home my father
Classmates help me
Stay with my grandma.
At home my parent not well educated
I come to school and ask my friends
If it's difficult, I do not do it.
Educator does not explain it to us
It's difficult I just do not do the work and come the following day to ask my educator.
Do you like reading?
I like reading especially my school books because that is where I get information from.
Knowledge is power so when I read I get the information I want.
My mother, my grandmother and my father are ex-educators so there is no way I will not read.
For how long do you read?
It depends on the book.
If I am enjoying it I can read until I finish the book.
Read for about 30minutes.
I don't like reading maths books but I read books on the other learning areas.
I read every book I can find.
I read a lot of xhosa books
I don't count but I read many books.
GROUP 2(Code-Switch :English/isiXhosa)
What do you feel when you do maths?
Maths is boring.
Maths needs some one who is fast to understand maths
Boring because educators do not explain things to us.
I like maths because if you want to find a job, you need maths.
What makes it difficult/easy?
Boring because the educator speaks English all the time and I find it difficult to follow English because I don't know English.
I like maths but the educator does not explain.
Maths is alright but when it comes to x, y, z etc then I get lost, I do not know what to do.
It's difficult because we don't have calculator to use.
Fractions

Who helps you do maths?
When I go home I ask some senior grade learners say grade 10, 11,or 12 at home to help me.
Or I come back to the educator
No one to help me at home
When it's difficult I get bored, but I try to do it.
I go home to practice if I don't understand it I come back to the educator
Do you like reading?
I like to read mostly prescribed school books because I want to know more stories.
I like to read for 2 hours.
I like to read especially exam time
I read my school books.
Group 3 (Responses in isiXhosa)
What do you feel when you do mathematics?
Feel happy because maths is going to help me to find a job.
Happy, it's easy because I can go out to do nursing.
Happy because you cannot get a job if you do not know maths.
Feel happy if I understand the formulae
Like maths sometimes finds it boring because the educator does not explain it properly.
What makes it difficult/easy?
Fractions
Can handle the maths alright but when it involves x, y, z abstract concepts get confused
Cannot grasp the concepts
Some of the mathematical terms cannot be put in xhosa- even the educator.
Lack of equipment like calculators
Easy because have text books
Need an experienced educator who knows maths.
When they do not understand they work in groups to teach themselves.
Do you like reading?
Read mostly only prescribed school books
Like writing not reading especially in front of the class get nervous.
Can read and read if the book is exciting if not will stop and do something else.
Reads for 2 hours and take a break.
If she does not understand something she continues to read until she understands it.
Otherwise, will stop and do something else.
Take a long time to read a book sometimes 3 to 4 months.
Who helps you do maths?
Will not do home work if he does not understand
No one at home to help.

ADDENDUM G -
LETTER OF REQUEST FROM PARENTS TO INVOLVE LEARNERS IN RESEARCH

CONSENT LETTER: ENGLISH/XHOSA

Parent/Guardian,

I am currently conducting research for my Masters Degree in Specialized Education at the University of Stellenbosch. The research is on the Barriers that Grade 8 Learners identify in a Rural Secondary school in learning Mathematics.

Two tests will be administered:

1. On testing factual Mathematics knowledge.
2. A biographical test.

It is aimed to conduct both these tests with a number of Grade 8 Learners to determine whether their rural circumstances have any influence on their studying Mathematics. Written consent will also be obtained from the Eastern Cape Department of Education. Should you give your, consent, your child would be asked to complete the tests during school time.

The sessions will take approximately 30 minutes and would take place on the school premises. Be ensured that complete anonymity is assured. And no information obtained for research purposes will be able to be related to your child in his/her personal capacity.

Arrangement for the specific day will be made with your child's school and educator. Please be so kind to complete the attached form, and return to the mathematics educator. Should you at any time need to contact me, I may be reached at: 0824381513.

I thank you in advance for your cooperation.

Yours sincerely,

STUDENT: L.Y.T.Sao

M.Ed (Specialized Education)

Tear off on the dotted line

....

✂

Mr/Mrs/Ms

Consent to Mr. L.Y.T. Sao to carry out research on my child.

SIGN DATE .

ILETA YEMVUME MZALI

Ndenza uphando kwizifundo ze Masters Degree in Specialized Education kwidyunivesithi yase Stellenbosch. Uphando olu lungemiqobo neenzima ezithi zifunyanwe ngabafundi bebanga lesithandathu (grade 8) kwizikolo ezisemaphandleni xa befunda iMathematics. Kuya kubhalwa uvavanyo kule miba ilandelayo:

1. Ulwazi ngeMathematics
2. Izinto ezinxulumene nomfundi buqu.

Olu vavanyo luyakwenziwa kubafundi abaliqela bebanga lesithandathu (grade 8) ukuze kuqinisekiswe ukubangaba iimeko zasemaphandleni zinefuthe kusini na ekufundeni kwabo iMathematics. Imvume ebhaliweyo iya kuthi ifunwe kananjalo kwiSebe LezeMfundo laseMpuma Koloni malunga nokuqhutywa kolu phando. Xa uthe wamvumela umntwana wakho, uyakubhala uvavanyo ngexesha lesikolo.

Isigaba ngasinye sovavanyo siyakuthabatha imizuzu engamashumi amathathu kumasango esikolo eso afunda kuso umfundi. Ndiyakuqinisekisa ukuba abafundi abathatha inxaxheba abasayi kusebenzisa amagama abo. Inkcukacha ezifunyanwa kolu phando azisayi kumchaphazela nganto umntwana wakho. Izigqibo ngosuku lovavanyo ziyakwenziwa nesikolo notitshala womfundi.

Uyacelwa ukuba uzalise eli phepha kule ndawo yempendulo uze ulibuyisele kutitshala we Mathematics.

Xa unqwenela ukunxibelelana nam nangaliphi na ixesha ndakufumaneka kule nombolo: 0824381513.

Ndibulela kakhulu ngentsebenziswano yakho.

Ozithobileyo

Umfundi: L.Y.T. Sao

M.Ed. (Specialized Education)

IMPENDULO:

Yenza uphawu olufanelekileyo ebhokisini engentla.