THE MATHEMATICS EDUCATION OF YOUTH AT-RISK:

NELLIE AND WISEMAN

Sheena Rughubar

Master of Education

(Mathematics Education)

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Supervisor: Dr Renuka Vithal

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ABSTRACT

This study examines the mathematics education of youth at-risk in South Africa. It explores how two learners at the margin understand and perform in mathematics in two radically different educational environments. It also examines what provisions, if any, are incorporated into the mathematics curriculum to accommodate these pupils. One of the research participants attended Thuthukani, a residential school for youth at-risk and the other was based at Sanville Secondary, a mainstream school. The differences between the two contexts were in the scarcity of resources, limited space and class sizes.

The qualitative case study, which was the preferred method of choice, was carried out in two stages. Observation of learners at the residential school was stage one. Stage two was the observation of a learner at the margin in a mainstream school. Observations were captured through audio and visual recordings and photographs. Pupils' written reflections and workbooks, combined with the information acquired through interviews, informal discussions and a research diary, supplemented the instruments to produce a rich data for analysis.

The analysis suggests that each of the components of this study, namely: the educational environment (context), the mathematics curriculum, the teacher and the learner at the margin influence the teaching and learning in the classroom. The study concludes with the researcher's recommendations on the mathematics education of learners at the margin.

DEDICATION

THIS STUDY IS DEDICATED TO

My father

MAHASWARDUTT RUGHUBAR (1925 – 1992)

A humble man

Whose love and belief in me

Provided my strength in adversity.

AND

My maternal grandmother

HIRANJI BUDREE (1916 – 1997)

A gracious old lady

And avid reader

Who inspired my life through her wisdom.

ACKNOWLEDGEMENTS

Kind words can be short and easy to speak, but their echoes are truly endless.
...Mother Teresa.

I did not actually realise what was meant by: *'reading for a degree'* until I embarked on the Masters degree in Education. There were stressful times when I was ready to give up on the study. However, through the support and encouragement of the motivating souls around me, I was able to complete this report. To these special people I wish to express my sincere thanks.

To Dr Renuka Vithal, for encouraging me when I was on the brink of quitting and providing in-depth training in and the understanding of the nature of educational research.

To my dearest husband, Deon, *'the air beneath my wings'* for providing me with his love and time to see this report to the end. To our darling daughters, Sanusha and Virata, for their patience, computer expertise and the provision of *'delightful snacks'*. To my mum, Prem, for being there, through the difficult circumstances in my life. To my niece, Upasana Srikissoon for assisting in locating Nellie for the study. To my sister-in-law, Harsha Kathard for listening to all my grievances and identifying with me.

To Mr K.S.Naidu for accommodating my data collection schedule. To the teachers and learners at-risk at Thuthukani and Sanville Secondary who made this study possible through their cooperation and acceptance of my intrusion into their lives. To the Administrators of the Thuthukani and the Principal of Sanville Secondary for affording me the opportunity of to collect data at the two sites.

To Nyna Amin, for providing me with the readings on youth at-risk and invaluable comments on my work in progress. To Les Moodley and Ranvir Singh for their computer expertise and time sacrificed to assist me in this regard. To Joan van Niekerk, at Childline, for allowing me the use of all her information on "street children". To the National Research Foundation for funding my research.

DECLARATION

I, Sheena Rughubar, declare that this dissertation is my own work, carried out in the Department of Education at the University of Durban-Westville and has not been submitted previously for any degree in any form at another university. This study was completed under the careful supervision of Dr Renuka Vithal. The work of others, when used, has been duly acknowledged in the text.

Rughubar

Researcher

Supervisor

“If” for Teachers

If you can see your students
as diamonds in the rough,
Inspiring them to do their best
and not just good enough.
If you can open doorways,
light sparks and keep them glowing
And see the love of learning
as seeds that you are sowing.
If you can keep on caring
and remember why you teach,
You’ll give your students wings to fly
and show them stars to reach.

Author : Unknown

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CHAPTER 1

INTRODUCTION: GETTING CONNECTED

The night is dark and I am far from home...lead me on.
- *Sai Kiran.*

1.0. INTRODUCTION

In July 1999, the University of Durban-Westville joined forces with the Department of Health and Welfare to set up the Thuthukani Harm Reduction Centre, a residential shelter for youth *"at-risk"*. While the Department of Health and Welfare took on the onus of providing food, clothing, shelter and medical services, the university undertook to set up a school at the shelter to cater for the educational needs of the youth. The school project was headed by Dr Cheryl Smith, who was the deputy dean of education at the university at the time. Ms Julia Zungu, a social worker and then co-ordinator of the Street Children's Forum in Durban, was in charge of the shelter. As the goal was to get the school operational without incurring expenditure, the school was first manned by student teachers, and then volunteer teachers. My interest in the learners at the school was stirred when I was introduced to Thuthukani by Dr Renuka Vithal, a lecturer in mathematics education at the university. As a master's student, I was required to conduct research in part fulfilment of the degree. Thuthukani afforded me the opportunity to conduct the first part of the research project. I became interested in how the children at Thuthukani experienced mathematics in the classroom. My intention was to follow a group of learners from the classroom of this residential school into the classroom of a mainstream school. However, the group of chosen children seemed to have disappeared when relocated to the mainstream school, leaving me without a research sample.

I then located a second site for the continuation of my project, which was no mean task. Despite the fact that there are many youth at-risk living in the city centre alone, locating one that attended a mainstream school, and a school that was prepared to allow the study proved difficult. Youth at-risk, who 'graduate' to mainstream schools are generally relocated to homes for destitute children, where they seek admission to schools near their new place of abode. Unfortunately many of these children who are relocated, fail to remain at the schools or places of residence. They choose to return to a life on the streets. Eventually, through a friend teaching at Sanville Secondary School in Durban, I was granted permission, by the principal to conduct my study on the school campus. This institution was established in the early 1900's. During this period, schools were built to separately accommodate learners from any one of the four racial groups that live in South Africa. Sanville Government Coloured School was to enroll learners from the 'Coloured' community (the 'Coloured' population was created through mixed marriages between 'Whites' and 'Blacks'). With the formation of the tricameral government, the governance of Sanville Secondary fell within the ambits of the House of Representatives. Although this school is considered a state school, it supplements its funds through school fees collected from learners and major fund-raising drives, for example: school dances. Pupil intake at the school is no longer restricted to one racial group only. The majority of these children come from homes that earn average incomes.

This report is therefore based on a four-week study that I conducted on how mathematics is taught to and learned by youth *"at-risk"* in two different teaching and learning environments, one being a residential shelter and the other a classroom in a mainstream school.

1.1. RATIONALE BEHIND THE STUDY

South Africa is a developing country, with an increasing number of children who are no longer living at home with their parents. They have either taken to the streets, living in shelters or homes for destitute children. The public often displays feelings, ranging from sympathy through to brutality toward these children. These individuals require a basic education in literacy and numeracy, the tools for which to manage and improve their lives. What happens to them when attempts are made to educate them in a shelter school as compared to a mainstream school?

On entering the '*portals*' of Thuthukani, I acknowledged the challenge facing the educators in these circumstances, some of whom appeared very young and inexperienced. Some of the thoughts that raced through my mind were: How are these young, inexperienced teachers going to cope with the emotional baggage that these distraught learners bring into the classroom? What are they going to do to motivate these learners with little self-esteem? What approaches do they use to cater for the needs of these learners in mathematics? How different are the mathematics lessons in these classrooms from those in my own? In a school that lacks basic equipment, what type of teaching and learning will transpire? How would I cope in a classroom at Thuthukani? As an experienced educator of mathematics in a secondary school, I empathised with these teachers, knowing just how difficult it is to change the mindset of many learners in their attitude toward mathematics. If learners, who are not considered '*at-risk*' in the mainstream school, experience problems with the subject, what then happens to these learners at the margin?

On my first visit to the school, I was met by a staff of friendly teachers, who appeared content in their crowded staffroom. An enthusiastic group of little boys and their teacher, welcomed me into their 'classroom'. All three 'classes' sharing the classroom, were learning mathematics simultaneously. The boys, in the group that I was observing, were engrossed in the mathematics lesson, using their own methods to subtract numbers. I was amazed at the harmonious manner in which these groups co-existed in one venue. I experienced a sense of fulfilment sitting in this classroom.

I belong to a family of educators who believed that teaching was not just imparting subject matter in a classroom; you had to get to know your learners outside of the classroom. My father, as a young teacher, had taught in the schools in central Durban. Many of the boys that attended these schools belonged to gangs, yet this did not change his attitude toward these pupils. Although he was a disciplinarian, his respect and love for, and belief in his students never waned. The learners over the years respected and loved him in return, which is evidenced in a handwritten note to him on his retirement:

It's a long time now we've been waiting
For those words that you never would say
And its now that our fond hearts are breaking
For they say you're going away
Then linger a while e'er you leave us
do not hasten to bid adieu
But remember S.M. Jhavary and those
Who lov'd you so true.

My father always said: *"the best years of my career were when I spent time in a classroom, teaching. Promotions may bring status but not the joy of working with children"*. It was these words that have always spurred me on and inculcated in me the desire to work with individuals who have been marginalised. As an educator in a mainstream school, I observed with sadness the manner in which learners who were considered to be underachievers were 'ignored' by both teachers and fellow-pupils. Even the learners that made a concerted effort were not acknowledged for their attempts.

Teachers all too often concentrate on the 'top' students at the expense of the 'weaker' pupils. I learnt not to underestimate the ability of any individual from a student of mine. The student was not performing well in mathematics and the head of the mathematics department wanted him to change grades in standard ten, from higher to standard. The learner refused to concede to this request. He not only passed mathematics with a good symbol but went on to complete a degree with mathematics as his major. This motivated me to work with pupils who experience problems in mathematics. Thuthukani and Sanville Secondary School provided me with the opportunity to contribute to the lives of youth at-risk.

Data collection, undertaken in the years 1999 and 2000, satisfied the guidelines of a qualitative case study. The aim of the study was to better understand the teaching and learning of mathematics for youth at risk. In order to do so the following critical questions were posed:

- In what kinds of teaching and learning environment are youth at-risk being taught?
- What mathematics is being taught to the youth at-risk?
- How is this mathematics being taught to these youth?
- How is the mathematics being learnt by the youth at-risk?

I familiarised myself with the educational programmes that are available for youth at-risk. Although I give an expose of various learning theories, I position myself in the framework of a social, cultural, political approach to the mathematics curriculum. If, through the study, I may impact on the mathematics education of these children, then so be it. Nonetheless, I have learnt about survival and dreams from these two individuals.

1.2. THE SIGNIFICANCE OF THIS STUDY

This study is significant for a number of reasons. Firstly, it examines the phenomenon of youth "*at-risk*", with special reference to the educational programmes that attempt to accommodate their psychological needs. Second, it examines the mathematics education of two youth at-risk schooling in two different educational sites. The comparison of education disseminated at a mainstream school and a shelter is rare. This study will also be able to provide insight for similar studies in other learning areas.

The study may enlighten teachers and other interested parties as to the type of education being delivered at Thuthukani. The teachers at the centre, will also be able to evaluate their productivity and make adjustments where necessary. It will inform others as to whether the learners at this facility are benefiting from the school on site. This may determine the validity of setting up other schools of a similar nature. It may also influence other shelters to follow suit. Many shelters aim to integrate learners into mainstream schools. This study may shed light on their experience of this strategy.

An institution of higher learning, namely, the University of Durban-Westville, was instrumental in the Thuthukani project. If this project is deemed successful, it may inspire this and other institutions to enter into other projects. The education authorities may derive insight into establishing schools similar to this to provide a basic education to street children.

Not only will it prove valuable to educators at Thuthukani but also to those in the mainstream schools. Attention is drawn to the theories and programmes that may be adapted to assist the learner at risk. Teachers in all classrooms may find aspects of these workable with their own pupils.

Policy makers and developers of theories may find this study useful, as the context is different to other studies that have been carried out. This may throw new light onto curriculum development. Consideration may be given to the outcomes obtained at each of the learning sites to help incorporate learners at the margin into the curriculum.

In today's world teachers are perceived as distant, materialistic individuals who will only do what is necessary in the classroom. The teachers at Thuthukani have reinstated faith in mankind by being prepared to work at the school voluntarily, under trying conditions. The attitude that they display toward the learners can be admired. They may inspire those educators who have retired from the profession to volunteer their services to assist learners at the margin.

Many youth at-risk are found in the mainstream school. However insufficient attention is paid to their learning, often because they are "failing" students in the mathematics class. This study may serve to make education authorities and teachers in the classroom aware that these pupils exist and institute practices that will assist these youth in the classroom. Even when teachers are aware of the presence of these children in their classrooms, they are not certain as to how to treat them. Are they to be seen as 'different' from the rest of the class or the 'same'? It is hoped that through the needs of the learners in this study, one can devise strategies to make learners at-risk comfortable in the mathematics classroom.

In my opinion, the most important significance of this study is that it has given me a clearer understanding of who the youth *'at-risk'* is. The programmes for such youth provide insight into some of the strategies that may be put into practice to help them. In this way I will be better able to teach such learners in the classroom.

CHAPTER 2

LITERATURE REVIEW

GLIMPSES INTO THE THOUGHTS OF OTHERS

Human beings, by changing the inner attitudes of their minds, can change the outer aspects of their lives. – *William James*

2.0. INTRODUCTION

The specific aim of the literature search was to explore the following:

- What is an appropriate definition of "*at-risk*" and what does it mean to be "*at-risk*", specifically for this study?

- What educational programmes have been designed for and tried with "*at-risk*" youth, both internationally and locally, especially in mathematics education?

The review is conducted under the broad headings of youth "*at-risk*" and educational programmes for children "*at-risk*". This chapter concludes with a summary of the review and identifies the opportunity for research.

2.1. YOUTH AT-RISK

The term "*youth at-risk*" is open to diverse interpretations. Developing and industrialized countries may have contrasting definitions of the same terminology. Persons who interact with these children, for example, health care workers, researchers and members of N.G.O's may perceive "*at-risk*" differently from those persons who pass "*street children*" at street corners or encounter these youth in the news. These perceptions and labels are discussed in greater detail below.

Although the term "*at-risk*" may imply that the youth have the potential to become endangered, the youth in this study have already placed their lives in danger. The term "*at-risk*" may not convey the severity of the youths' situation, but it directs our attention toward the environmental hazards that need to be addressed (Amin 2001). Another term commonly used to describe these children is "*street children/kids*". Local newspapers describe street children as "*degradation of society*" and "*Street Children – a menacing problem to society*" (Roopnarain 2002:3). Using the label "*street*" stigmatises these children and keeps them where they are. Richter in Swart-Kruger and Donald (1994:116) acknowledges the negative connotations associated with the term "*street children*" but believes in its value "*because the children who 'hang out' on the street share certain common problems*" and are portrayed as "*quasi-families*".

Homeless children, globally, have either been labeled by others or have chosen terms of "endearment" for themselves. On South African soil they are "*street kids*" in Durban, "*malepipe*" or "*malunde*" in Johannesburg and "*strollers*" in Cape Town (Swart-Kruger & Donald 1994, Chetty 1997). Amin (2001) cites several different names from studies: Khartoum has "*tarzails*", Mexico sees the "*pelones*", "*street sparrows*" fly in Zaire, "pajaros fruteros" in Lima, the "*peddlar children*" are in Dublin and the "*gypsy children*" in Paris while the "*moustiques*" sting in the Cameroons, and London sports the "*street arabs*". The terms that are chosen, conjure a powerful negative image of these at-risk youth, which work to the detriment of these homeless children.

The Inter-Non Governmental Organisation for street children suggests the following definition for homeless children:

> *A street child or street youth is any girl or boy who has not reached adulthood for whom the street (in the widest sense of the word, including unoccupied dwellings, wasteland, etc.) has become her or his habitual abode and/or source of livelihood and who is inadequately protected, supervised or directed by responsible adults* (Swart-Kruger and Donald 1994:108).

This definition does not consider the negative factors that lead these youth to a life on the street. Terms such as 'habitual' and 'inadequately' lend a negative flavour to the label "*street child*".

There is a tendency to move away from labels with negative connotations to more socially acceptable terms such as "*youth at-risk*" or "*at-risk youth*". What is understood by "*at-risk*"? Exposing to danger, taking a chance of loss or encountering the unknown all imply at-risk, which is tantamount to some form of hazard. One may argue that all children, despite supervision, are exposed to dangerous situations. In the At-Risk Continuum, McWhirter et.al. (1988: 8) attempt to explain "*at-riskness*". All children are placed in a category on a continuum ranging from minimal risk to imminent risk. The responsibility of being in an at-risk situation is transferred from society to the child. Hence the concept " *at-risk youth*" does not highlight the plight of a group of children who are more vulnerable to danger than others. How then do reporters and researchers describe this subset of society? Two commonly used descriptors are "*children of the street*" and "*street child/ kid*" (Chetty 1997, Le Roux 1994, Hecht 1998).

Glauser (1990) contends "*street children*" are seen as a homogeneous group and trespassers of public space. According to the norms of society, the family and home are equated with safety and the street translates to danger. Physical and emotional abuse in the family that lead to run-away children, are of no consequence. According to Glauser (1990), society is more concerned with the disappearance of street children than caring about what happens to them after their removal from the street. These children are considered as being, beyond redemption by policy makers as evidenced by no co-ordinated government policy to cater for their needs. Activists, on the other hand, who set up social programmes for these children are thought to do so to appease their 'social guilt' (Glauser 1990). These activists, however, may be the only people interested enough to do anything for these youth.

It is argued that society is responsible for the factors that alienate youth (Amin 2001). These youth live in a social environment that is detrimental to childhood, growth and

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It is argued that society is responsible for the factors that alienate youth (Amin 2001). These youth live in a social environment that is detrimental to childhood, growth and development. The following have been suggested as ecological hazards responsible for "*at-riskness*" in youth:

- Destructive relationships which result in the child feeling rejected and hungry for love. She is unable to trust, expecting to be hurt again.
- Climates of futility are experienced by the insecure youth who is crippled by feelings of inadequacy and the fear of failure.
- Learned irresponsibility is portrayed by the youth who may mask her sense of powerlessness by indifference or rebellious behavior.
- Loss of purpose as displayed by self-centered youth who are searching for meaning in a world of confused values. (Amin 2001)

The creation of a reclaimed environment, which involves: (i) relating to the reluctant, (ii) brain friendly learning, (iii) disciplining for responsibility and (iv) the courage to care, to counteract the hazards is suggested (Amin 2001).

Both political and social factors drive these children away from their homes. Chetty (1997) cites the following as reasons for, especially Black, children taking to the streets.

a. Political factors include the Group Areas Act, township conditions, township violence and education.
b. Social factors encompass urbanisation, westernisation, poverty, family disintergration and disruption, unemployment, violence and conflicts, abuse and alcoholism.

An increase in the number of children left orphaned and destitute by the death of their parents due to HIV/AIDS (Clarke 2002(a)) has also led to an increase in the number of youth at-risk.

The literature aids in defining and categorising "*at-risk*" and "*street children*". It provides a deeper understanding of the concept "*at-risk*" and of the youth who are at-risk. The reader gains insight into the influence of demographics and family and social interaction on "*at-risk*" behaviour.

The South African society has negative perceptions and pre-conceived notions of "*at-risk youth*". To society, these children have no future and will amount to nothing. Swart-Kruger and Donald (1994:118) describe how

> *.....street children are characterised and stereotyped as both criminal and morally depraved. This characterisation results in attitudes and acts of victimisation at both formal (police harassment and arrest) and an informal level in the social structure.*

The picture of "*bands of lawless children, armed to the teeth and rampaging for food and shelter*" (Clarke 2002(a):1) that South Africans have of street children is similar to the views held by societies in the rest of the world. The Brazilians see "*street children*" as forebearers of danger (Hecht 1998). Glauser (1990:146) describes how the Paraguayan society perceives "*at-risk youth*"

> *The use street children make of the street differs from what is normal, usual and acceptable...Furthermore they are usually perceived as a physical menace...by the public who fear for their integrity, tranquility, security and property.*

Not all members of society fear the existence of street children. Pimps and drug-dealers target the at-risk youth and employers exploit child labour (over-work and under-pay these children). Desperation leads these children to a life of deviant activities. The lifestyles that they have chosen have taken them away from their homes, making them more vulnerable to social, sexual and psychological abuse on the streets (Chetty 1997). In order to survive these children become involved in activities that have serious physical, emotional, cognitive and social consequences. The world over, street children are "*exploited and victimised*" and " *classified with criminals*". They feel exploited by almost everyone: "*the media, the pushers, the sex purchasers, the sociologists and the do-gooders*" (Chetty 1997).

I have chosen to use the term " *at-risk*" or at times, "*learners at the margin*" in my study as I believe that the children are a product of their environment and we need to address the factors that led to the creation of their circumstances. However, quotations carry the labels used by others in the literature. Why learners at the margin? I use the term 'learners' because of the form of educational provision that may or may not exist for these children. Why margin? Despite impending risk, these learners have already experienced some form of deprivation or abuse. Booyse (1991) refers to the child who has been deprived of opportunity as "*environmentally deprived*". These pupils find themselves in an environment that makes it difficult for them to fully develop their latent personal potential and to achieve accordingly. As a result they become marginalised from society. Education is considered as the most important avenue for the development of an individual's potential (Booyse 1991). The educational system in South Africa is influenced by the history of apartheid. The government of that era designed education separately so as to suppress the Black people. Overcrowded classrooms, underqualified teachers and textbook shortages characterised the schools in Black areas. This resulted in a high drop-out rate amongst these learners. The educational system, therefore, has shortcomings that prevent the meaningful and effective development of many of its learners. The pupil living in a supportive environment will receive instruction and guidance to cope with the world in which he lives. An at-risk youth lives in a non-supportive environment and does not enjoy this privilege. Despite the fact that both the former and latter learner share the same class, the emotional, social, psychological and educational problems that the youth at-risk is exposed to in the school situation pushes her/him to the margin of educational provisions.

For the purpose of this study I propose the following description to that category of "*street children*" placed in an educational setting:

> *The learner at the margin refers to any individual, who is not yet adult,*

that has left home, has been abandoned or rejected by her/his family or has become orphaned and lives on the street or in a shelter/home in urban areas but is accommodated in residential education, for example, at a shelter, or enrolled at a mainstream school. The at-risk learner may have already experienced physical, emotional, social, psychological and substance abuse, as well as, malnutrition and educational deprivation. Lack of adult supervision, love and care results in continued exposure and vulnerabilty to these elements.

2.2. EDUCATIONAL PROGRAMMES FOR CHILDREN AT-RISK

Having described the "at-risk" youth, I now focus on the educational provisions created for these children. Educational programmes have been designed internationally (Hecht 1998, Meggert 1989, Wells 1990, Hathaway et.al. 1989) and locally (Chetty 1997, Le Roux 1994) for youth at-risk. This literature review does not give an account of all programmes available but highlights a sample of various approaches to educating these youth. Most of these do not specifically provide information on the mathematics component.

2.2.1. International Educational Programmes

My search for literature on educational programmes available for youth at-risk led me to the following international practices.

2.2.1.1. "Sweat Therapy"

Brazil practices "*sweat therapy*" whereby the lives of at-risk youth are transformed through reprogramming and reshaping. The at-risk youth is relocated to rural areas to work on farms. The purpose of this relocation is two-fold: (i) *to acquire farming skills* and (ii) *to discourage habits like drug abuse and life on the street*. The youth are not offered any vocational choices, but are required to work hard in return for shelter, regular meals, psychological support and moral teaching (Hecht 1998). No mention is made of any teaching of basic skills in numeracy or literacy. Many of the at-risk youth from the rural areas in South Africa come to the urban areas because of the poverty and violence, for example: faction fights and family violence. It has been shown in South Africa that not many of these children would be enthusiastic to go back to farming the lands especially under difficult conditions. An attempt to house the street children in the country proved unsuccessful, since most of the group has always lived in the urban areas (le Roux 1994: 66). At the present time there is a dearth of vacancies in the unskilled labour market, leaving many an individual unemployed. This factor, together with the laws governing child labour, would prevent the "*sweat model*" from being practised in industry in South Africa. Above all else, the "*sweat therapy*" programme does not aim to create a literate community. This form of therapy is not a workable solution for the learners at the margin who are under the age of fifteen. On the contrary, instead of turning out youth older than sixteen from shelters onto the streets, this type of therapy could be adapted. The youth "*at-risk*" could receive training in small business enterprises, which will make them self-sufficient.

2.2.1.2. Model of Factors of Success for Students At-Risk

Hathaway, Sheldon and McNamara (1989) outline the factors that result in failure for students at-risk and illustrate the short-term, intermediate and long-term effects of the factors, on the learners. They also cite systematic causes, for example: negative labeling and low expectations, and proximate societal causes, for example: lack of employment and career opportunities (for parents), and substance abuse, that lead to learners being at-risk. Short term effects, such as low or unrealistic high goals and poor self-esteem, lead to intermediate effects, examples of which are: school failure, disempowerment and dropping out of school. This leads the youth to become dependent on family or welfare or involved in acts of crime. These researchers presume that all at-risk youth are part of a family and are presently attending school hence prescribing measures for preventing youth at-risk from dropping out of school.

In an article entitled "*The Solution Lies In Programs That Work*", Hathaway, Sheldon and McNamara (1989) propose a school-based model outlining factors of success for learners at-risk. Poverty, race and success in school influence this model, which originates in the U.S.A. The underlying elements of the model are collaboration amongst and support by parents and community. Other important factors that are to be considered are classroom ethos and practices, student expectations and learning processes and peer culture and support. This model does not detail any specifics with regard to application nor recommend any particular curriculum. The youth at-risk in this study have already had the experience of failure, be it in the classroom, the home or by society. The fact that they are no longer living with their families has marginalised them to the periphery of society. Since the parent component is absent from the lives of learners in this study, this model may be unsuitable for these youth. However, there is an emphasis on the classroom ethos and practices (Hathaway et al 1989), as well as, student learning processes, for example: the readiness to learn, prior learning and commitment. Teachers, at South African schools, who have learners that are at-risk in their classrooms, may be able to adopt, adapt and integrate the above strategies into their own teaching practices. This may result in youth who feel more secure and believe in their ability to achieve.

2.2.1.3. The Pre-empt and Prevent Strategy.

Shirley Wells (1990) examines the characteristics of programmes that have proven successful for at-risk students who attend mainstream school. The intention of this programme is to prevent American students, who have been identified as being at-risk, from dropping out of school. The aim is to identify these learners as soon as possible and institute preventative measures to assist students. She does not prescribe any particular programme but suggests guidelines for administrators, curriculum developers, the school and parents. Positive attitudes and respect for learners, together with a strong sense of ownership help make any at-risk programme successful.

Wells conducted extensive research on successful preventative programmes and formulated the "*Characteristics of Overall Successful At-Risk Programs*" (Appendix A).

Some of the characteristics identified by Wells appear in the "*Model Program*" described by Wehlage et.al. (1987). The model identifies four categories that secondary schools can operate in order to retain at-risk learners. These are:

> 1. *Administration and organisation: alternative programmes such as schools within a school.*
> 2. *Teacher culture: teachers take on an extended role to deal with the "whole child" considering the problems the child experiences.*
> 3. *Student culture: being a voluntary programme, the commitment of the learner is required. The program stresses "family" atmosphere.*
> 4. *Curriculum: individualised, clear objectives, prompt feedback and active role of students. Experiential learning is important in this model.*
>
> (Wells 1990:22)

The proponents of the "*Model Program*" are of the opinion that alternative education programs are "*the most successful methods of dealing with secondary at-risk students*" (Wells 1990). They suggest six characteristics of successful alternative programmes: small size; programme autonomy (independent of traditional programmes); a commited teaching force; nontraditional curriculum (individualised approach, beginning at individual's level and use of "*real life*" examples; experiential education; and positive atmosphere and supportive peer culture. Some of the suggestions proposed by Hathaway et.al. (1989) in their model reappear in the "*Model Program*", for example: commitment of the learner, consideration of the "whole" child, feedback and appropriate and relevant content-curriculum.

Although the model of alternative education is recommended for learners at-risk at secondary school level, teachers at different levels of education could consider implementing those aspects that are physically possible and practical into their classrooms. The alternative programme suggests a school within a school, resulting in a small class size to work with. This is not physically possible in most of the mainstream schools in South Africa that educate learners at the margin because of financial constraints and teacher shortages. Schools based in shelters can adopt the principle of "whole" child teaching and adapt the mathematics curriculum to accommodate the learners' experiences. There is mention of "experiential learning" and the use of "real life" examples. Mathematics that proves useful and relevant to the learner, is valued by the learner, as s(he) can make sense of it. This aspect of this theory may be extracted from the programme and utilised in the classroom of the youth at-risk. In this way, the learners will be motivated to want to learn. Teachers may not be able to prevent all youth at-risk from returning to the street but may reduce the number that do want to leave the schools.

2.2.1.4. Self – Esteem Enhancer

This programme also finds its origins in a developed country, namely the U.S.A. According to Meggert (1989), the self – esteem of the child is of paramount importance when creating a programme for at-risk youth. The programme recommends the following four-phase approach: (i) *identity*, (ii) *strengths and weaknesses*, (iii) *nurturing* and (iv) *maintenance*. The first phase of identity is to assist the individual to understand one's self in a more balanced manner. This leads the learner to phase two where s(he) examines her strengths and weaknesses. This process is enhanced by others, either teacher or peers, providing feedback, which should be in the ratio five is to one (positive to negative), in order to improve the low self-esteem. In order to nurture this growth in self-esteem, the learner needs to learn how to change her attitudes and perceptions. In my opinion, for any individual to be successful, s(he) has to be motivated and possess a positive self-esteem.

Although Meggert's activities may have proven successful, consideration of circumstances must be taken into account. Some activity may lower rather than enhance the self-esteem. For example, strategy 63, "*What's in your wallet*" (Meggert 1989:107), an exercise in identification, may tempt the youth at the shelter to steal a wallet as they do not carry wallets. The learner at the mainstream school may feel even more marginalised if the other learners in her class have wallets and she does not. This task assumes homogeneity of learners. The task "*Write a letter to yourself*" (Meggert 1989:112), which intends to promote maintenance of self-esteem, may leave some learners feeling inadequate, as experience at Thuthukani shows that there are children who cannot read or write. "*Slams and strokes*" (Meggert 1989: 110) asks for a pupil to provide a negative and a positive feedback to another pupil. The learner's on the margin are very sensitive and may overreact to these comments. However, an activity as " *Dreams of the future*" (Meggert 1989:109) which requires the individual to visualise the kind of person they would like to become and how they would like others to see them may actually boost the child's self-esteem. In this manner, the at-risk youth will feel more confident about his/her ability to achieve. Although this may not be directly associated to the mathematics curriculum, it could influence performance in the subject. The trust exercise (Meggert 1989: 108) should prove useful to learners at-risk as these youth find difficulty in trusting others due to their experiences of abuse, abandonment and violence. It may be necessary to adapt these exercises to accommodate the experiences of youth at-risk. Suggestions for these exercises may be elicited from the pupils themselves.

The teacher may want to use the idea of "strengths and weaknesses" to help the child identify her deficiencies in mathematics. The learner may be asked to draw up a list of sections in mathematics that she likes or understands against those she finds difficulty with. The list may then be used, by the teacher, to motivate the pupil by placing emphasis on what the child knows.

Three of the four programmes discussed above, have been developed by researchers of the north (developed countries). The Brazilian model is the only one that suggests a programme for youth already at the margin. It is not easy to adopt any one programme to use in the South African context without making adaptations. Situations and individuals are different thus requiring the educational programme to be tailored to suit the varying educational sites. Suggestions that are workable in one country, be it developed or developing, may prove less successful with youth at-risk in South Africa. The apartheid era that was prevalent in this country has inculcated many prejudices in the majority of its citizens. These prejudices, which cannot be erased overnight, may prevent some of the ideas from the north from being fully workable.

2.2.2. South African Educational Programmes

Having described the programmes developed abroad for youth at-risk, I will now discuss those programmes being practised by centres for youth at-risk or "street children" in South Africa, and more especially in Durban. The majority of the youth who are at-risk and choose the life on the streets of South Africa are "Black". During the apartheid years (prior to 1994), the laws governing separate development in this country kept these children confined to the townships and rural areas reserved for Blacks. The abolishment of the laws restricting movement saw an influx of these homeless youth into the city centres. According to Vusi Khoza, the chairman of the Street Children's Forum in Durban, there are "some 500 street children in central Durban and five shelters to house them" (Copeland 2002:4). This "*great trek*" into the urban areas ignited an interest for the welfare of these children by feeding schemes, places of safety, children's homes, foster parenting, Ark ministries and Living World Ministries (Chetty 1997). However, this is only a temporary relief to a problem, which has its origins in political, social and economic factors.

Of the few formal programmes available for youth at-risk in South Africa, the most significant is "*Street-Wise*" (Chetty 1997). Street-Wise is the brainchild of Jill Swart, a South African anthropologist and Chris Williams, a British educationist. The principal aim of the Street-Wise model is the acquisition of educational and vocational skills. Its components include an outreach, shelter, assessment, education and graduate programme. The Street-Wise educational project has four main focal points:

> *Remedial programmes concentrating on numeracy, literacy and general education rehabilitation of children.*
> *Formal education following remedial action.*
> *Life skills training.*
> *Job skills training – to instill work ethos and develop concentration span.*
>
> (Le Roux 1994: 65)

Basic numeracy in the above project is fashioned and taught according to the principles embodied in the curriculum / syllabus followed by the mainstream schools in South Africa. Learners of varying mathematical ability and grades may be taught in the same group. No special programme is set for these learners at the shelter. According to Mr Felix Ingatha, the teacher at Street-Wise in Marian Ridge (a suburb west of Durban), mathematics at the shelter is taught exactly as it is taught in the neighbouring school (personal communication: 18/11/02). Learners who are competent enough are enrolled at the mainstream school. Children who are unable to cope immediately with schoolwork remain at the shelter until they are able to do so. The curriculum that is used by mainstream schools is followed at Street-Wise. Learners at this shelter write the same tests and examinations as their counterparts in the mainstream (Mr Ingatha obtains these from the neighbouring school; hence does not have to set them himself). Those children who cannot cope with schoolwork within the year are entered into a *"life skills"* programme (Pariola 1999:36). The graduate programme prepares children to leave the Street-Wise programme for formal schooling and employment. Street-Wise has achieved moderate success, as some of the children perceive this intervention as prying into their personal lives and loss of autonomy (Le Roux 1994).

A second progamme for youth at-risk is that used by Tennyson House, a shelter that caters exclusively for girls. On entering this facility, the girls are evaluated by means of a number of tests, for example: Ravens Progressive Matrices Test, Bender Gestalt of Sensory Motor Integration. Initially, attempts are made to re-unite the girls with their families and re-integrate them into society. As at Street-Wise, those individuals who remain at Tennyson House are placed in the mainstream classroom. A learning programme was set up at the facility, with the assistance of students at university, to assist these learners in mathematics. This programme is closely related to the school curriculum. The tutors used the school-work done by the girls to assess their mathematical abilities. The aim was to assist the learners with homework and re-teach sections of the syllabus that required remediation (Vithal et.al. 1998).

A third programme is one that is practiced by the teachers based at Thuthukani. The vision statement for the centre reads as follows: "*To operate a one stop multi-disciplinary and multi-sectoral programme for children living in difficult circumstances*" (Project Thuthukani 1999: 3). Their aim is to operate a formal school for these children. Their objective is to establish a bridging programme from Thuthukani to the mainstream school and to return a minimum of 30% of the children to the mainstream. In order to achieve this, individual diversities must be catered for and flexible programmes must be created. The curriculum objectives of Thuthukani are listed as follows:

- *Functional / Academic / Multi-leveled Bridging Programme.*
- *Self Empowerment / Classroom Skills / Positive Life Skills.*
- *Positive Role-Modelling / Learner-based Teaching / Mediated Learning.*

(Project Thuthukani 1999: 20)

Of the six learning areas proposed, only two were in operation at Thuthukani at the time of my visit, namely: basic literacy and basic numeracy. According to the above-mentioned document basic numeracy will include the following:

- *Conceptual understanding through to an age appropriate stage.*
- *Problem-solving skills*
- *Investigative generalisation and transference skills.*

(Project Thuthukani1999: 21)

The curriculum that operates in the mainstream school is to be followed at Thuthukani. According to Julia Zungu: "*Every country had a street children problem and provided shelter and food. Durban was different, providing a 'harm reduction programme' which aimed to reduce the risks and damage of life on the streets*" (Cole 2001: 9). From conversations held with teachers at the school, I discovered that they were asked to follow the curriculum prescribed for the mainstream school. The teachers were using their discretion as to what to teach. As a result these teachers were not strictly abiding by the curriculum.

All three of the shelters for youth at-risk basically operate on the same principles, which aim to rehabilitate and educate the youth. The education of these children may take place in the mainstream classroom or at the shelter, with a view of re-instituting these youth into the mainstream. The ultimate goal is to re-integrate the individual into society.

The learner at the margin in the mainstream school does not enjoy the privilege of a special educational programme since the assessments conducted on the child deemed her/him capable of coping in the mainstream school. At the same time, schools that are based at residential shelters and put into practise special educational programmes for the youth at-risk, do not take advantage of the opportunity. This is evident in the fact that both types of schools ascribe to the same mathematics curriculum. Although the programmes for at-risk youth take into consideration various factors, for example, identifying characteristics of the youth, they exclude the needs of the teachers of at-risk children and the specifics of classroom practice.

The search for information on educational programmes for youth at-risk made me aware of the lack of availability of literature in this regard. Some of the centres for youth at-risk that I approached for data on their learning programmes were: Youth for Christ, Lakehaven Children's Home and Street-Wise. My attempts to source out such material from local facilities for at-risk youth was met with comments like:
"*...we have no documented information...we do have classes at our facility, but I do not know how they operate...the person in charge is not in...call in later...or leave your number and s(he) will get back to you*".
The fact that these institutions do not possess documented policy regarding the teaching practice at the facility implies that the teachers may have no curriculum to follow. These teachers could therefore enjoy the liberty of teaching little mathematics to their learners. On the other hand, these teachers may be practicing a curriculum that is not documented.

2.3. CONCLUSION

The review was planned to answer specific questions. The search for the answers revealed gaps and silences that allowed for a unique study. From the review I became aware that there were many complex and unresolved debates around at-risk youth. I gained tremendous insight as to what it meant to be a youth at-risk.

The programmes for at-risk were broad and considered factors such as identifying characteristics of youth, listing features of successful strategies and included provisioning for shelter, education, medical treatment, vocational training and job placement. The specifics of these educational practices were very elusive. Although the literature on South African programmes for learners at the margin provided some information on the teaching of mathematics, it failed to supply details on the classroom practices followed. If the curriculum does not consider the learner at-risk in a mainstream school, how then can the youth at-risk schooling at a shelter benefit from such a curriculum? This study, therefore, by examining the teaching and learning of youth at-risk in both mainstream and special facilities hopes to provide some answers to the silences and gaps that exist with regard to these children.

CHAPTER 3

THEORIES AND EDUCATION

Just as the oppressor, in order to oppress, needs a theory of oppressive action, so the oppressed, in order to become free, also need a theory of action.

Paulo Freire

3.0. INTRODUCTION

The purpose of this chapter is two-fold. The first is to examine the theories underpinning the mathematics curriculum and being employed in the mathematics classroom. This is important in explaining how learning occurs. It also impacts on how teaching takes place, since the teacher's theoretical leanings does influence her practice. The second is to establish how these theories cater for the learner at the margin. The specific aim of this chapter is to realise answers to the following:

- What are the theories of learning related to mathematics and how do they (if at all) accommodate the learner at the margin?

- How is the teaching and learning of mathematics carried out in terms of the intended, implemented and attained curriculum with special reference to "*at-risk*" youth?

3.1. THEORIES OF LEARNING RELATED TO MATHEMATICS

Over the years various perspectives on the teaching and learning of mathematics have been presented and adopted. Some learning theories that have influenced mathematics teaching and learning in South African classrooms are behaviourism and constructivism. These theories could not fully explain the performance of the country's masses in mathematics. To minimize the great divide between the mathematically literate and non-literate, other approaches emerged. In my opinion, a social, cultural and political approach to the mathematics curriculum has the potential to empower a greater percentage of the population. Nonetheless, we cannot deny the fact that behaviourism and constructivism still command a place in the classroom. We may not create a whole nation of mathematicians but we can try to have a mathematically literate populace.

3.1.1. The Behaviourist Theory

Behaviourists subscribe to the theory that the minds of learners are empty, waiting to be filled by knowledge which teachers transmit to them. The following principles underlie behaviourism:

- The assumption that knowledge can be transferred intact from one person to another, allows pupils to learn what they are taught.
- The learner is perceived as a passive receiver of knowledge.
- Knowledge can be taken directly from experience making the learner's current knowledge redundant to learning. (Olivier 1989)

The methods employed in the classroom are aimed at specifying and analysing behaviour. The world comprises of interacting variables that can be controlled experimentally (Nickson 1994). Learning is viewed as the forming of habit, based on reinforcement. The more times a stimulus-induced response is elicited, the longer the learning (response) will be retained. This minimises the learners' creative powers. This suggests rote-learning: drill and practice are important factors in the learning of mathematical knowledge.

Visions of the learner as a sponge absorbing the mathematical structures invented by others are conjured (Govender 2002). The individuals are portrayed as incapable of computing and developing their own computational strategies. According to behaviourism: teach the theory and then involve the child in practical problems. This implies that children must apply the rules taught to solve problems. Learners are expected to conform to rules and the teacher's methods of problem solving. The learner views mathematics as abstract, prescriptive, formal and meaningless.

Behaviourist theory portrays the teacher as the all-knowing dispenser of knowledge and the learners as passive recipients, hence subscribing to a teacher – centered approach to teaching and learning. Although drill and practice may prove useful in some aspects of mathematics, for example: the learning of multiplication tables, it does not allow for application of knowledge. Skills acquired through prescriptive methods are not necessarily transferable and children become mathematically illiterate (Penchaliah 1997). Terminology such as "*specifying behaviour*" and "*controlled experimentally*" portray the mathematics classroom and mathematics as clinical and prescriptive.

The child at the margin is not an "empty vessel" but rather like a "saturated sponge", with all the emotional baggage that he carries. Learners at the margin are created from situations of violence, poverty and, even, death in which they have lived. This youth at-risk (as are most other learners) is therefore, not capable of absorbing anything that has no utility and relevance to his reality. This individual cannot be expected to conform to rules and methods that do not make sense to him. The learner who cannot regurgitate the facts given by the teacher is considered to be incompetent in mathematics. His individuality and ability to think is stifled. Hence the youth at-risk is unlikely to progress in a classroom that is governed by behaviourism only.

School mathematics is an activity having its own goals and means and cannot be simply transplanted into another activity (Atweh & Cooper 1995). If this is the basis of behaviourism, what happens to the learner at the margin? This theory led to the classroom becoming a centre of chalk-and-talk. As a result, there was a shift toward constructivism, which was considered to be more learner-centered.

3.1.2. Constructivism

An increased interest in constructivism as a theoretical perspective in mathematical education resulted in a shift away from the behaviourist paradigm toward interactive processes (Nickson 1994). The theory is based on a view that "*knowledge is made and not given – it is constructed by an active cognising subject rather than transmitted by a teacher or text*" (Adler 1992:29). Rakgokong (1994:15) maintains that a constructivist approach emphasises "*communication and negotiation and hence the use of language in the construction of meaning*". Communication through discussions with others is important for construction of concepts. This implies that pupils must have some form of verbal interaction in order to share their meaning and formulate mathematical concepts. Learners have an idea. They construct and reconstruct their thinking; hence learning becomes meaningful.

Socio-constructivists contend that learning is a social, as well as, an individual activity. The problem - centered learning context, which is considered to be "*compatible* " with socio-constructivist theory, leads to subjective knowledge as a result of personal constructions (Muthukrishna 1994).

Learning is construed as a two-directional flow of information between teachers and learners where the teacher imparts knowledge to the children. This knowledge is not just absorbed but actively processed. The pupils interpret and adjust information thereby constructing their own mental representations of situations and concepts (Nickson 1994, Noddings 1987, Govender 2002). The learner's pre-existing knowledge will influence the type of knowledge gained (Muthukrishna and Rocher 1999). As a consequence, each learner in the classroom may interpret the same situation differently, resulting in numerous ways of knowing.

An active, self-reliant attitude to learning is inculcated within the learner through discovery, negotiation and reflection. Many children develop their own methods rather than relying on methods taught at school as cited by Govender (2002: 65) in: "*many children are not using the "proper" mathematical methods taught to them at school, but rather are relying upon naïve intuitive strategies...* ". Murray, Human and Olivier show that learners prefer to use their own methods of computation, which proved to be highly successful. Researchers attribute this to the fact that when children construct methods for themselves, they use only those that they really understand (Govender 2002).

Errors and misconceptions are considered an integral part of the learning process (Olivier 1989). Accommodation and assimilation allow new information to become a part of the existing schema of the learner (Piaget 1969). The mathematics educator becomes a critical facilitator of learning, supporting and guiding the child to construct his own, rather than a dispenser of knowledge.

Noddings (1973) describes it from both cognitive and methodological perspectives. He is of the contention that "*constructivism as a pedagogical orientation has to be embedded in an ethical or political framework*" (1998:159) while Peter Taylor (Vithal 2001) suggests a "*critical constructivism*" that acknowledges the socio-cultural context of knowledge construction. The primary aim of the mathematics teacher is to "*promote the growth of students as competent, caring and loving people*" (Noddings 1998). These teachers will then be able to inspire, support and assist all learners with mathematics despite their orientation toward the subject.

In spite of the interactive nature of the constructive theory of learning, focus still remains on the teacher, the learner and specific mathematical concepts. It does not extend to the whole classroom context in which teaching and learning takes place (Nickson 1994:19)

Robyn Zevenbergen (1996:95) refers to constructivism as a "*liberal bourgeois discourse*". She maintains that constructivism, especially radical constructivism, denies the social and political context of mathematics and "*legitimates the marginalisation of many social and cultural groups*" (1996:95). Constructivism ignores the wider socio-political context within which learning takes place and the significance of the learning outside the classroom. Immediately, the learner at-risk is disadvantaged since it is the social and political issues that have set him at the margin, of both society and education. If the intention is to have these learners re-integrated into society, then the social, political and cultural contexts need to be considered.

Many pupils are marginalised because they are viewed as ineffective learners of mathematics (Zevenbergen 1996). An effective learner is one who can construct knowledge that resembles that which is acceptable in the field. Students are not rewarded (rather they are penalised as in examinations) for constructing mathematics according to their own meaning. These learners are perceived as "*misconstruing knowledge or having misconceptions*" (Zevenbergen 1996:104). Pupils do not necessarily construct the same meaning as the teacher envisaged nor do all pupils construct the same meaning. This implies that youth at-risk construct meaning according to their experiences, which is a far cry from that of the policy-makers, researchers and theorists of South Africa. One cannot assume that these children are ineffective learners because they have not enjoyed the same privileges as the perpetrators of apartheid. The political aspect of meaning making is ignored in this theory. Mathematics that is thought to be formal and abstract is more highly regarded by school mathematics (Atweh et.al. 1998).

Mathematical knowledge is awarded high status in society. It is the only subject in the school that can enforce power and status and has been used to prevent social access (Gerdes 1988). Society uses school mathematics to "*stratify students according to ability*" (Atweh et.al.1998: 80). Constructivism has helped to entrench this belief in the superiority of mathematics. Constructive theory can only explain the disparity in the performance across social groups through the fact that past experiences provide the basis upon which new knowledge is constructed. In this way constructivism may be able to explain the poor performance of the learner at the margin. Learners who share a social or cultural background similar to that recognised by the formal school context construct meaning, which is deemed valid. Do youth at-risk share these similar backgrounds? If the answer is no, then does this mean that learners at the margin do not construct valid meaning? If each individual constructs according to her/his own experiences, then who determines the validity of the meanings?

Mathematical language has its own code. As a consequence, those individuals who are from cultural or social groups whose language is different to that of the formal schooling are disadvantaged when reproduction of the unique language of the mathematics is required. Once again, contructivism fails in questioning the linguistic code of mathematics.

As stated above, mathematics plays a vital role in the mainstream school curriculum. It is hoped that the learners at the margin will be able to go into the mainstream school. If constructivism has the ability to marginalise the learner by not acknowledging the social, political and cultural factors that influence her thinking, what then happens to the learner who is already at the margin? The constructivist theory is learner-centered and pupils are required to draw on their backgrounds and experiences to make mathematics more meaningful and relevant. What happens to the learner at the margin whose experiences are associated with abuse, poverty and pain? Would s(he) want to associate learning with these experiences? This student may associate mathematics with pain and withdraw to the outskirts of the class causing her/him to be further marginalised.

3.1.3. The Social, Cultural and Political Approach

Having discussed the principles of behviourism and constructivism and how they may or may not impact on the teaching and learning of mathematics, especially in the classroom of youth at-risk, I go on to interrogate the social, cultural and political approach to the teaching of mathematics. As a master's student in mathematics education, I was introduced to the above approach by my lecturer, Renuka Vithal. Although this approach to the context of mathematics may be discussed according to the following areas: ethnomathematics, people's mathematics, critical mathematics education and issues of class, gender, race and equity, I am of the opinion that these dimensions are interrelated and hence cannot really be separated into water-tight compartments.

Through the decades Mathematics has been portrayed as rigid, cold and unappealing, unchangeable in nature, and the "*objective judge*" to decide on the "cans" and "cannots" in society (Volmink 1994, Willis 1998). A paradigm shift requires changes in individuals' attitudes toward the teaching and learning of mathematics, especially amongst the people and institutions that supported apartheid.

Ethnomathematics appears to concern itself with the social and cultural aspects of the education curriculum. It focuses on the mathematics of traditional cultures and on different groups of society, for example: the child street vendors (Carraher 1988). Aboriginal children playing cards (Graham 1988), the Oksapmin in Papua New Guinea and the Kpelle people of Liberia (Nunes et al. 1993). Frakenstein (1990) describes ethnomathematics as the emerging discipline which analyses how people think mathematically in their daily lives, and shows that there exist logical structures in different mathematical practices in addition to those in "academic" mathematics.

In the South African context, culture in mathematics education is usually referenced against Eurocentricism and apartheid. In order to obtain an unbiased perspective as to conflicts across race, gender, class and religion, traditional culture would also have to be considered. Very often, in South Africa, this concept of culture is regarded as synonymous with religion and race and tends to become distorted (Vithal 2000).
In non-western countries informal mathematics is extended to other mathematical activities. Whether an individual is schooled or not, (s)he can enter a supermarket and calculate a best buy. Informal learning, which involves learning in context, is learnt through observation and imitation and rarely involves verbal explanation (Nunes et.al. 1993). Hence, this street mathematics develops as a result of a "*discrepancy*" between an individual's needs in problem solving and the amount of mathematics learned (or not learned) at school. Although a pupil may have difficulty with routines learned at school, he may be able to solve problems in another more effective manner. This is evident in mathematics classrooms in South Africa. Ethnomathematics is more realistic to the learner because of the fact that much of the meaning of the situation is preserved through oral presentation. School mathematics, on the other hand, is written, in the attempt much of the specifics of the situation is omitted. This '*informal*' or '*everyday*' mathematics (Jurdak & Shahin 1999) - is not the learning of particular procedures but rather the development of mathematical concepts and processes (Nunes et.al. 1993).

Does school mathematics "repress" and "confuse" the practical mathematical knowledge that children acquire outside of school (Gerdes 1988)? Carraher & Schliemann appear to answer this question with their remark that children who were capable of solving arithmetical problems encountered in the market-place, found difficulty with solving the same problem once exposed to school mathematics (Gerdes 1988). As a consequence, ethnomathematics faces a dilemma when seeking recognition in the mathematics curriculum. When the mathematics curriculum is compiled, it takes into consideration certain approaches in order to attain pre-determined goals, one of which would be to meet the needs of a developing South Africa (Vithal 2000). If this is so, then the curriculum may think about considering the mathematical needs of the learner at the margin by integrating the "*informal*" mathematics into the curriculum. However, the fact that learners come from different backgrounds, bringing with them varying cultures, gives rise to the concern of conflict within the classroom. The interaction of many cultures, makes it difficult at times for the teacher to be able to accommodate the youth at-risk in all her lessons, as she has to also make allowances for the other learners. Perhaps the teacher in a classroom that is comprised of only learners at the margin, may be in a better position with regard to this issue. One cannot lose sight of the fact that the teacher also brings into the classroom her own cultural and social values, which may impact on her teaching practice.

Critical mathematics education leans toward the social and political dimensions of mathematics education resulting in an overlap between ethnomathematics and critical mathematics. Critical mathematics education enables the learner to judge, understand and apply mathematical knowledge in society. In Towards a Philosophy of Critical Mathematics Education (1994), Skovsmose's views on the relationship between society and education are expounded. The crises and conflicts in society and democracy are two issues of concern for him. The conflicts that develop outside the classroom as a result of inequalities in society are reflected in schools. The political framework of South Africa, prior to 1994, was responsible for creating the differences in opportunities between the races of the land. This, in turn, resulted in unequal opportunities for learners, hence marginalising the masses. Democracy is an issue close to the hearts of South Africans as our country has only attained this status less than a decade ago. It is difficult for society to practise democratic values after living under the laws of apartheid for many years. The onus lies on society, and especially the school and family, to teach these values and attitudes to the learner.

According to Julie (1993) People's Mathematics, which is embedded in the critical pedagogy, has four features. The first reveals how mathematics is used to marginalise certain groups in South African society, creating social inequalities. The second is "the quest to establish fallibility as the underlying philosophy for mathematics pedagogy" where "*mathematics is viewed as created by people*" (Julie 1993: 33). Thirdly, is the "*incorporation of the social history of mathematics into the mathematics curricula*". The fourth feature is the application of mathematics to socio-political situations. In the last aspect, Julie refers to "relevance", which he contends is "*narrowly constructed*" (1993: 35) and was associated with political struggle.

Julie (1993) identifies some gaps in the People's Mathematics programme, which include: a lack in the development of democratic competence through mathematics, the lack of experience with applications and models; and the given content is taken and adapted to make it relevant to context.

Frakenstein (1995) focuses on issues of race, gender and class in the United States of America. She examines the equity and social justice within mathematics education. Her contention is that mathematical applications taught at school are portrayed as neutral, hence creating class "unconsciousness" amongst learners. She regards this as mathematical disempowerment for the class that is being neutralised. The issue of class "unconsciousness" becomes a reality to the youth at-risk who is placed in a mainstream school. Being in the minority, she becomes the "neutralised class".

In "*The Politics of Mathematics Education*", Mellin-Olsen (1987) pays particular attention to learners who fail at learning mathematics. He attributes this failure to the "*lack of experience of how to apply thinking tools*" which he locates as a political issue

(Mellin-Olsen 1987: 205). He perceives pupils as *"the purveyor of ideology"*, ideology being *"the set of attitudes which the individual takes over from the system of groups she has as referents for her behaviour"* (Mellin-Olsen 1987: 194). He believes that students fail because they reject mathematics, which results in resistance to the subject. Resistance can be overcome by converting rejection to activity. What would make these learners want to reject mathematics? Could it be the lack of experience that makes them shy away? Can you blame the youth at-risk for lack of experience if they were not afforded the experience?

In South Africa, it may be dangerous to introduce a political approach into the classroom, considering the history of the country. The classrooms of today comprise of learners from the various race groups, which may differ from that of the teacher. Learners and teachers may possess varying ideologies, which may conflict with each other. The teacher of at-risk youth may have to exercise greater caution as many of these learners have become marginalised due to political issues of yesteryear.

As mentioned earlier, it is difficult to separate the different strands as they are all interwoven. Issues of race have already emerged in the discussion; gender and class also have an impact. In her article *"Perspectives on social justice, disadvantage, and the mathematics curriculum"*, Sue Willis (1998) identifies four perspectives of disadvantage and the mathematics curriculum. The first is a *"remedial"* perspective where the curriculum is taken as given and the 'disadvantage' lies with the child who by virtue of race, gender, class or disability lacks the ability to succeed in mathematics. The solution is to provide the necessary help. The second is a *"non-discriminatory"* perspective. The curriculum is a given with respect to what is learnt. The problem lies with pedagogy and assessment practices and the solution is to change these practices. The *"inclusive"* perspective comes next, where the curriculum is neither given nor unchangeable. The curriculum content and sequence create the disadvantage. The solution lies in the nature of the typical child. In the last perspective, namely, *"socially critical"* the curriculum is *"actively implicated in producing and reproducing social inequality"*. The 'disadvantage' arises out of the way in which the mathematics learner is constructed with the solution being to "*challenge and modify the hegemony of mathematics*" (Willis 1998:16).

What are the implications of these theories and approaches to the youth at risk? These children are a product of the deficiencies and conflicts that exist in society. They have become marginalised either because of their race, class or disability in mathematics. Their social, political and cultural backgrounds only serve to aggravate their "at-riskness". In order for these learners to be able to succeed in the mathematics classroom, all factors affecting their lives need to be considered. The teacher also brings into the classroom her/his own political, social and cultural values and theories of learning. However, the teacher may need to make a conscious effort so as not to allow these values to overshadow those of her learners. Each of the theories and approaches discussed above, has its merits and demerits. It is therefore difficult to suggest any one particular approach that will work for all learners, especially the learner at the margin. Since every teaching context is different to the next, the teacher is at liberty to use those criteria that work for her/him from each of the theories and approaches. In this way s(he) creates a teaching strategy that is unique to the needs of the learners in her/his classroom and accommodates the learner at the margin.

3.2. THE TEACHING AND LEARNING OF MATHEMATICS FOR CHILDREN AT THE MARGIN

During the period of data collection outcomes-based education had already appeared in some classrooms in South African schools. A whole new language was evolving in education. However, the classrooms that I visited to collect data had still not been affected by this new system. The curriculum that was currently in operation was the Revised Curriculum of 1994. Educators were still writing up aims and objectives in order to create lessons that will assist the learner pass the examination. It proposed problem-centered learning through discovery as the means of disseminating information in the classroom.

A search for literature on the teaching and learning of mathematics for youth at-risk proved to be limited. This required the general literature on the teaching and learning of mathematics be adapted for learners at the margin. This section will examine how mathematics teaching and learning of at-risk youth is executed in terms of the intended, implemented and attained curriculum.

3.2.1.The Intended Curriculum: Policy and Intention

The intended curriculum is that curriculum which is specified at a national level. This curriculum in the Third International Mathematics and Science Study (TIMSS) is measured on the basis of a set of international criteria, by a local panel of highly qualified and experienced experts in mathematics. They analyse the use of the South African syllabi, curriculum guides and most used textbooks in mathematics (Howie: 1997) It is the answer to: *What are the learners expected to learn?*

The focus of the National Curriculum Statement (2002: 4) regarding the teaching and learning of mathematics, aims to develop in learners:

- *A critical awareness of mathematical relationships used in social, environmental, cultural and economic relations.*
- *The necessary confidence to deal with any mathematical situation without being hindered by the fear of mathematics.*
- *An appreciation for the beauty and elegance of mathematics.*
- *A spirit of curiosity.*
- *A love for the learning area.*

This statement has been designed for learners in general and makes no mention of the learner at the margin. It describes a mathematically literate person as one who is able to contribute and participate in society confidently. Further, mention is made of the fact that the mathematics learning area plans to develop an appreciation for diverse social, historic and cultural practices. This may be a manner in which the curriculum caters for the learner at the margin. I am not certain whether the learner at the margin is really interested in the beauty and elegance of mathematics. The question I ask is: elegance according to the teacher's method or the learner's? The intention to develop a love for the subject may materialise if consideration is given to "whole' child learning.

The teaching and learning of mathematics is expected to enable learners to:

- *Develop deep conceptual understandings so as to make sense of mathematics.*
- *Recognise that mathematics is a part of a creative human activity.*
- *Participate with confidence in the world of work and society by being mathematically literate people.*

(National Curriculum Statement 2002)

The contact time for formal teaching of mathematics will vary between 22,5% and 27,5% of the teachers' allocated time at school (National Curriculum Statement 2002:1). This depends on the phase that he is teaching. The teacher-pupil ratio at secondary school level is recommended at 1:35 (personal conversation with a secondary school educator). The learner is to be assessed by the teacher to ascertain whether teaching and learning is effective, hence the power lies with the teacher.

The intended curriculum envisages a teacher who is *"qualified, competent, dedicated and caring"* (National Curriculum Statement 2002: 3). These educators are expected to be mediators of learning, as well as, interpret and design learning programmes and materials. They are to serve the role of leaders, managers, scholars, researchers, administrators while being specialists in their learning area.

According to the National Curriculum Statement (2002) the learner is envisaged as one who will be inspired by values and act in the interests of society. Democracy, equality, human dignity and social justice will be the issues that inspire the learner. The curriculum wishes to create a life long learner who is literate, numerate and confident, and capable of being a critical and active citizen.

It is suggested that a core curriculum supplemented by group specific content be introduced to cater for multiculturalism in the classroom (v.d Horst 1993). A further suggestion is to establish remedial cognitive programmes to assist learners who have been disadvantaged socially or culturally. There is a perception that standards have "*softened*" to accommodate the needs of the "*different*" groups within the classroom (Willis1998: 4).

Although Apple (1992) agrees with a curriculum pedagogy that is largely problem-centered and integrates mathematics into the lives of learners, he still has the question: but whose problems? An important fact that seems to have been ignored in the compilation of the curriculum for South African schools, is: we are a part of Africa and not Europe (Holdstock 1987, Willis 1988). Mathematics had a "*curriculum transplantation from highly industrialised capitalist nations to the Third World countries*" (Gerdes 1988). As a result of mathematics catering for the social elite, the majority of children perceive the subject as useless.

3.2.2. The Implemented Curriculum

The implemented curriculum is the curriculum as it is interpreted and delivered by the educator of mathematics in the classroom. It answers the question: *How is the instruction organised?* The implemented curriculum may be gauged from the type of responses teachers offer to questions about their learners and the lessons taught.

Romberg (1992: 433) suggests the following as the aims for teaching mathematics to all learners.

- *Empower learner to create own mathematical knowledge.*
- *Reshaping of mathematics in school to give all groups more access to its concepts and to the wealth and power its knowledge brings.*
- *Bring the social contexts in which mathematics is used and practiced in the classroom.*

The point on reshaping mathematics to make it more accessible to all learners has positive implications for the learner at the margin. Whether all teachers in the mathematics classroom are in fact giving consideration to these learners is questionable. Experience, as a teacher of mathematics, has illustrated that teachers generally concentrate on those learners who are able to perform well in the subject. The teacher's need to prove her effectiveness in the classroom seems to be measured by the number of A symbols learners attain in any given examination. This is done at the expense of the learner at the margin.

When planning teaching-learning opportunities for learners, consideration for the multicultural composition of the class is important to meet the challenges of a changing classroom. The existence of every child in the class ought to be acknowledged through the differentiation of subject level and tempo of the lesson (v.d.Horst 1993). In the classroom, the teacher is the agent of culture. S(he) makes judgements and choices on what should be taught, how it should be taught and to whom it should be taught (Nickson 1994, Noddings 1992). The educators' views, beliefs and preferences about mathematics influence their instructional practices. There are teachers who do not show tolerance of cultures other than their own. The child at the margin who does not share the same culture as this teacher is disadvantaged. Teachers who do not fully understand or enjoy a particular aspect/section in mathematics will either omit the section from their teaching or dispense of it in as few lessons as possible. Learners who are already experiencing problems in their understanding of mathematics are further disadvantaged.

Teachers adopt a particular strategy because of "*supposed effectiveness*" (Nickson 1994:13). This may be true because they are more concerned with obtaining the correct answers rather than the child's understanding of the subject matter. A second reason may be that these are teachers who belong to the old school of thought, and believe that if the method being used was successful why change a winning formula? Some teachers of mathematics tend to use drill instead of exploration and imitation rather than investigation despite the aspect of mathematics that is being taught (Volmink1994). Even in geometry some teachers teach their pupils how to prove the theorem rather than allowing them to discover for themselves. The retention of information acquired through these methods of instruction is short lived since learners have not been able to internalise the information.

Teachers are encouraged to ensure that as much mathematics teaching as possible is based upon shared activity and that the subject is presented as open to discussion and investigation (Nickson 1994). The trend is a move toward the sharing of ideas and problems among pupils and between pupils and teachers. The learning and application of mathematical concepts is more purposeful through the shared nature of the subject. However, there are those teachers who do not believe in group work and discussion in their classrooms because they are of the opinion that pupils do not learn but rather copy the work.

The mathematics curriculum does not differentiate amongst learners; in many a case neither does the teacher. The problem arises from the fact that all children do not have equal opportunity to achieve in the subject, for example: middle class children are asked the higher order questions (Willis 1998: 13). These examples are not in the child's reality. As a result, the child does not understand the question and cannot answer correctly. In order to improve the implementation of the curriculum, the teacher could draw equally upon and extend the learners' experiences. By teaching mathematics through real world problems, the teacher is able to change the pupils' attitudes toward the subject. Learners will become internally motivated and develop an affinity for the subject. Many teachers themselves do not know how to solve these problems, therefore cannot assist their pupils. All learners in the classroom could be given equal support by the environment. In many instances, the classroom environment does not reflect mathematics as an integral part of human culture (Nickson 1994).

The manner in which a learner understands the mathematical content will influence the classroom instruction. If the child poses a question that provokes re-thinking on the part of the teacher, s(he) could affect the teacher's knowledge. Teachers who have limited, fragile or incorrect knowledge with regard to a particular aspect in mathematics tend to rely on the top performing students to assist him/her. As a result, the educator accepts answers that are not wholly correct thereby causing confusion in the mind of the child (Zaslavsky: 1994). On the other hand, this questioning influences dialogue and alerts the teacher. It calls for deeper understanding and greater effort on the part of the teacher, resulting in a change in attitude. Poorly prepared teachers produce weak and poorly prepared students, resulting in a lack of enthusiasm on the part of both teachers and pupils (Webb 1998).

Learner-centered and problem-centered education are the way forward in the mathematics classroom. The problem – centered lesson is based on problems in an everyday context rather than the school context and proves to be more successful. Outcome - based education makes an attempt at striking a balance between formal schooling and the knowledge that is produced and acquired in other settings. The basis of the problem-centered approach is that pupils do not have to do computations in any prescribed way, but rather through the use of common sense. This is not always the situations in classrooms as teachers tend to prescribe methods for learners to follow.

3.2.3. The Attained Curriculum

The attained curriculum is the answer to the question: *What have students learnt?* This question is generally answered by their achievements and attitudes. Assessment indicates the learners' achievements. This may prove both positive and negative in the case of the youth at-risk. A good assessment may motivate the learner into wanting to achieve while a poor assessment may de-motivate the pupil and further marginalise the individual.

Many students learn mathematics because of what the book "*tells*" them or it is part of the "*work*" given by the teacher (Nickson 1994: 25). Learners do not see mathematics as a subject for exploration or discussion nor does it serve to acquire any relevant or useful information. This attitude towards mathematics could change if pupils were involved in planning, challenging, negotiating and evaluating the work that they do in the subject. If children are involved in constructing the objectives in mathematics, their own learning will be guided (Dewey 1963). Being involved in planning and negotiations will make the mathematics more realistic to the child. Many children have resigned themselves to the fact that the only thing that counts in a mathematics classroom is what the teacher wants and what the teacher knows (Volmink1994). Children are confronted by problems they cannot solve or with different views to the same problems.

Why do children fail mathematics? Many learners do not recognise the context of the question. This is often the result of learners not understanding the language in which the question is phrased. For others, the content of the question may lie outside the reality of their world. Consequently, these pupils draw answers from their everyday resources rather than from specialised resources of mathematics. Learners are poorly motivated in the classroom because the features of a particular problem are very different from other situations for which they have well-developed schemas. Word problems are often mishandled in the classroom because they lend themselves to "*solutions – by - template*" (Wu 1997: 26). Pupils tend to solve the problems by rote, be it theorems or applications, implying poor integration between theory and application.

The existence of Folk Mathematics demonstrates that mathematics is produced and reproduced by human beings as it is used in their daily lives (Mellin – Olsen 2000). The manner in which it is used depends on how the mathematics is developed (learnt). Since mathematics is a human activity that can be learnt through discovery, students could rediscover bits of mathematics and construct it themselves. Pupils who practice problems are stimulated into using their own strategies. Through exploring problems and ideas and communicating with each other and with the teacher, many learners, even those at the margin, are able to solve them in their own way.

Human beings communicate with each other through language. Learners interpret the teacher's instructions according to their understanding of the words being used. The individual's language is developed according to his reality. Language is important in the development of thought. There may be occasions where misconceptions may arise due to language usage - what is being interpreted is not what is meant. Mathematics has a language of its own, which, at times, can prove difficult for English - speaking learners. Differences do exist between mathematical English and ordinary English. It is even more difficult for a student whose mother tongue is not English to comprehend mathematical English. Misinterpretation of a question or instruction does not necessarily imply a lack of knowledge. Many pupils communicate in their mother tongue in order to understand the mathematics that they are taught.

From the results of achievement tests administered to South African learners in grades 7 and 8 in the TIMSS study (Summary Report 1997), the following can be observed:

- Learners did not perform well in any area of mathematics.
- South African results indicated the lowest overall improvement from grade 7 to 8.
- It appears that South African students generally possess inadequate problem-solving techniques.
- The South African students generally have difficulty in constructing their own answers.
- The problem of language was evident in the international results. The majority of South African learners wrote these tests in a language other than their mother tongue.
- There appeared a strong link between the home environment and achievement.
- The performance of learners on questions covered by the curriculum did not differ much from those not in the curriculum.

If these were the results of learners in the mainstream school, what then happens to the learner at the margin based in schools of this nature? Are the residential schools/shelters, which are implementing the national curriculum, achieving their goals? Will the implementation of outcomes-based education alleviate the problems facing the learner at the margin and improve the understanding of mathematics being taught in the classroom?

The ability to be mathematically literate, gives one a sense of confidence and enhances the self-esteem. If the system of outcomes-based education is to promote innovation and creativity, then the use of street mathematics in the solution of problems in the classroom may be acceptable. This will enable the learner at the margin to become more competent in the subject as s(he) will be employing methods that are familiar to her/him. The development of self-empowerment, thinking skills and independent learning within the at-risk youth can be accelerated.

3.3. CONCLUSION

The theories of learning provided insight into how the learner develops his/her mathematical skills while at the same time illustrating the fact that they ignored the needs of the learner at the margin. The literature is very explicit with regard to the need for mathematical problems to be situated in the learner's *'reality'*. The use of street mathematics by many individuals places emphasis on the utilitarian value of the subject.

From the discussion on the teaching and learning of mathematics for children at the margin it can be observed that there exists a discrepancy in what is expected from the curriculum and what is actually achieved. In chapters 5 and 6 I will share the mathematics education experiences of two learners at the margin.

CHAPTER 4

METHODOLOGY:

THOSE MEMORABLE MOMENTS.

Without all the colours there would be no rainbow.

- Desmond Tutu

4.0. INTRODUCTION

The purpose of the study is to describe and explain how two at-risk youth are taught and learn mathematics in two different sets of environment. The research takes the form of a qualitative case study (Cohen & Manion 1980; Shumway 1980; Stake 1998; Govender 2002). To facilitate discussion and analysis this chapter outlines the methodology adopted to carry out the study. It includes the descriptions of the research context, the research participants, research procedures, the research instruments employed in the study and an interrogation of the disruptions experienced by the researcher. The research context and the time frame for data collection are two important factors influencing this study.

4.1. THE RESEARCH CONTEXT

In August 1999, I accompanied Dr Renuka Vithal and the Co-ordinated Masters in Education and Training students to the Thuthukani Harm Reduction Centre in Durban as part of a masters module in mathematics education. I returned home knowing that '*this was the place where I wanted to conduct my study*' in mathematics education.

The Thuthukani Harm Reduction Centre, a residential shelter for at-risk youth or "street children", had opened recently (July 1999). The shelter is housed in a derelict, unused building situated in a business complex in central Durban (see appendix B – Thuthukani: location and ground floor plan). The high brick walls that surround the shelter keep the buildings hidden from the passersby on the street. Roads that carry a high volume of traffic run adjacent to and above the school. The shelter is void of any playground. The residents of the centre use the car park as a sports field. The area surrounding the buildings is dirty. The stench of urine as you walk through the narrow passage towards the entrance is unmistakable. The complex is built around a quadrangle where the morning assembly is held. The management at the shelter is trying to revamp an unkempt garden by planting trees and seedlings. Lack of good ventilation results in the interior of the buildings being dank and dark. The few windows that exist are broken, leaving the rooms cold in poor weather. Photographs depicting the exterior of Thuthukani, taken from the car park, appear below.

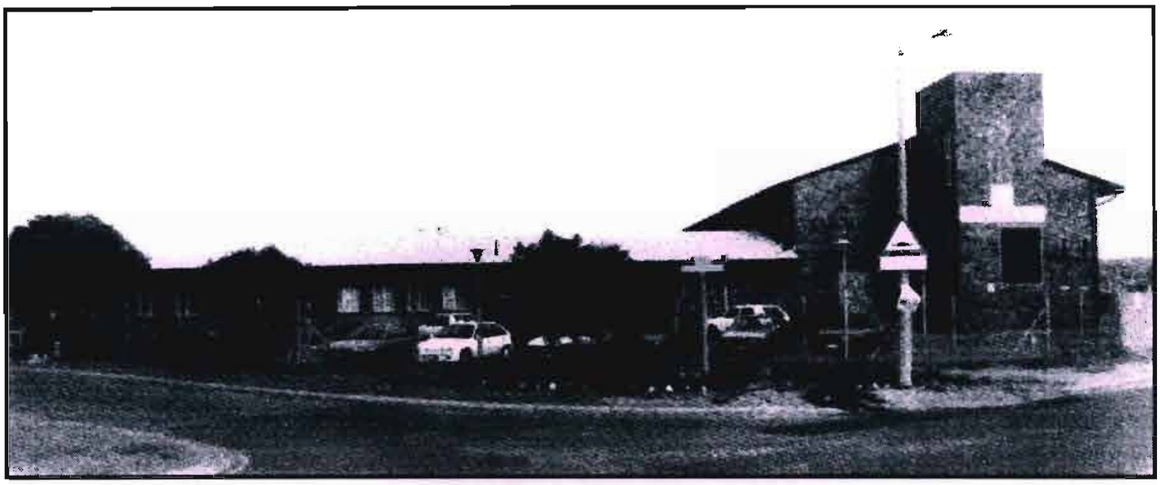
A

B

The co-ordinators of the shelter were still in the process of settling in, in November. Qualified teachers had volunteered to teach at the school (they were to receive a travel allowance), which was being set up. Telephonic permission for undertaking my study at Thuthukani was sought from Ms Jasmin Paras, a University of Durban-Westville representative at the shelter, and Ms Julia Zungu, who was in charge of the shelter. My arrival at the school in early November saw the pupils placed in classes after being '*assessed*' by a social worker (discussion with teacher – pilot group- RJ: 4/11/99). The centre was still formulating a suitable curriculum and setting up a basic infrastructure for the running of the shelter. A state of flux prevailed, as teachers were concerned about the continued existence of the school due to funding issues. In the midst of this complex situation learners (who were already victims of circumstances) were trying to survive. There I met Wiseman.

The second site chosen for the study was Sanville Secondary (a pseudonym used at the request of the principal to support anonymity) is a well-established school, which has been in existence for seventy-eight years (established in 1924). This previously "Coloured" school was situated in buildings on the fringes of the city centre for sixty-five years. The intake of "Black" learners into the school, in 1984, heralded a change in the apartheid system of education. In 1989, the school relocated to a "Coloured" township, south of Durban. The school is situated on the border of a residential and industrial area. It comprises of seven, well-maintained buildings which house the administration offices of the school, the staff room, school hall, technical facilities, resource centre and classrooms (see appendix C – Sanville Secondary: location and ground floor plan). Wire fencing is erected around the periphery of the school campus with a signboard at the gate, welcoming the visitor to the school. Two tarred car parks, one for staff and the other for visitors, are situated in neatly manicured gardens. The large play field, situated at one end of the terrain, accommodates the various codes of sport and extra-curricular activities, which are offered to the learners at the school. Maintenance and renovations to the school were underway during the period of my visits. Below is the photograph of Sanville Secondary School, taken from the road directly outside the car park reserved for teachers.

C



The school boasts a staff of thirty educators (of both "Indian" and "Coloured" origin) and a student population of one thousand and forty. The pupils enjoy the advantage of qualified teachers who are given professional support through departmental workshops, departmental curricula and syllabi, inter-school and internal workshops and meetings. The placing of pupils into a given grade is executed according to achievement in tests and examinations written throughout the year. This is in accordance with the Department of Education's regulations governing promotion and retardation. The principal of the school granted me permission, verbally, to carry out my study at his school. It was in this school that I met and came to know Nellie.

4.2. RESEARCH METHODOLOGY

My main goal in undertaking this study is: to explore the type of mathematics education youth at-risk receive in a mathematics classroom. These learners are already at the margin of society when they come into the classroom. Careful consideration has to be given to the techniques and procedures used in the process of data collection, so as to ensure that these learners are not made to feel any more alienated than they are. This is to ensure that I, as the researcher, am able to obtain the most authentic set of data possible.

Besides, these learners have problems of their own, therefore I would rather that they be integrated into the class group. According to Kaplan (1980), the aim of methodology is:

> *To describe and analyse these methods* (those being adopted by the researcher), *throwing light on their limitations and resources, clarifying their presuppositions and consequences, relating their potentialities to the twilight zone at the frontiers of knowledge. It is to venture generalizations from the success of particular techniques, suggesting new applications, and to unfold the specific bearings of logical and meta-physical principles on concrete problems, suggesting new formulations.*
>
> (Cohen & Manion 1980: 26).

The aim of methodology is to assist researchers understand not only the products of scientific inquiry but also the process of the inquiry. The research project on hand calls for an in-depth investigation and analysis, which lends itself to a qualitative case study. A discussion of the qualitative method of inquiry and the case study ensue.

4.2.1. The Qualitative Method

This process of understanding is based on distinct traditional methods of inquiry that explore a social or human problem. It '*explores the experiences of people in their everyday lives*' (Mayan 2001: 5). The research is conducted in its natural setting, which in this study, is the mathematics classroom. The researcher attempts to understand the situation without imposing any preconceived expectations on the study. Since the aim of this form of inquiry is to understand phenomena in their natural setting the researcher does not try to manipulate the external influences. The goal is to obtain full and sincere responses to open-ended inquiries.

Qualitative research allows events to be captured through the words of the participant with the intention to disclose and reveal. The language of the research participant is important. The actual words of the subject are critical to the process of conveying the meaning as it allows the researcher to discover the issues that the subject considers important and meaningful. Methods used by qualitative researchers produce a deeper understanding of social phenomena (Silverman 2000). They use non-numerical and non-statistical procedures such as interviews and observations. When undertaking qualitative data collection, the following elements may be considered:

- The researcher must get close enough to both the people and situation being studied to enable her to understand the depth and details of the activity taking place;
- It is important to capture what actually takes place and what people actually say;
- Qualitative data consists of pure description of people, activities and interactions, as well as, direct quotations from people, both what they speak and they write down (Govender 2002).

There are those researchers who question the reliability and validity of the qualitative approach. However, the use of brief conversations, snippets from unstructured interviews, and extracts from learners' work can provide concrete evidence in support of a particular contention. The subjectivities of the researcher and her/his reflections on observations may become data in their own right (Silverman 2000). Critics of qualitative research contend that these researchers are influenced by their political values, while Silverman (2000) is of the opinion that flexibility encourages the qualitative researcher to be innovative. In my opinion, the qualitative approach best suits the needs of my study because it allows me to use the learners' work, extracts from interviews and conversations and reflections of the participants to better understand their experience of mathematics teaching and learning.

4.2.2. The Case Study

Cohen and Manion (1980) describe case study as the observation of the characteristics of an individual unit, for example, a child, a class, a school. A case study is not a methodological choice, but a choice of object to be studied (Stake 1998). The researcher chooses to study the case. It is a detailed and in-depth study of a particular case, which maybe simple or complex. The purpose of this observation is to "*probe deeply and to analyse intensively the multifarious phenomena that constitutes the life cycle of the unit* (Stake 1998: 99). The researcher's aim is to establish generalisations about a greater population of which the unit is a part. The case study has also been referred to as the "*teaching experiment*" (Johnson 1980 in Shumway). He describes case study as follows:

> *It involves the intensive study of individuals or situations. It may involve interrogation and observation of an individual to assess his characteristics and then relate these characteristics to certain performance patterns. In view of the complexity of human learning it might be fruitful to investigate concept formation, problem solving, motivation, sources of difficulty or errors by this method.*

The cases being investigated are two youth at-risk, one male and the other female. An in-depth study of their lives in the mathematics classroom was undertaken. Their activities in the classroom were observed and recorded on video-cassette and the participants were interviewed to assist in explaining their understanding of and performance in mathematics.

It is important for consistency and sequence to prevail in a case study. This assists the researcher in drawing out the themes that exist in her study. The case researcher sometimes experiences problems in identifying where the child ends and the environment begins (Stake 1998). However the behaviour patterns of the system play a pivotal role in understanding the case.

There are different purposes for studying cases, three of which may be identified as follows:

- *intrinsic case study which is undertaken because the researcher wants a better understanding of the particular case.*

- *instrumental case study, where a particular case provides insight into an issue or refinement of theory. The case facilitates an understanding of something else.*
- *collective case study which is an instrumental study of several cases to inquire into phenomena or general conditions.*

(Stake 1998: 88)

This study of at-risk youth may be categorised as a collective case study as it involves the study of two cases, which will lead to a better understanding of youth at-risk. I may also classify the study as intrinsic since I, as the researcher, would like to gain insight into the mathematics education of these learners at the margin.

Central to every case study is the method of observation. Participant observation and non-participant observation are the principal methods employed by researchers who use case study.

- The non-participant observer stands aloof from the group activities which s(he) is investigating. This observer generally sits at the back of the classroom, recording the verbal exchanges that transpire between teacher and learner using a set of '*observational categories*' (Cohen & Manion 1980).

- The participant observer "*engages in the very activities he sets out to explore*" (Cohen & Manion 1980: 101). S(he) may work with or without the guise of a cover. Some advantages in the participant observation approach are:
  * Data collected on non-verbal behaviour is superior to that of experiments and surveys.
  * The investigator is able to discern ongoing behaviour and make appropriate notes about its salient features.
  * The researcher can develop a more intimate and informal relationship with those he is observing because of the length of observation period.

* Case study observations are less reactive than other types of data-gathering methods.

There are criticisms to this approach of observation, namely, subjectivity, biasness, it is impressionistic and lacks in a precise quantifiable measures. The retention of the researchers perspective is questioned, as is the validity of observation-based research.

The type of setting in which the research takes place influences the type of observation. This is true of my experiences as a researcher. At Sanville Secondary (where the classes were large and the setting formal), I retained my position as non-participant observer. I was allocated a seat at the front, left-hand corner of the classroom. From this position, I visually recorded the lessons on videotape and recorded data in my reflective journal. Since the teacher spent much time at her table, marking, it afforded me the opportunity to hold discussions with her, which I later entered into my reflective journal. The formal atmosphere that prevailed in the classroom did not lend itself to interacting with the pupils. As a result I was not able to peruse through the books of other learners. Nonetheless, the teacher made available, to me the tests and exercise books of a second student. However, in the relaxed, informal atmosphere of Thuthukani (with the maximum class size of ten) it was difficult not to be drawn in to participate. The eagerness of the learners to share their work with you and enthusiasm of the teacher, wanting feedback on his lessons, does not allow the researcher an excuse to remain on the periphery. I was also able to acquaint myself with the work done by the other pupils in the class and hold informal discussions with them. I became the '*observer as participant*' (Mayan 2001: 12) by becoming involved in the activities in the Thuthukani classroom whilst taking the time to record my observations.

4.3. Time Frame for Data Collection

Data collection at Thuthukani was confined to two weeks. This included a pilot survey carried out with a group of younger learners at the school, making observations, recording lessons on video tape and conducting interviews and discussions with teachers and learners. Time was a major factor. I was a senior mathematics educator at a secondary school and hence had my responsibility toward my own students. It was also that part of the year when examinations were looming, making its demands on teachers. The mathematics lessons at Thuthukani were conducted early in the morning. As I was to follow the progress of learners from Thuthukani into the mainstream school the following year, it was imperative for me to collect the data before schools closed for the Christmas vacation. The second round of data would be collected once the learners had settled into the mainstream school in the following year. Special concessions were made for me during the writing of examinations at my school to accommodate my collection of data.

The time period spent in the classroom at Thuthukani and my own commitments at my school, dictated the length of my classroom visits at Sanville Secondary School. I wanted to observe (more or less) the same number of lessons at each of the sites. This would allow both research participants, to be given equal attention, in the narration of their stories. Unlike Thuthukani, were mathematics lessons of forty-five minute duration are held daily, Sanville Secondary runs a timetable on a five-day cycle of thirty-four lessons. As a result the length of the lessons vary according to the day of the week.

Although I would have preferred to observe more lessons in each of the given contexts, the data collected provided sufficient information to make a detailed analysis. It is the dynamic nature of contexts and disruptions in conditions that determined the data collection. As a result of the disruptions experienced at Thuthukani, I allowed myself three days more than I spent at Thuthukani to accommodate the lessons lost when the teacher at Sanville Secondary was absent from school due to illness and involved in fund-raising endeavours.

4.4. DISRUPTIONS OR DIVINE INTERVENTION?

I had envisaged research in Mathematics Education to proceed in a neat, ordered manner:

- propose a research topic to investigate
- develop the methodology to follow

- determine the research sample
- collect the data
- write up your findings.

There was to be a smooth transition from step one through to step five. However, Day 3 of data collection (with the senior pupils) at Thuthukani showed me what research was all about. I met my first disruption (and the reality of research). My research subject, Wiseman, was absent from class. The Queen of England was in Durban and he had an appointment to have tea with Her Majesty. My data collection was of secondary importance to him. The next interruption came in the form of a religious holiday, Diwali (8/11/99). Since there were a few teachers of Indian origin at the school, lessons were cancelled to accommodate religious tolerance. The teachers at Thuthukani had volunteered their services to the school. However, they were to be compensated for travelling. Thuthukani, being a new institution, had some teething problems. Teachers were concerned about their allowances and the future of the school, resulting in their not teaching for the day. What did this mean for me as a researcher? Was this another day of '*no data*'? More importantly, what implications did these disruptions have for the learner?

My original study was to observe a group of at-risk youth that schooled at a residential shelter (in 1999) and follow them into a mainstream school in the following year (2000). The aim of this study was to determine how they learnt mathematics in each of these environments. The teacher had identified a group of boys who he thought had the potential to cope in the mainstream school. At the beginning of the year 2000 I returned to Thuthukani to obtain the names of the learners and the school in which they had been placed. These learners were no longer resident at Thuthukani, but had been placed in children's homes around Durban. Some of the learners had left Thuthukani before they had been placed. None of the learners that I had observed in 1999 were to be found. Others that had been placed had left their residences. Where do I go from here? Was I to start a whole new study? These '*series of disruptions and changes in important aspects of the context*' (Vithal 1998 in Valero & Vithal 1999: 8) led to a modification in my research strategy.

This initiated my search for at-risk youth, living at a home for abandoned or abused children and attending a mainstream school. The search led me to Nellie. The interruptions in data collection did not end here. Changes in school times to accommodate extra-curricular and co-curricular activities shortened the duration of lessons on days three and five on the time-table of Sanville Secondary School. The teacher was a member of the school's fundraising committee. She required time off from school to co-ordinate a fundraising activity at the end of the week. (Pupils were left to their own devices while a group of teachers left school to organise the activity). The teacher was also away from school for two days due to ill health. This meant no lesson for the learners and no data for me. The school closed early on day five to accommodate a career's day for neighbouring schools. These disruptions illustrate '*the changing and unstable*' (Valero & Vithal 1999: 8) nature of the contexts in which the research was conducted.

In developing countries, the researcher faces challenges due to the rapid and constant changes of society. Valero and Vithal (1999: 6) suggest that cognisance of this should be taken into account by researchers of the '*north*' (developed societies). This could bring to the fore "*new relevant problems and insights which remain hidden in 'normal' research situations*". If these disruptions caused me, as the researcher, to become anxious, what happens to the youth at-risk present in these classrooms? Do they become agitated by the lack of stability?

Vithal and Valero (2001: 45) emphasize that '*the difficulties of research in situations of social and political conflict must be put on the broad range of frameworks and approaches*'. It is also suggested that consideration be given to the fact that these disruptions may be able to '*generate research to shape and guide national policy*'. Research conducted in the classroom, stemming from these difficulties, will help all stakeholders better understand and transform education.

Were these disruptions or divine intervention? My answer to that question is: both. Had the youth, that I had been observing at Thuthukani, not disappeared, my life would not have been enriched by Nellie's experiences. This is definitely divine intervention. All the other incidents mentioned above were disruptions!

4.5. THE RESEARCH PARTICIPANTS

This study comprised of two participants who may be identified as follows:

- at-risk youth resident at a shelter and schooling on the premises: Wiseman
- at-risk youth living at a home for children and attending a mainstream school: Nellie.

4.5.1. At-Risk Youth Resident at Thuthukani

For the first three days at Thuthukani, I observed lessons in a class of younger learners. Jasmin Paras (at the shelter) had suggested my joining this group. This was used as a pilot to construct my perceptions on how lessons are conducted at the school. It was easier to get into the classroom of younger children. I did not know what reactions to expect from the youth. Since three groups of learners shared different areas of the same room, the learners in the other groups would become accustomed to my presence in the room.

During this time I befriended the teacher of the senior group in the room, Mr Xulu, and explained my intended study. I was welcomed into his group. The teacher explained to the learners the reason for my being there amongst them. They were informed that I would be observing and recording their lessons, making copies of their exercise books, taking photographs of them in their environment, engaging in informal discussions. At the end of the observation period, they would have to write a reflection for me. The learners, in this senior group, were promised anonymity and assured that I was neither a police informant nor a newspaper reporter. My purpose there was to learn from them, not cause them any harm.

The pupils continued to work, unhindered by my use of the video recorder camera nor my presence. Mr Xulu identified four learners in his group whom he considered capable of coping in the mainstream school the following year. Confirmation of their placement in the mainstream school would be done by Jasmin and '*social workers*' (discussion with teacher: 9/11/99). I observed these four pupils in their learning environment. The pupils, all boys, in this senior group were uninhibited and felt free to question me about both their work and my camera. They proudly volunteered their books for my perusal. Wiseman (a pseudonym to protect his identity) became a focal point of my study, since his enthusiasm for and interest in mathematics always found him answering the questions asked by the teacher.

4.5.2. At-Risk Youth at Sanville Secondary School

Attempts at locating a youth at-risk who was housed at a children's home, attending a mainstream school and whose school was prepared to participate in the study were proving fruitless. I was beginning to believe that I needed to change my direction of study, when I discovered Nellie (again a pseudonym) through a friend, an educator at her school. The principal of the Sanville Secondary School had conceded to my request: to carry out my study at his school. Nellie's form teacher (who is also her mathematics educator) was informed of my visits to her classroom by the principal. Mrs James was very accommodating. I did not want Nellie to be uncomfortable or to feel conspicuous in the classroom. My aim was to observe her in the classroom environment without my influencing her behaviour. The teacher explained my presence to the learners: to observe the mathematics lessons for two weeks. She allowed the use of a video-recording camera in her room. The teacher pointed out Nellie to me and furnished me with a brief synopsis of her background. After observing three lessons in the classroom, Mrs James and I informed Nellie of the exact nature of my visits. Besides the observations in class, I would be:

- making copies of her exercise books and tests
- conducting an unstructured interview with her.

As she was not willing to write a reflection for me, we discarded that aspect. The learner was enthusiastic to participate in the study.

The table below summarizes the similarities and differences between the two learners:

Similarities	Differences
Race	Gender
At-risk youth	Educational background of learners
	Types of school attended
	Place of residence
	Grade level of learners
	Teachers' experience and qualification

TABLE 4.1. Similarities and Differences between Wiseman and Nellie

4.6. INSTRUMENTATION

The use of various research instruments in the collection of data, enabled triangulation, cleared misconceptions and facilitated understanding, analysis and interpretation. The following instruments were used in this study:

- video camera recordings
- photographs
- reflective journal of researcher
- unstructured interviews
- informal discussions with teachers and learners
- pupils' written reflections
- pupils' work

4.6.1. Video Camera Recordings

Video camera recordings played a vital role in visually capturing the interaction that took place in the classroom. It presents a picture of exactly what transpired in the unique setting at Thuthukani. The recordings illustrate the feelings of the learners through facial expressions, gestures, tone of voice and posture. Permission for the use of the cam-corder was obtained from both learners and educators (in both schools). Learners in both the schools were willing '*to be filmed*'. The youth at Thuthukani were excited to see themselves on the '*small screen*'. The teacher at Thuthukani was more than accommodating and even '*dressed for the camera*' (RJ: 10/11/ 99 – day 4). He wanted a copy of the video for himself. Five lessons of the grade eight class at Sanville Secondary were recorded on video. At Thuthukani, three lessons in each of the respective groups (namely, the pilot group and the senior group) were recorded. The recordings, which are referenced as video recording followed by the date and lesson number, provided me with the necessary information to construct the context for the writing of this report. It provided much of the information for the compilation of chapters four, five and six.

4.6.2. Photographs

Photographs served as reinforcement in the writing up of the context of this report. They were primarily of the physical environment of both research sites. Some of the photographs taken were given to the pupils as a token of appreciation. All photographs were taken with the permission of the persons concerned. None of the photographs of the learners or the teachers have been printed so as to protect the identity of the individuals. Photographs depicting the physical environment and condition of Thuthukani and Sanville Secondary are illustrated in section 4.1. The Research Context. The photographs aided in reconstructing the context of writing the report.

4.6.3. Reflective Journal

I, as the researcher, kept a journal (referenced as RJ followed by the date of entry and day of lesson when cited as data). This journal captured the daily reflections, experiences, perceptions and descriptions. It proved to be an invaluable source in the construction of the context and supplemented the information that had been captured visually. The following extracts from the journal illustrate the type of entries made and the purpose each served:

- Descriptions of the environment –
  These children have to live in and work under such difficult conditions....yet they are enthusiastic about learning. (RJ: 2/11/99 – day in pilot class)

- Lack of resources –
  There is no evidence of storage space...the 'chalkboard' stands on the floor, against the wall ...she has to bend to reach the board...no chair provided for the teacher...(am I lucky in my school!) (RJ: 2/11/99 – day 1 in pilot class).

- My role as a researcher -
  I found it difficult to restrain myself from correcting the teacher during the lesson. I had to remind myself that as the observer it was not my place.
  (RJ: 5/11/99 – lesson 1 at Thuthukani).

- Incidental encounters with visitors, staff, and learners –
  It's the first time in 19 years that I felt the real joy of being an educator.... The little boy just walked up to me and gave me the most sincere hug.
  (RJ: 5/11/99 – directly after assembly at Thuthukani)

- Concerns about the collection of data –
  Another day lost ...I will not be able to collect sufficient data for the study...I should reconsider this research question (RJ: 9/11/99-lesson 2 at Thuthukani).

- Concerns about the progress of the study –
  I have no idea as to where to go from here…seems like a dead end. I will have to change my research question in order to complete my study.
  (RJ: March 2000 – on the discovery that the learners from Thuthukani could not be traced).

- Teaching practices of teachers –
  …Pupils were asked to record the questions in their algebra books and work through them. The teacher sat at the table at the front of the room, marking the matric trial examination scripts (RJ: 12/09/2000 – lesson 2 at Sanville Secondary).

- Pupils attitude toward the mathematics lessons –
  She (Nellie) places her head on her folded arms on the desk and falls off to sleep. (RJ: 12/09/2000 – lesson 2 at Sanville Secondary).

An attempt to get pupils at both Thuthukani and Sanville Secondary to keep a journal failed. The idea was abandoned.

4.6.4. Unstructured Interviews

Interviews allow the researcher to determine what the person knows, thinks (attitudes and beliefs), her/his likes and dislikes (values and preferences). It also gives insight into what experiences have taken place.

In an unstructured interactive interview the participants '*tell their stories*' or '*talk about their experiences*' while the researcher listens to learn. In this way more in-depth responses are elicited from the interviewee. This form of interview does not restrict the learner. Nellie was given an interview of this nature. It provided her with an opportunity to use her own language to describe her experiences. The grammar has been preserved when citing excerpts from the interview to allow the reader to know exactly how Nellie speaks. I was better able to understand Nellie's emotions and behaviour after the interview with her. Questions related to her behaviour in the classroom and her understanding of mathematics were posed to Nellie, for example: *How do you feel about mathematics?* The interview took place on the final day of my visits to Sanville Secondary School. The conversation was recorded on audio-tape (interrupted by the sounds of the aeroplanes resulting in sound recordings being poor at times). This also interrupted Nellie's trend of thought at times. When excerpts from these interviews are cited as data they are referenced as N: Interview, N being Nellie's initial.

4.6.5. Informal Discussions with Teachers and Learners

The informal discussions with both teachers and learners (referenced as discussion followed by a name or title and date) prove to provide some very significant information regarding their perceptions and feelings about the challenges that each of the participants was facing. These discussions, which differ from the unstructured interview in that it is not carried out at any pre-scheduled time, took place throughout my stay at each of the schools. Questions asked during these discussions were not pre-planned. The teachers used these discussion times to their advantage as well, by drawing on my experiences as an educator of mathematics. Mr Xulu, being a fairly inexperienced teacher, asked for feedback on his lessons. These discussions benefited all participants in the research process. Notes on these discussions were recorded as soon as I left the classroom on my way back to school or during the course of the lessons.

4.6.6. Pupil's Reflections

On my last day of observation at Thuthukani, learners were asked to record in writing their thoughts and feelings about their school and the subject, mathematics. Wiseman preferred writing to an unstructured interview. This may be as a result of his being afraid of the fact that he cannot express himself clearly. Pupils were allowed to express themselves in their own words, as discussed in 4.2.1. above. From this exercise, I was able to gauge Wiseman's writing skills and, more importantly, his ability to use and understand the English language since this impacts on the comprehension of mathematics in the classroom. I have preserved the incorrect grammar and spelling in quotes to give the reader a better sense of who Wiseman is, since these express his feelings more intensely. Although it did not provide such in-depth information as the interview, these expressions of feelings supplemented the discussions. Wiseman's written reflections are referenced as (W: reflections) where W is Wiseman's initial.

4.6.7. Pupils' Exercises and Tests

(See Schedule: Appendices D & E)

To obtain a more detailed analysis of these two learners' ability and performance in mathematics, I made copies of the exercises, completed in class, by both the research participants. Mr Xulu was not able to give me a copy of Wiseman's tests (I have not seen any evidence of a written or oral test). Mrs James made copies of Nellie's tests, including a major term test, available to me. (I was also given copies of two of her progress reports). These exercises illustrate both the quality and quantity of work done in each of the learning environments. Misconceptions and the comprehension level (strengths and weaknesses) can be identified. They provide insight into lessons taught prior to the observation period and the continuity in the teaching and learning of mathematics in these two contexts. Appendix D is a collection of Wiseman's work while appendix E is that of Nellie.

4.7. CONCLUSION

This chapter examines the decisions for, the criticisms against and debates on using a qualitative case study. Circumstances determined the direction and design of the study. Time constraints demanded the use of numerous research instruments yielding a data – rich study. The next two chapters relate the stories of Wiseman and Nellie respectively. In chapter six I undertake to analyse the data collected.

CHAPTER 5

WISEMAN: AN EXPERIENCE OF 'REAL' EDUCATION

If you can dream it, you can do it.
Walt Disney

5.0. INTRODUCTION

In this chapter, I share data gathered about Wiseman, a learner at the Thuthukani Harm Reduction Centre, the learning environment and teaching content from the perspective of the researcher (a participant observer), the teacher and the learner. The information presented in this chapter is based on class observations, conducted over a six-day period, of the context and the learners in both the pilot class and Wiseman's class, with particular interest in Wiseman. These lessons were recorded on video cassette.

I use my perspective as the point of departure for each of the components. Information recorded in unstructured interviews and informal discussions with either the learners or members of staff, in my reflective journal and the learners' reflections and a copy of Wiseman's workbook are used to supplement these views.

The categories that I have identified for presenting the data are as follows: learner's background, the learning environment, the mathematics content, mathematics teaching and mathematics learning, as they will assist in answering the critical questions that I am asking.

5.1. YOUTH OR MAN ?

Wiseman, a black male, is fifteen years old. He is a tall, well-built young man. Despite the fact that the clothes he wears are oversized (the clothes are donated to the Centre leaving him with no choice), he is always neatly dressed. While many of the youth at the centre do not concern themselves with their personal hygiene, Wiseman always arrives at class washed and clean. He does not wear shoes but would not say what had happened to the pair that was given to him. The soles of his feet have become hardened through walking around barefoot. In a discussion with a teacher, I discovered that the clothing and shoes given to these children were often sold, stolen or exchanged for glue or cigarettes (RJ: 3/11/99 – day 2 in pilot class).

Most of the learners at Thuthukani, have experienced negative family, school and social interactions. Wiseman, being a resident at Thuthukani, may have had similar experiences. These combined with a poor socio-economic background have led him to a life on the street. He does not really speak much about where he comes from or what experiences he has had. Since access to information on Wiseman's background proved difficult, it places limitations on a fully detailed description. Wiseman displays a characteristic evident in many youth at-risk: he is afraid to open up. According to a member of staff at Thuthukani

> *We are not allowed to question the pupils about their background.*
> *We do not want to frighten them off. If a pupil talks, we listen*
> (discussion with teacher from pilot class as noted in RJ: 3/11/99 – day 2).

At – risk youth face many stressors such as lack of food, shelter and physical safety, social rejection, peer threats and abuse, sexual and substance abuse, intimidation and lack of skills (Chetty 1997). Like youth at-risk the world over, the children at Thuthukani experience both deprivation and depression. His experiences, prior to arriving at the shelter, have caused him to look older than his years. Wiseman, in spite of being emotional and sensitive, has become resilient, streetwise and protective over his territory.

There is definitely no trace of his boyish looks or behaviour. His eyes show signs of tiredness that may be the result of lack of sleep, depression or substance abuse as many of the boys leave the shelter premises in the afternoon. Some of these children stay out all night, only returning to Thuthukani the following morning . There appears to be a sadness that lies within him as he rarely smiles. A flicker of a smile appeared on his face when he was chosen as part of a group to meet with Queen Elizabeth II (Queen of England) and have tea with her. However, he does not really show any excitement (RJ: 9/11/99 – lesson 2).

During lesson time, the following mannerisms are displayed by many of the learners:

- faces are covered in the presence of strangers
- heads are placed in the crooks of elbows placed on desks
- looking around the room or out the window
- playing with their pens.

This type of body language could imply shyness, embarrassment, tiredness (due to nocturnal activity), boredom or disinterest (with the lesson) or the after-effects of drugs. However, Wiseman is generally very alert and attentive, except for the day when he became agitated with the incorrect content of the lesson and began rocking in his chair (video recording: 10/11/99 – lesson 3).

While many of the learners at Thuthukani still need to acquire the basic skills of numeracy and literacy, Wiseman has attended school prior to living on the streets of Durban. He has the ability to read and write, as illustrated in his written reflections:

> *My name is Wiseman. My sername is Shandu.* (W: Reflections)

The fact that he ran away from his previous (mainstream) school because '*....teacher...he is not nice...hit with stick...*'(discussion with Wiseman), illustrates the fact that he is not prepared to accept abuse. The abuse that he endured at school may have contributed to his taking to life on the street.

Unlike the measures in place in the mainstream school to address the issue of pupil absenteeism and abscondment, attendance at Thuthukani cannot be made compulsory by teachers. Freedom of movement allows learners leave the premises and return as they please. This also includes learners walking out of lessons as they please.

> *This morning as I parked my car outside the classroom, three boys*

from the school climbed out the classroom window and left the school grounds while the assembly was on (RJ: 5/11/99- lesson 1).

I questioned a teacher about this and she said:

> *We can't force the learners to come to class. They leave here (the Shelter) before class starts. Some don't even come back. Everyday numbers (of learners) in classrooms change.* (Discussion: 5/11/99)

Wiseman's attendance appears to be very regular. This becomes evident when examining the tasks completed by him in his workbook (RJ: 5/11/99 – lesson 1). While the majority of the learners at the school arrive in class long after the school bell has sounded, Wiseman ensures that he arrives at the lesson on time. He displays a great sense of resposibilty. He enjoys being at Thuthukani.

> *I like my school. My school is very beautifull. .... I love you so much school becouse it is very clin. ...(I like) My school becuose very good. It give me for respect* (W: reflections).

The last statement illustrates Wiseman's need to be respected as an individual.

I like a charch (W: reflections) indicates that Wiseman upholds certain values in life. He has had exposure to religious education prior to entering the doors of Thuthukani. Many of the youth at the shelter resort to violence when confronted with a problem, as they may know no other way of solving the problem. Wiseman has also lived on the streets for a period of time and had to protect himself. Although I have not seen Wiseman involved in an altercation with other learners, he may also resort to violence if his rights are challenged. Despite this, Wiseman together with many of the boys, show much respect for their teachers.

Like many of the children at his school, he also shows an affinity for sport as he indicated in his reflections.

I like to be soccer, full ball an the basked ball (W: reflections).

He is aware of the various codes of sport and plays soccer with his friends in the car park at the shelter.

Winning a popularity contest is not one of the aims of the youth at Thuthukani. Living a life on the streets makes the individual suspicious and wary of the other people around him. Wiseman portrays these characteristics, finding it difficult '*to trust anyone*' with his affections and feelings ('discussion' with Wiseman). He prefers to sit on his own at one end of a row of desks rather than in a group with the other boys. While the other learners tend to discuss the solutions to questions, he enjoys working on his own. If approached by another pupil with a problem in mathematics, he is willing to assist. However, he does not readily engage in other discussions with the pupils seated around him. He feels protective over the younger residents at the shelter. This may be the result of knowing where they come from. Being one of the older boys at the shelter, gives him a sense of authority and self-esteem.

> *"...big children ...hit small boys...take away their things...shoes... clothes...I...not hurt small boys..."* ('discussion' with Wiseman).

While the other learners at Thuthukani were thrilled to have a new face amongst them, my presence in the room did not seem to affect Wiseman in the least. The other boys showed their interest in the video camera by asking questions about it and wanting to be filmed. However, this was not the case with Wiseman. He seemed to have developed enough trust in me by the final day of my observations to bring me his work for me to check it out, something that the other boys had done from day one. While the pupils were writing down their thoughts about their school, he and I had a casual conversation. Much of what he told me he wrote down in his reflections. Many of his answers were monosyllabic. He was very guarded when answering questions. I could not really penetrate the screen around him.

Here is a self-assured individual who displays leadership qualities and possesses a high self-esteem, evidence of which is revealed in his boldness and willingness to work mathematics examples on the chalkboard. He does not live for the day but has hope for the future. He is confident of himself and sets himself goals in life, the first being the attainment of a better education. His ambition is:

> *I want go to the Moment Hig School* (W: reflections).
> *I want to be scientist. I like science and mathematics.*
> (discussion with Wiseman).

According to his teacher, Wiseman should be one of the learners who would be placed in the mainstream school in the year 2000. He refers to Wiseman as the *'best student'* in his class because he is able to answer the questions in mathematics (discussion with teacher).

> "*We are completing the reports of the learners. We will give them to Jasmin. The social workers will decide on who goes to the other school. There are those four boys (points them out) who may go to* the school" (discussion with teacher: 9/11/99).

This should afford him the opportunity to fulfil a part of his dream – the desire to attain a secondary school education.

5.2. THE LEARNING ENVIRONMENT

Upon entering a school, one generally expects to find class units individually housed in classrooms. Due to the shortage of rooms at Thuthukani, the units are required to share the available space: two long, narrow rooms and three smaller rooms.

The unit of learners to which Wiseman belongs is based in a large hall (in fact, it is the dining hall) which is divided into three sections to accommodate three different groups of learners simultaneously. There is no form of partitioning to divide the units, hence pupils do not enjoy the luxury of privacy. The lack of space finds learners sitting cramped on uncomfortable furniture. Each class unit is provided with a portable chalkboard.

The learners in the group, that I am observing, are arranged in three rows facing the chalkboard, which leans against a table. This group comprises of "Black" boys, whose ages range from twelve to fifteen. Wiseman is one of the older boys in the group. The roll of this unit fluctuates between seven and ten as the youth join or leave units regularly. Their desks/ tables are arranged alongside the classroom wall that looks out onto the carpark. The first row of boys sit at two large tables, one of which is shared with the teacher. The next two rows consist of desks. The location of the chalkboard at the front of these rows of desks/tables, gave the class unit some resemblance to the traditional classroom in the mainstream school. There is a notable absence of a teacher's table, chair and a storage cupboard in the rooms.

The learning environment is made attractive by copies of pupils' work being pasted on the wall. Certificates of merit had been previously presented to learners. According to the teacher, these certificates are pasted on the classroom wall in the hope of motivating the other learners in the group (RJ: 5/11/99 – lesson 1). I noticed certificates that belonged to learners who had left the shelter, still pasted on the wall. Some of the questions that spring to mind concerning this issue are: If the certificate is to serve as motivation, why have these learners left the learning environment? Did the certificates have no value and meaning to the youth? What message were these discarded certificates sending out to the other learners that remained? It appeared to me that the certificates did not necessarily motivate all the youth at Thuthukani.

The limited resources at the school are only available due to the sponsorship by foreign donors, well-wishers and business houses. There are no textbooks for the learners, only the one that the teacher possesses. A limited quantity of consumable stock, which includes chalk, is made available to teachers. Pens, rulers and exercise books are handed to learners at the start of each lesson and collected by the teacher at the end of the lesson to avoid them being lost. A photocopy machine is housed in the office. There is also a very restricted library on the premises.

In order to teach a lesson, the teacher has to compete with two other teachers, two other groups of learners, as well as, the sound of the loud traffic of both cars entering the yard and the traffic on the roads. Wiseman and his peers have to also contend with their room being used as a thoroughfare by other learners and members of the shelter's staff. Since this school is only four months old, there are many interested parties who come to inquire about the running of the school. The time-table at Thuthukani is so constructed that all units are taught mathematics in the first session. Three lessons in mathematics are taught simultaneously in the same room. The learners have to be attuned to the voice of their teacher in order to grasp the lesson. This is no easy task for the learners. (RJ: 5/11/99 – lesson 1).

5.3. THE MATHEMATICS CONTENT

The mathematics being taught to this group of learners may be classified as equivalent to grade seven in the mainstream school. The teachers at Thuthukani follow a diluted version of the curriculum prescribed for the mainstream school, in that they do not adhere strictly to the syllabus, in terms of depth of content and sections of work taught. Teachers work individually and independently of one another. These educators determine what, when and how to teach depending on the mathematical ability of the class unit. This results in different lessons being taught to children who may be of the same age group.

On inspection of the students' books, I found that the teacher had taught algebra over the last month, the period being from 12/10/99 to 10/11/99. This was the only written data available. There is no evidence of the teaching of geometry during this period. The following aspects of the algebra syllabus had been covered, according to Wiseman's workbook:

Fractions, which included:

i. Change proper to mixed fractions (12/10/99)
ii. Change proper to decimal fractions (13/10/99)
iii. Addition of fractions (14/10; 15/10; 22/10/99)
iv. Subtraction of fractions (17/10; 19/10; 22/10/99)
v. Multiplication of fractions (20/10; 21/10; 22/10/99)
vi. Division of fractions (25-27/10; 3/11; 10/11/99)

Measure of time:

i. Convert seconds to minutes (28/10; 29/10/99)
ii. Convert minutes to hours (1/11; 2/11; 5/11/99)
iii. Converting hours to minutes (9/11/99)

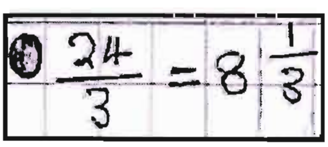
Integers:

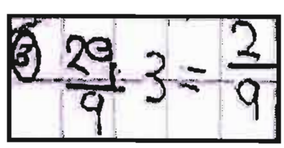
i. The number line (4/11/99)
ii. Rules for multiplication (4/11/99)
iii. Addition of Integers (4/11/99)

During the observation period the teacher taught lessons on time conversion (5/11/99 and 9/11/99) and the division of fractions (10/11/99).

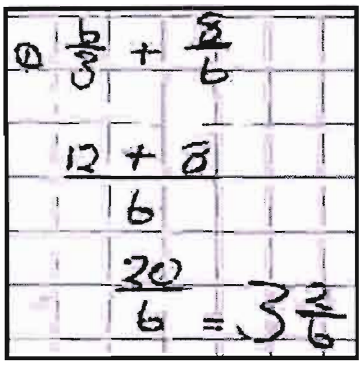
Examples of exercises done by Wiseman for the period 12/10/99 to 10/11/99 as they appear in his workbook are illustrated below. These examples encompass the various sections of work completed in the mathematics lessons.

(12/10/99)

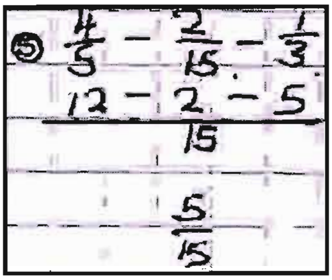




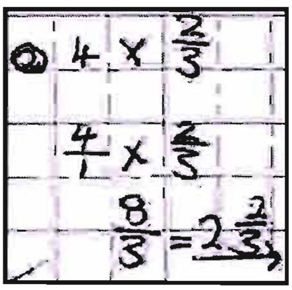
(15/ 10/99)



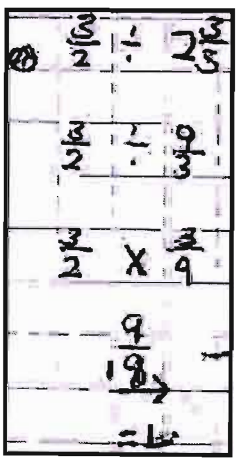
(19/10/99)



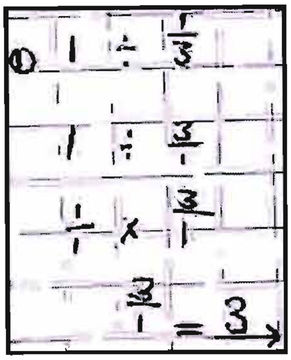
(21/10/99)



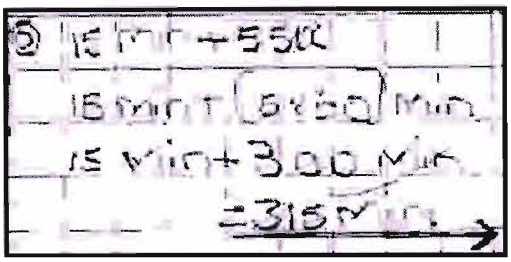
(26/10/99)



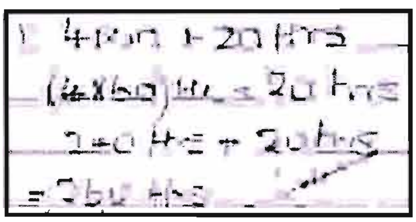
(03/11/99)


$① \; 1 \div \frac{1}{3}$
$1 \div \frac{3}{1}$
$\frac{1}{1} \times \frac{3}{1}$
$\frac{3}{1} = 3$

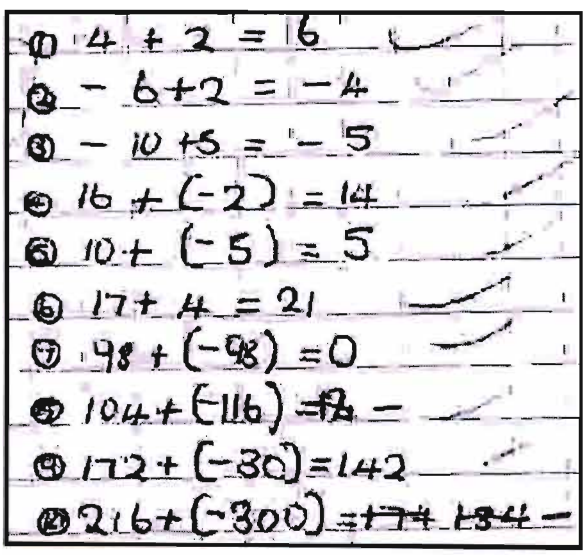
(28/10/99)


⑤ 15 min + 5 hrs
15 min + (5×60) min
15 min + 300 min
= 315 min

(1/11/99)


4 min + 20 hrs
(4×60) hrs = 20 hrs
240 hrs + 20 hrs
= 260 hrs

(4/11/99)


① $4 + 2 = 6$
② $-6 + 2 = -4$
③ $-10 + 5 = -5$
④ $16 + (-2) = 14$
⑤ $10 + (-5) = 5$
⑥ $17 + 4 = 21$
⑦ $98 + (-98) = 0$
⑧ $104 + (-116) = \cancel{12} -$
⑨ $172 + (-30) = 142$
⑩ $216 + (-300) = \cancel{174} \; \cancel{184} -$

Every example cited above had been marked with a tick in Wiseman's books, even those examples with no answer, as can be observed in question 8 on 4/11/99. On examining the books of other learners, I found that the same pattern prevailed. Having given an overview of the mathematical content that is being taught to these learners, I shall go on to examine the manner in which the mathematics is taught to Wiseman's class.

5.4. MATHEMATICS TEACHING

The teacher in the classroom is a young Black male, Mr Xulu, who has recently qualified as an educator in mathematics from the University of Durban-Westville, having obtained an undergraduate degree in education with mathematics as a major. Mr Xulu lives in Umlazi, a "Black" township (as classified by the apartheid regime) south of Durban. He says that he always had a passion for working with children and therefore looked to "*teaching as a good career*" (discussion with teacher: 10/11/99-lesson 3). Why would an inexperienced teacher choose to teach as a volunteer at Thuthukani? According to Mr Xulu: "*there are no jobs available...I better help these children instead of not doing anything...it seems like a good experience*" (discussion with teacher: 10/11/99-lesson 3). His response to my question on the teaching of at-risk youth was: "*It is difficult to share a room with other teachers. You have to ignore the sounds coming from the other groups in the room. Teaching these boys is difficult...they have problems*" (discussion with teacher: 10/11/99-lesson 3). These learners have serious social, psychological, emotional and educational problems. The task of teaching such learners requires teachers who are well-qualified and experienced, capable of being flexible in their methods and having a knowledge of African languages (Chetty 1997). It is therefore, understandable why Mr Xulu regards his job as "*difficult*".

He has a pleasant disposition and his smile allows pupils to see him as a friend. He is enthusiastic about the teaching of mathematics and animated in his presentation in the classroom.

> *The teacher laughed and excitedly pointed at the pupils when they*

answered the questions correctly. It was as though he was saying 'Well done! I'm proud of you' (RJ: 9/11/99 – lesson 2).

Even in the instances in which he reprimands the boys, which are few and far apart, he exercises much control. He does not raise his voice, but rather approaches the learner and addresses him by his name.

Blessing!...go sit next to Wiseman...Be quiet please!...
too much noise... Thulani! {video recording: 5/11/99 – lesson 1).

Mr Xulu enjoys teaching the boys at Thuthukani. His group of learners respect him and the majority are eager to learn. He felt that these youth needed the teacher to be *"caring, understanding and patient'* (discussion with teacher: 12/11/99). He recognized the fact that although these are very troubled children, they are still individuals. The learner's display of talent during the morning assembly evoked the following comment from him:

"The learners are very talented, as you saw this morning...the assembly gives them a chance to show what they can do... I must also give them a chance in the classroom... you saw what the boys wrote about their school (reference to the reflections of the learners)...they want to learn ... they want to be better people.."' (discussion with teacher: 12/11/99).

Mr Xulu starts each of his lessons by standing at the front of the desks and greets his learners. He always follows this by the issuing of the pens and exercise books. He either announces the topic in mathematics that he plans to teach that day or goes directly to asking the boys questions related to the new topic, which he writes on the chalkboard.

Teacher: Good morning boys. Take out your workbooks...
Sase amaseconds?...how many seconds make one minute?
(video recording: 9/11/99 – lesson 2).

There is much interaction between him and his pupils during the lesson. Although he maintains discipline in the classroom, the learners are not afraid of him, and regard him as approachable. This is evident in the fact that they are not afraid to question him and ask for explanations when they are not certain of some aspect of their work. He does not hesitate to praise the learners for work well done. While walking around the classroom he engages in a one on one conversation with pupils, which does not always pertain to mathematics. As pupils are attempting the exercise in their workbooks he assists them on an individual basis. How does Wiseman interact with Mr Xulu? Wiseman has created a transparent wall around himself. He does not smile nor does he demonstrate any emotions as such. He comes into the classroom with a purpose to learn and that is exactly what he does. While the other learners have casual discussions with the educator and even joke with him, Wiseman continues with his mathematics exercises. Although he perceives the teacher as kind and caring, this pupil only interacts with the teacher if he is answering a question or he would like to inquire about the exercise. He calls on the teacher to examine his completed work. Wiseman appreciates the fact that the teacher calls him by name when addressing him and praises him for work well done. The opportunity afforded to him by the educator to display his knowledge on the chalkboard, fills him with pride and self-confidence. These become evident in the following comment:

> *" ...teacher... he know my name... like my work...write 'very good' in my book......tell me to write on board.....*(discussion with Wiseman).

I did not notice Wiseman speaking to the teacher outside of the allocated lesson time.

During the presentation of his lessons he asks many questions to elicit responses from the learners. Examples of the questions are:

- *"...one day...one day is made up of how many hours?...*
  *...how many minutes make one hour?... "(*video recording: 5/11/99 – lesson 1)

- *"... the thing that needs to be substituted... times ga ubane?...*

because we want to have what? ...Two times sixty?"

(video recording: 9/11/99 – lesson 2)

- *"...any whole number is divided by a number...what is the number? ...any whole number is divided by a certain number?...twenty-four over three?...three into twenty four...how many times?..."*

(video recording: 10/11/99 – lesson 3)

The major part of his lesson is presented in English, but he sometimes reverts to Zulu, especially when reinforcing something.

Teacher: ... Twenty four hours ... so wena fundile ... so you know what I'm saying ... See ... so converta.

(video recording: 5/11/99 – lesson 1)

The teacher is in the habit of repeating both his questions and the pupils' answers.

Teacher: Sixty...Ja, it's sixty...sixty seconds in one minute. And...er...how many ...er... minutes makes ... er... one hour?...How many minutes makes an hour?

(video recording: 9/11/99 – lesson 2)

Despite learners working examples on the chalkboard and the teacher involving the learners through questioning, the lessons are still very traditional in nature. They are resonant of the *'chalk and talk'* type of lesson. Repetition to reinforce concepts translates to the 'drill' method of teaching.

The teacher is ready to apologize to pupils if he has made a mistake. This was evident in the lesson I observed on the last day of my visit to the school. He was confused as to whether he was working with the multiplication or division of fractions, although the question read: 3 ÷ 3/8. When he realized his error he responded in the following manner:

> *Sorry...division of fraction ...of fractions ...Sorry for inconvenience ...division of fractions...ja, division of fractions. Change your topic in your books...okay...now I corrected my mistake...*(video: 10/11/99- lesson 3).

In the teaching of conversion of time, he attempted to convert minutes to hours. The following is the procedure he followed:

2 min + 1 hr

(2 x 60) + 1 hr

120 + 1 hr = 121 hr. (RJ: 5/11/99 – lesson 1).

Neither the teacher nor the learners recognised the fact that the answer could not be possible. The same method had been used to convert seconds to minutes. The pupils had perfected the method and were obtaining the correct answer according to what had been taught. At the end of the session, the teacher approached me for feedback on his lesson. I explained to him the error in his calculations (which he very graciously accepted) and suggested that he rather convert hours to minutes or minutes to seconds. In the following lesson the teacher taught pupils how to convert hours to minutes. Unfortunately, some of the boys who had a meeting with the Queen of England, did not get the opportunity to correct the error in their thinking and their books.

At the conclusion of every lesson the teacher collects the learners' workbooks. He marks the books and makes a comment. In no book was there any answer marked incorrect. Incorrect, as well as, incomplete answers are marked correct. Every learner received the comment *'V. Good'* at the end of the exercise. An assessment is given to each task, for example: 5/5. There is no recorded evidence of correction to tasks, remedial exercises or tests in this classroom.

He expressed his frustration with the lack of resources.

> ' ... *The learners do not have textbooks... there is no paper to run exercises or worksheets. If children lose their books...there is no other book for them'* (discussion with Mr Xulu : 10/11/99 – lesson 3).

He welcomed my offer to get him a copy of any other textbook available. Mr Xulu also expressed his views on lesson preparation:

> " ... *It is sometimes difficult to prepare a lesson... You cannot always teach the lesson as you plan...sometimes you have the students... they are not interested ... don't want to learn...don't pay attention... you have to change the lesson plan... "* (conversation with Mr Xulu: 10/ 11/99 – lesson 3).

During my observation period at the school, I have not noticed the teacher carry any form of preparation into the classroom. He usually walks into the classroom with the learners' books, pens and a textbook, which he only referred to during lesson 3 on 10/11/99. From my observation it appears that Mr Xulu decides in class what he will be teaching for the day. This may explain his confusion as to whether he was to teach the multiplication or division of fractions. Another concern of the teacher is the erratic attendance of learners in his class, as he feels that it is disruptive to his teaching programme.

> ' *...they don't come to school for days ...when they come back ...it upsets my programme...the regular learners are gone on to new work... I cannot teach all the work again...*" (discussion with teacher: 10/11/99-lesson 3).

Does this account for the repetition in delivery of lessons, for example, the conversion of time or is it poor preparation on the part of the teacher?

5.5. MATHEMATICS LEARNING

Wiseman has a great affinity toward the sciences.

I like mathematics, English, General Sience. (W: Reflections)

In the two lessons that he attended, I found him to be a very attentive pupil, an individual who is not easily distracted. Wiseman sits quietly at his desk and raises his hand when he wants to answer a question. He takes down the required exercises from the chalkboard without communicating with the other learners from the classroom. On the last day of my being at the school, he seemed rather agitated. Throughout the lesson he rocked to and fro on his seat, placed his head on his hand or chewed on his pencil (video recording: 10/11/1999 – lesson 3). His agitation increased when he found that the teacher was confused with regard to the section he was teaching. The teacher was confused between the division and multiplication fractions. The question on the board read division:

$$3 \div 3/8$$

but the teacher discussed the example as:

$$3 \times 3/8$$

W: Ini lo, Sir ? ... division ?

Teacher: Ja, division of fractions ... division of fractions ... Multiplication of fractions ... No. It's multiplication of fractions.

Wiseman disagreed with teacher: "*No sir, division of fractions*". He leans forward and questions the other boy in front of him about the section. He looks into his book and then at the front of the room seeming irritable (video recording: 10/11/1999 – lesson 3).

He is a very active participant in the lesson, always ready to answer questions. He uses his fingers to assist him in calculating his answers. For example, when calculating three multiplied by eight he counts in multiples of three on his fingers (RJ: 10/11/1999 – lesson 3). In the example of division of fractions cited above the class reaches an answer of 24/3. Wiseman informed the teacher that the example is not complete and that the answer can be simplified to eight.

His enthusiasm for the subject is illustrated by his willingness to work out examples on the chalkboard. When at the front of the class, he explains to the pupils the steps being used in obtaining the answer and repeats certain steps in Zulu. He also questions pupils by asking for answers to various steps as he proceeds. In his explanation of the example $\frac{3}{4} \div 12$ (which follows below), he illustrates to pupils that four by twelve is the same as twenty four plus twenty four.

Wiseman: *Three over four divided by twelve .... is equal to three over four divided by twelve over one....change twelve to twelve over one.... write down three over four and change division to multiplication....and twelve over one to one over twelve...therefore three over four multiply by one over twelve. .... multiply three by one* (pointing to the numerators)*....three by one?*

A Pupil answers: *three.*

Wiseman: *Three* (writes answer on the chalkboard)*....four by twelve?* (pointing to the denominators)....(As there is no answer forthcoming from the learners in the class, he continues): *twenty-four plus twenty four.*

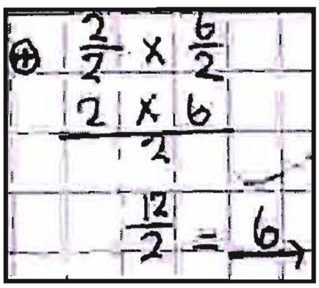
(video recording: 10/11/99 – lesson 3).

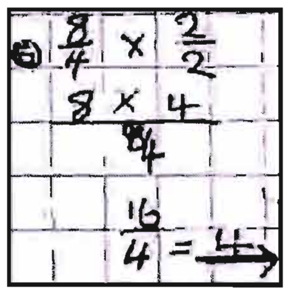
On the completion of the example on the chalkboard, the teacher compliments him: *'Very good Wiseman, very good'* while his peers applaud him.

Some of the inconsistencies that I observed while perusing through Wiseman's workbook are as follows:

a) The absence of the equal to sign is prominent in his work. He sometimes decides to insert the sign in the final step. The incorrect use of this symbol is observed throughout the book.

b) An exercise set on the 22/10/99 carried the following:





The multiplication sign is confused for addition resulting in a common denominator being determined. However, the very next example: 7 x 1 2/9 was correctly multiplied. Other computational errors noted were: (I) the incorrect conversion of fractions, for example: 6/4 = 24/8, or 7 9/3 = 21/9.

(ii) the incorrect inversion of fractions, for example:
1 ÷ 1/3 = 1 ÷ 3/1

(iii) fractions are not simplified, for example: 2/6 or 2/4, or incorrectly simplified, examples of which are: 72/144 = 144 or 712 / 712 = 712.

c) (dated 5/ 11/99)

① 2 Min + 2Hrs
2x60 Hrs + 2 Hrs
120 Hrs + 2 Hrs
= 122 Hrs

(dated 29/10/99)

① 2 Sec + 10Min
2 x 60 Min + 10 Min
120 Min + 10 Min
= 130 Min

Despite the fact that Wiseman, and many other learners, are able to answer the following questions: *one minute is made up of how many seconds?...*

one hour ... is made up of how many minutes?

he is unable to recognise the error in his calculation, namely: that a minute is greater than a second and an hour is greater than a minute.

The exercises that are written on the chalkboard are copied in the workbooks. Wiseman continues to work on his own, fully engrossed in the exercise. He does not like to be interrupted when working, preferring to work on his own. After he has completed the exercise, he calls for the teacher or me to examine his work. He takes pride in the presentation of his work.

5.6. CONCLUSION

My experiences as a researcher at Thuthukani made me revisit my position as an educator in the mainstream school. I admire the enthusiasm displayed by many of the educators, especially those who serve on a voluntary basis. The willingness of the youth, in Wiseman's class group, to learn under such trying conditions, makes me appreciate my comforts in life. These experiences assisted me in the next stage of my data collection, in a mainstream school. I am now better equipped to handle any shortcomings that I may encounter as I am now aware that disruptions in the data collecting process may occur.

CHAPTER 6

NELLIE: LESSONS IN SILENCE

Never look down on anybody, unless you're helping him up.

Rev. Jesse Jackson.

6.0. INTRODUCTION

In this chapter I tell the story of Nellie, a learner at Sanville Secondary School, her learning environment and the form of mathematics education that she experiences from the perspective of the researcher (in the role of non-participant observer), the teacher and Nellie herself. The data presented in this chapter is based on class observations, carried out over a period of five days, of the context, the learners (with Nellie as the focal point), and the teacher in the classroom. The visual recordings of four of the five lessons observed, together with the information recorded in an unstructured interview with Nellie, in informal discussions with the subject-cum-form teacher, in my reflective journal, and copies of Nellie's tests and exercise books are used in developing this chapter. The categories in this chapter, identified for the presentation of data, are as follows: the learner's background, the learning environment, the mathematics content, mathematics teaching and learning.

6.1. BACKGROUND

Nellie is a Black, fifteen-year old female. She is of medium height and well built. This, neatly-groomed, young lady is always attired in full school uniform (shirt, skirt, tie, blazer, socks and shoes). Her hair is tied back in a ponytail. Nellie is a quiet, friendly, soft-spoken and well-mannered individual. Although she smiles, there seems to be a sadness in her big eyes. She shows signs of tiredness in the classroom as illustrated by the following observation:

I often find Nellie yawning during the lesson...today she placed her head *on her folded arms, on the desk, and fell off to sleep* (R.J: 12/9/00 – day3).

Here is an individual who is in need of a listener. Given the opportunity, Nellie cannot stop talking about her experiences. It is evident that Nellie wants to talk to some one about herself. She does not want to be addressed by her registered name. Her request: "*call me Nellie ...I like that name*" (N: interview). Nellie wants to tell me all about her life and her fears. I have to repeatedly direct her back to the question being discussed. When I told her about my desire to interview her, she was ever willing to co-operate. She readily hands over her exercise books to me for examination, and even volunteers to bring in her friend's books (from another school) for me to look at. My presence in the classroom does not seem to interfere with the manner in which she conducts herself. Nellie is excited about the fact that there is somebody who wants to know about her. This makes her feel special.

According to Nellie, she has a brother, who is in primary school, and a twin sister who is an epileptic and does not attend school. They have left their parental home, outside Pinetown, Kwazulu-Natal, because of emotional and physical abuse and are living in homes for destitute children. The home that she lives in is within walking distance of the school. Nellie does not mention her dad but cites her mum, who is a nurse, as the reason for her leaving home. She is a very emotional, sensitive child who seems to be deprived of parental love.

> *My twin had fits ...no... my mother ... my mother used to say she's acting and she used to hit her...ja...then my mother used to work nightshifts and she used to work in the morning... and she ...she used to wake us up like two o'clock...and we had to do her... her work and make her food for lunch for her work... and we must iron her clothes and all that. When we want to go back to sleep... she used to hit us. When my sister had fits she used to tell her that she's acting. Now her sister's want to go tell the social workers what ...how she's reacting to us. ...Cos the people used to ask us: Is*

*this our real mother?...and we used to ask them why they asking us that. They used to tell us that the way she is acting to us ...she's acting funny...and then her (*the mother*) sister went to tell the social worker. And then the social workers should come and ask this questions...The other social worker came and she* (the mother*) wanted to hit her (*the social worker*)* (N: Interview).

Nellie has a very pleasant disposition, which makes her a very endearing person. Although she is reserved, she is able to get along with her peers. Her personal life is not shared with these other learners for fear of being mocked and belittled. She expresses her fear of being ridiculed by the other learners because

"I live at the home and they don't...I feel different...the other children ...they do not understand...they will laugh at me...tease me..." (N: interview).

Although Nellie sits centrally in the classroom, she appears, at times, to be very lonely. She speaks in whispers to the pupils next to her. When working through the exercises set by the teacher, she prefers to work independently.

Nellie is able to communicate well in English. She has been to three primary schools, in various parts of Durban, before coming to this secondary school last year (1999). However, her school years were very disrupted through illness. This may be a contributory factor to her failing at school. She explains as follows:

Miss I used to sleep in class...I never used to answer. Now in that school I used to fall too. Whenever I enter that school I used to bleed ...and then when...you know like they used to just take me out of of the school and take me to the hospital...and the doctor used to see what I got and they never used to find...and they used to take me back to the school and I used to bleed...so...I never had a chance to do all my school work properly because I...they told me to stay at home (N: Interview).

Sanville Secondary School has very stringent rules governing absenteeism, late arrival at school or to a lesson and early exit from school. Learners who are absent or away from the classroom for any part of the day have to present a letter of explanation to the principal's office (discussion with the teacher: 7/9/00- day 2). A learner who has been absent from lessons in mathematics is required to update her/his work and present it to the teacher. These may be reasons for the improvement in Nellie's attendance at school this year (2000). Statistics from her progress report indicates that she has been absent for only one day during the first half of the year. Speaking to the form teacher, I received the following:

> *Nellie is very quiet...she does not speak up much in class. Her attendance has improved this year. She is repeating grade eight this year...she failed last year...I don't know much about her background...but she lives at a home for children in the area*
> (Discussion with form teacher: 7/9/00-day 2).

The rules set by the school also ensure that learners are punctual for their lessons. Nellie's intense fear for punishment in the form of detention procures her a position in the first third of the queue waiting to enter the mathematics room. This fear may be the result of the punishment inflicted on her by her mother.

I questioned Nellie about her reluctance to speak in class and she confided about her fear and preference of being alone to being in a group.

> *I'm scared Miss. I'm not...I'm not used...like of talking...cos even at home ...I don't talk...I just go to my room and sit by myself*
> (N: Interview).

Nellie has confessed that she is not used to talking and is scared of the teachers

(N: Interview). Her fear is evident in the fact that she is hesitant to raise her hand to answer a question (video recording: 13/09/2000-lesson 4). She did not hesitate to tell me about how she saw most teachers: "*they just don't understand...they just shout*"
(N: Interview). Although I am a teacher, it seems as though she felt that I could understand. My heart went out to this 'little girl' who was in such pain.

Although her attendance has improved, it does not seem to have impacted on her performance at school, especially in mathematics. Her progress report in June indicates that the subject with the lowest score is mathematics. According to her teacher, Nellie has not performed well in her mid-year examinations, as well as, in the term tests and class tests throughout the year. The marks attained in some tests during the course of the year and the progress report issued to pupils in June bears testimony to this, as shown below:
Class tests: 24% & 32,5%; Term test: 32,5%; June examination: 27%
(source: copies of tests and progress report).

> *She has to work very hard if she is to be promoted to grade nine. Her performance in all subjects was poor* (Discussion with teacher: 13/9/00 - lesson 4).

Nellie states that she "*wants to learn*" (N: Interview). She tries hard to remember the information that the teacher has taught, but in vain. As a result she has developed a low self-esteem, lacks confidence and merely goes through the motions of daily survival, taking one day at a time. This is a learner who would assume the role of follower without having to think it over. Nellie does not refer to anything in the future but rather continues to reflect on the past, which seems to imply that she has set herself no goals.

6.2. THE LEARNING ENVIRONMENT

The environment at any institution sets the tone for effective teaching and learning. The traditional layout of the school buildings and the atmosphere that prevails at Sanville Secondary School, lends itself to achieve this educational aim. Each teacher has her/his own form-cum-subject room. The classroom, in which Nellie and her classmates are housed, is large and well ventilated. These forty boys and girls, whose ages range between twelve and fifteen years, use this room as both their form base room and their mathematics classroom. There are both "Black" and "Coloured" pupils in this group. The desks are arranged in groups of three, facing the chalkboard at the front of the classroom, as in any traditional classroom setting. The overcrowded room can accommodate a maximum of forty-five learners, leaving very little or no space for movement between the desks. The teacher's table and chair are placed at the front right corner of the classroom, with a cupboard for storage at the front left corner. The charts on the walls of this room reflect the mathematics being taught to students in the various grades that the teacher instructs. Cartoon characters are used in preparing these charts to attract the attention of learners to their mathematical content and portray mathematics as a fun-filled subject. The purpose of the charts may be to:

* inculcate an interest in or an appreciation for the subject
* reinforce the mathematics being taught to learners in this class
* serve as revision and a tool of reference when learners are engaged in mathematical tasks
* inform the visitor to the classroom about the subject being taught in that room.

Other charts, covering topics of general knowledge also appear on the wall. The teacher does not update the information that is displayed on these walls, as there is data of class units that date back to 1996.

Each pupil possesses a mathematics textbook and workbooks for the different aspects of mathematics that they are taught. The textbook being used by the learners is Laridon et al (1992). *Classroom Mathematics Standard 6.* Students and teachers have access to computers and a well-equipped library/resource centre. The school community has worked tirelessly at fund-raising in order to make these facilities available. The educators have computers, a photocopy machine and CD copier to assist them in the compilation of worksheets, tests and examination papers. The learners have also been exposed to the use of mathematical instruments, for example: using a protractor to measure an angle (RJ: 13/09/2000- lesson 4).

Although the setting of the school may appear very serene, the educators and learners have to contend with both air and noise pollution. This is due to the cluster of factories that are situated adjacent to the school's play-field and the fact that an international airport lies within a ten-kilometre radius of the school. Lessons are disrupted and examinations disturbed by the sound of low-flying aircraft, the sirens that are sounded in the industrial area and passing traffic. The school is being renovated, adding to the disruptions that the school population experiences (RJ: 14/9/00- lesson 5).

6.3. THE MATHEMATICS CONTENT

During the course of the year the teacher had taught algebra and geometry. Besides the tasks set in class and often completed at home, the learners have to complete written assignments and present lessons to the class for which they are awarded marks. The aspects of the mathematics syllabus, to be taught in a given school quarter, is determined by the group of teachers teaching the particular grade. Although each teacher develops her/his lessons individually, standardized tests and examinations are used across the grades. Class tests and standardized term tests are administered to the learners. All aspects of work taught are tested.

Paging through the workbooks of learners, I found that the following aspects of the mathematics curriculum, as prescribed by the National Department of Education, had been taught and tested for the period 11 February 2000 to 14 September 2000:

ALGEBRA

1. Natural and Counting Numbers

(i) Multiples and Factors

(ii) Squares and Square Roots

(iii) Cubes and Cube Roots

2. Integers
(i) The Number Line
(ii) Addition, Subtraction, Multiplication and Division.
3. The addition, subtraction, multiplication and division of Integers
4. Substitution
5. Fractions
6. Equations, including problem solving.

GEOMETRY
1. Angles
(i). Classification
(ii) Measuring
2. Intersecting Lines
(i) Supplementary and Complementary Angles
(ii) Vertically Opposite Angles
3. Parallel Lines
Corresponding, alternate and co-interior angles.
4. Triangles
(i) Classification
(ii) Sum of Angles
5. Linear Equations in Geometry.

During the week of my visit to the school, the mathematics lessons taught were as follows:

6 & 7/09/2000 - Oral Presentation by learners
12/09/2000 - Revision Exercise for term test
13/09/2000 - Linear Equations in Geometry
14/09/2000 - Remedial work on controlled test

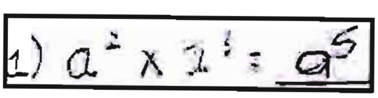
A special testing slot is created on a Wednesday morning. On Wednesday, 13/09/2000 the grade 8 pupils wrote the term test in Mathematics. To date the learners in this class have written two standardized term tests (March and September), a mid-year examination in June and four monthly tests (February, April, May and August). For the oral presentation, the learners have to choose a topic from the aspects of mathematics already taught to them during the course of the year. Topics in Geometry seem to enjoy a preference over those in Algebra. Learners made charts to enhance their presentation (RJ: 6/09/00- lesson1).

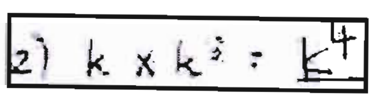
The nature and wording of questions set in class exercises, revision exercises, class/term tests and remedial exercises are similar, as illustrated in the section on equations below:

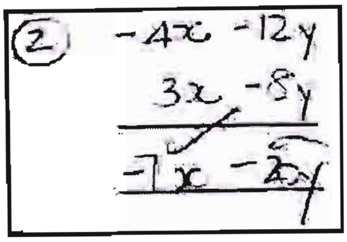
DATE	Nature Of Exercise	EXAMPLE
1 September 2000	Classroom Exercise	Solve for x: X – 9 = 0
12 September 2000	Revision Exercise	Solve for y by inspection: Y – 4 = -6
13 September 2000	Controlled Tests	Solve for x by inspection: X – 8 = 1
14 September 2000	Remedial Exercise	Solve for x by inspection -x – 8 = -2

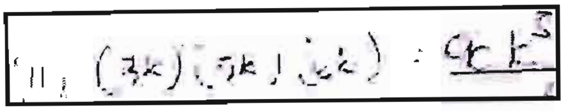
Table 6.1. Samples of Questions on Equations

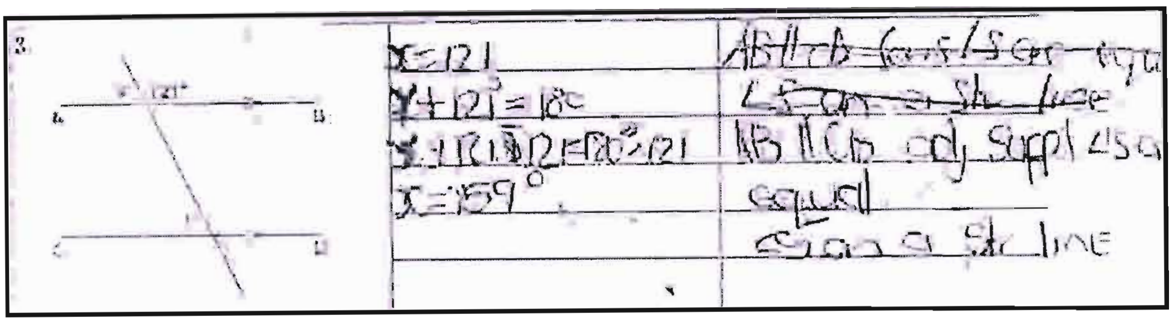
As a result of the number of exercises attempted by Nellie, it is difficult to give an example from each exercise. I therefore selected a few examples of exercises and tests completed by Nellie, as to date (15/09/2000), to illustrate below. More exercises may be located in appendix E.

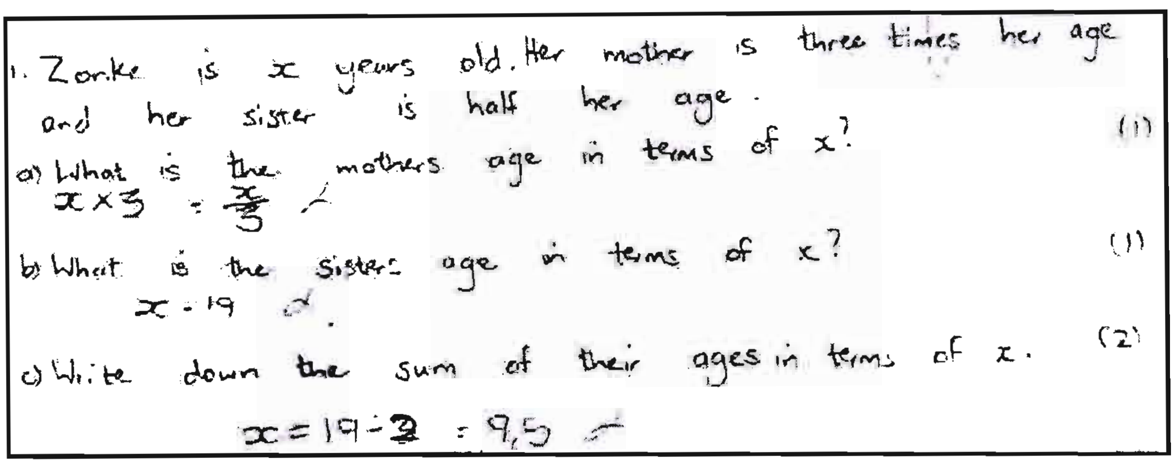












6.4. MATHEMATICS TEACHING

Mrs James, a "Coloured" female, has always lived and attended school in a suburb of Durban. She has completed "*a teaching course in maths from a college of education*" (discussion with teacher: 7/9/00-day 2). For the past ten years she has taught students from grades eight to twelve. Although Mrs James enjoys teaching, but does find the job "*a bit frustrating*" when she cannot "*get through to the students*" (discussion with teacher: 7/9/00-day 2). She continues "*the increase in class sizes and teaching load makes it difficult for me to give pupils individual attention*". This pleasant lady carries herself very professionally, which is evident in the manner in which she introduced herself to me: "*I'm Mrs James*", not divulging her first name.

The educator is a disciplinarian who commands the respect of her students and peers. The teacher expects her pupils to work quietly, constantly reminding them that "*you have work to do*" (video recording: 12/09/00 – lesson 3). She expects her learners to respect each other. When a pupil spoke out of turn, the teacher responded:

> *Teacher : Apologise to her.*
> *Male pupil : Sorry.*
> *Teacher : Sorry who ? Rabbit ?*
> *Male pupil : Sorry Ria.* (video recording: 12/09/00 – lesson 3)

The teacher-pupil hierarchy is obvious in this classroom. "*Grow up boy…I don't want to hear your stories…*" and "*Hey!*" when calling out to a pupil in the class (video recording: 12/09/00 – lesson 3), illustrate the impersonal relationship that the teacher shares with the learners. These words portray her as cold and aloof, the authority in the classroom. Immediately a barrier is set up between the learners and the teacher. Nothing outside of the domain of mathematics is discussed between the teacher and the learners. There does not seem to be a one-to-one relationship between the learners and the teacher. The pupils work on their own when a task is set. I did not notice any pupil call for the teacher for assistance when faced with a problem (RJ: 13/09/00 – lesson 4). Her response to my question on how she viewed Nellie in the classroom is: "*To me…eh…she is just like any other child I teach. I do not treat her differently from the other learners…I don't want to make her feel …mmm…uncomfortable*" (discussion with teacher: 7/9/00-day 2).

Mrs James is very accommodating by allowing me into her classroom. As an educator myself, I know this is not always the most comfortable situation. The fact that the both of us teach in secondary schools, allowed us to share many an experience, including our dissatisfaction being over-worked and underpaid. She volunteered as much as she could about the learner, Nellie, including access to her tests and the mid-year report card. She also gave me an overview of the rest of the learners in the class. The teacher had continued to work as she would have had I not been in her classroom. This is obvious by the fact that she graded tests while the lesson was in progress. Mrs James is involved with fundraising at the school, which causes a disruption to her lessons at times, for example:

> *Tomorrow I will be away from school during the maths lesson. The school's debs' ball is coming up…I'm on the committee for fund raising. Tomorrow it's career's day at school…other school's are coming over. We're going out of school to do buying…the debs will sell to the visitors to raise funds.* (discussion with teacher: 14/09/00)

I ask myself the following question: do the purchases have to be done during tuition time? It seems to me that the extra-curricular activities of a minority group have taken precedence over the needs of the majority of the school population.

The teacher starts each lesson by greeting her students and then informing them as to what the lesson for the day will entail. Students then take out the material required for the lessons. For their oral presentations, the learners had prepared charts. Seated at the back of the classroom, the teacher assesses the learners. She questions the learners if their explanations are not clear.

> *Teacher: How does your denominator get rid of four?*
> *Pupil : Miss, the LCM, Miss.*
> *Teacher: What is your denominator?*
> *Pupil : My denominator is eight and three….so…*
> *Teacher : Eight and three…*

Pupil : ...the L.C.M is twenty four. Eight goes in twenty four three times and three goes into twenty four ...er.... eight times.

Teacher : That's right.

(video recording: 7/09/00 – lesson 2)

There is not much interaction between the teacher and the pupils outside of the presentation of the lesson.

> *Today the teacher set pupils a revision exercise. This was to prepare the learners for the controlled test that they are to write tomorrow (13/09/2000). The questions, on the solution of equations, were written on the chalkboard by the teacher, Pupils were asked to record the questions in their algebra books and work through them quietly. The teacher sat at the table at the front of the room, marking the matric trial examination scripts* (RJ: 12/09/00-lesson 3).

A similar pattern of behaviour is observed during the following lesson (video recording: 13/09/00 – lesson 4). Questions are asked by the teacher to encourage pupil participation. However, the students tend to answer in unison (as in the extract below) since the questions are not directed to any learner in particular.

Teacher: We have worked with linear equations in algebra. Today we look at linear equations in geometry.

(The teacher refers the learners to a diagram in the worksheet which she had handed out earlier in the lesson.)

Teacher: What will the two angles add up to?

Pupils (in unison): One hundred and eighty degrees.

Teacher: Why?

Pupils: Adjacent supplementary angles.

Teacher: What is the equation that we need to calculate the *value of x ?*

Pupil: X plus two x is equal to one hundred and eighty degrees.

Teacher: What is x plus two x?

Pupil: Three x.

Teacher: I want x...I must divide by?

Nellie: Three.

Teacher: Very good...Three x divided by three is equal to one eighty divided by three. What is the value of x?

Pupil: X is sixty degrees.

Teacher: Complete the following...(She writes the statement on the board as pupils give the answer):
Angle DCB is equal to x is equal to?

Pupils: Sixty degrees.

Teacher: Angle ACD is equal to two x is equal to?

Pupils: One hundred and twenty degrees?

After explaining a second example to the learners, she sets the class a task from the worksheet. She then settles herself at the table and grades the set of controlled test papers that were written by pupils that morning, commenting aloud, on the student's marks as she progressed. From her seat at the teacher's table, she is not always in a position to observe what the pupils are doing as illustrated in the excerpt below:

> *She (Nellie) places her head on her folded arms on the desk and falls off to sleep. The teacher is unaware that the learner is asleep. She only realises this after approximately five minutes. Only on one occasion, during the lesson, does the educator walk around the room to correct exercise books.* (RJ: 12/09/00-day 3)

This practice of Mrs James encourages learners, like Nellie, not to carry out the mathematical tasks set, but to continue with unrelated matters as exemplified above.

The teacher is considerate about the quantity of work she gives her pupils:

Teacher: Is the work too much?

Pupils : Yes.

Teacher: Quiet…Listen…In number one I've done one a …so you do b and c… in number two I've done a, you do b and c. Just do that today…tomorrow in class you gonna do three and four…And if your mother shouts and says you don't have homework, you do number three and number four at home…And those writing on pages … you better come with your books tomorrow.

(Video recording: 13/09/00 – lesson 4)

Remedial work is done with pupils to highlight the errors made in the controlled test. The teacher explains the reasons for pupils losing marks and shows them how to answer the questions:

The key words are important when doing problem solving. In number two…most of you did not set out the answer correctly. What is wrong with this?

Five times two is equal to ten is equal to ten minus three is equal to seven.

Five times two is ten …and ten minus three is seven…Is five times two equal to seven?

She then goes on to explain how the problem should be set out:

Five times x minus three is equal to seven. Five x is equal to seven plus three. Five x is equal to ten. Then you divide by five, the co-efficient of x and you get your answer.

(video recording: 14/09/00 – lesson 5)

Learners are expected to work independently. The educator does not approve of them discussing the tasks set for them. Mrs James appears to prefer the tried and tested methods of teaching. She does not venture into new arenas, for example, splitting the learners up into groups and allowing them to work on their own. Much of her lesson is characterised by the following type of instructions:

> *Listen, you don't just copy...look at your friend and see the correct answer...do magic, magic. You don't write rubbish in your books.*
> (video recording: 13/09/00 – lesson 4).

The teacher attempts to bring humour into mathematics by including cartoons on worksheets (Appendix E). Mrs James extends her students in the field of mathematics by exposing them to mathematics quiz games held amongst the schools in the area. She also enters them in the AMESA challenges (Appendix E) and the Mathematics Olympiad.

> *The head of the mathematics department at another school in the area organised a mathematics quiz for the students in area. The pupils who entered had enjoyed the game* (discussion with teacher: 14/9/00-lesson 5).

6.5. MATHEMATICS LEARNING

Nellie sits centrally in the classroom, between a male and female learner. She appears restless and tired during most of the lesson, demonstrated by the fact that she yawns often (video recording: 12/9/00 – lesson 3). Her attention span is very short and she is easily distracted. Very often Nellie can be found whispering to one of the other learners seated next to her, looking around the room with darting eyes or interfering with the contents of her school bag. During the oral presentation by pupils, Nellie played with her pens, zipped and unzipped her school bag and spoke to the learner next to her (video recording: 12/09/00-lesson 3). She did not pay attention to what the pupils where saying.

When asked to practice a revision exercise for a forthcoming test, Nellie placed her head on the desk and fell off to sleep.

Teacher: Nellie...(Pauses, waits for Nellie to raise her head)
Are you sleeping or are you writing?
Nellie lifts up her head...looks around in a daze...does not answer.
Boy (at next desk): She's sleeping.
Teacher: Sit up and write please.
Nellie looks at the boy...irritated that he told Mrs James that she was asleep.
Teacher (to the boy): Hey! Thank you.
Nellie looks around at her neighbours, embarrassed. She opens her book, takes a rubber stamp from the girl on the next seat, applies ink to it from her pen and stamps the pages of her algebra book.
(video recording: 12/09/00-lesson 3)

Pride in the presentation of her work does not seem to be important to Nellie. Evidence of this appears on the pages of her algebra book, where she used a rubber stamp (Appendix: E). This may also be a sign of boredom with the lesson, lack of interest in learning or that she simply does not understand the mathematics being taught.

She appears to be pre-occupied and forgets easily.

Teacher (who is examining the geometry books): Geometry book Nellie.
Nellie: Miss, I forgot it at home.
Teacher: What?
Nellie: I forgot it at home.
Teacher: Forgot it at home?
Nellie shrugs her shoulders and continues to flip the pages of the book on the desk (video recording: 13/09/00 – lesson 4).

Nellie does not seem, in the least, concerned about the fact that she does not have her book in class. The shrugging of her shoulders and her non-response to the teacher's final question suggests that she does not consider it important to have her completed (or incompleted) tasks at school. My question on her ability to cope with mathematics elicted the following response:

> *Miss, it's hard for me…I try…I like maths…but I try to like… understand it…I understand maybe like when my teacher explains. When she gives us homework…I just…lose it* (N: Interview).

The attitude that she displays toward the subject does not correlate with the comments above.

There are times during the lessons when Nellie appeared to be very attentive, recording the work written on the chalkboard into her exercise book. While working through the given task she flips through the pages of her book to make reference to previous exercises. When attempting a task, Nellie does not like entertaining conversation with other pupils.

Nellie is not a very active participant in the lesson discussion. She rarely responds to the questions asked by the teacher.

> *Nellie answered a question for the first time during the lesson today, the lesson being on linear equations in geometry* (RJ : 13/09/00 – lesson 4).

> *Teacher: I want x. I must divide by?*
> *Nellie (wants to raise her hand but is hesitant): Three.*
> *Teacher: Very good.* (video recording: 13/09/00 – lesson 4).

The learner's response regarding her non-participation in the lesson was:

Researcher: I've been watching you... you don't talk in class. You don't ask the teacher any questions.

Nellie: Miss, I'm scared, Miss.

Researcher: Why?

Nellie: I don't know...I just get scared. When the time's to answer, I just get...I just shake and I just put my hand down...and I just get scared...like I must put down my head...and cover myself...I don't know why. (N: Interview – 15/09/00)

Nellie's actions typify fear and a lack of self-esteem and confidence.

According to Nellie, she used to perform better in mathematics in the primary school but now she "*is going worse*". She is scared because "*sometimes when you give the wrong answer the children just laugh and they want to just tease*". Nellie is also afraid of the teachers. "*Some of the teachers don't understand, they just shout when you give the wrong answer*". Nellie says that she likes and understands the geometry. "*I do better in geometry*" (N: Interview). Evidence of her preference for geometry is revealed by the greater number of completed exercises in this aspect as compared to algebra. This was compared with books of another student in the class. As a result, she chose to speak on *'Types of Angles'* for her oral presentation.

Teacher: Nellie.

Nellie takes her chart and walks to the front of the room. She hands her chart to the two volunteers at the chalkboard, who hold up the chart for her.

Nellie (points to her chart): This map is about geometry ...and I've just got some examples...Reflex angles which is equal to one hundred and eighty degrees, obtuse angles equals to ninety degrees and right angles equals ninety degrees and you also get....

Teacher: What is an obtuse angle, Nellie?

Nellie turns to face the teacher: This.

(She points to the drawing of an obtuse angle).

Teacher: Is that a right angle?

Nellie: This here. (She points to a right angle)

Teacher: You got ninety degrees under obtuse angle there.

(Nellie covers her mouth with her palm).

Angelo, correct her mistake. What's an obtuse angle?

Angelo: An obtuse angle is if...er...less than ninety....

Another pupil interjects:...more than ninety degrees....

Teacher:...and less than what?

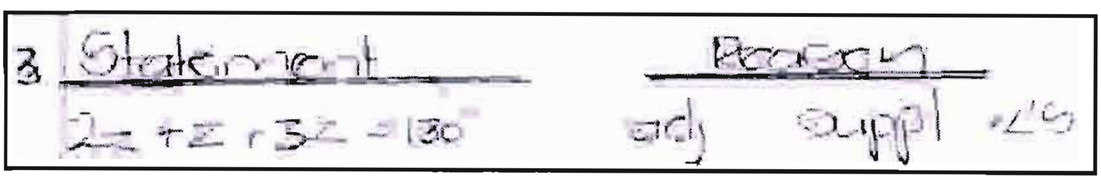
Pupil : One hundred and eighty.

Teacher: Less than one eighty. Thank you, Nellie.

The pupils in the class applaud. Nellie smiles and walks back to her seat. (video recording: 11/09/00 - lesson 2)

However, in her presentation to the class, she seems to be confused with the various types of angles. Her confusion may be the result of nervousness or fear of dispensing the incorrect information.

Many of the geometry exercises executed by Nellie in her workbook are devoid of any geometrical diagrams, which is evident in the exercise on Linear Equations in Geometry: 13/09/00. The example below bears testimony to this omission:



This makes it difficult for the learner to make a connection between the calculation and the picture. Visual representation will enhance the understanding of the question asked, making the solution to the problem much easier.

Algebra, on the other hand, creates a problem for her.

You know this x…and like she (the teacher) have to put two and minus those negative things…that sometimes I just don't get it…know… when she explains in class…I'll understand it… and like when I have to go home…like she gives us homework…I never…I only got two, three …the others I just…don't understand. (N: Interview)

According to Nellie, she does try at home, on her own, to work out the exercise, by referring to worked examples, but still fails to obtain the correct answers. Nellie does not show any enthusiasm in wanting to know the mark she obtained in the term test. While the other pupils urge the teacher to divulge their marks, she continues with the task set by the teacher.

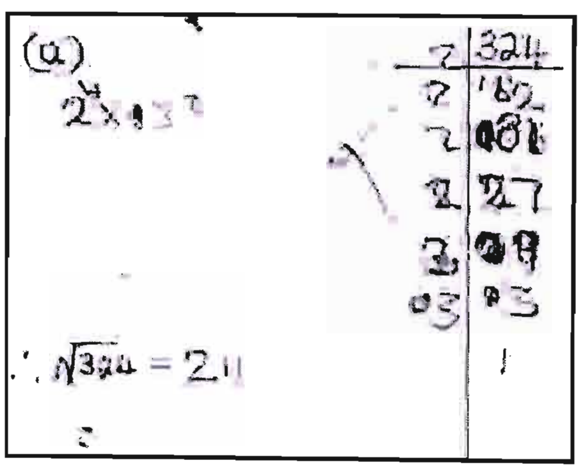
Some of the inaccuracies observed in Nellie's workbooks are presented below:

- The learner chooses to insert or ignore the equal to sign in the working out of exercises, an example of which is

  DCE $180^\circ - 30^\circ = 150^\circ = 150^\circ - 30^\circ$

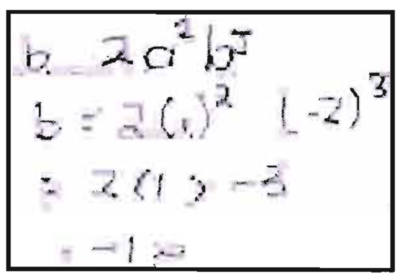
  Nellie does not realise that 180° - 30° is not equal to $150^\circ - 30^\circ$. This is apparent throughout her exercise books.

- When required to determine the square root of 324 (using prime numbers) in a test, her answer read as follows:



Eighty-one and twenty-seven have each been divided by 3, as is evident in the working of the example. However, the written factor is two. $2^4 \times 3^2$ is the product of the displayed factors, but does not multiply out to 24. It appears that Nellie simplified 24 as two times four and multiplied that product by 3. I cannot explain how Nellie executed the division process. The process itself is correct while the factors are not. The same type of error is repeated when calculating the cube root of numbers.

- In a task on substitution, given to learners on 18 August 2000, the following was noted:



It is not clear how $(-2)^3$ transformed into –3.

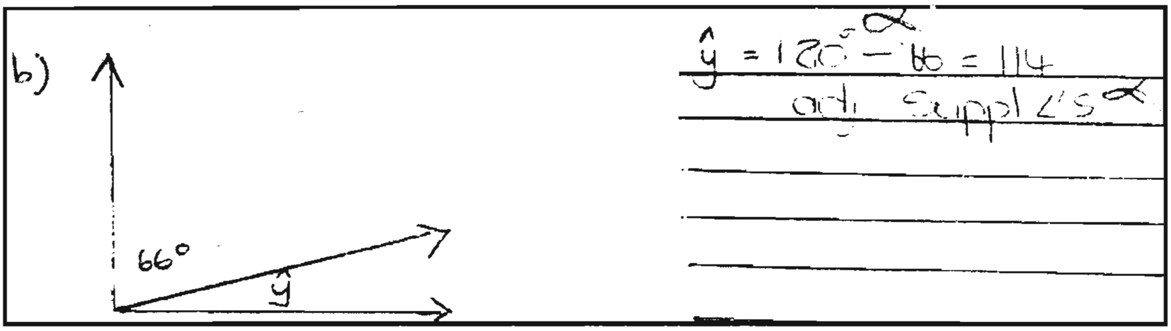
- Other computational errors observed were:

(i) the incorrect subtraction of algebraic expressions, for example: $3x - 5x = 8x$. Seven such errors were noted.

(ii) in the solution of linear equations Nellie experiences difficulty in solving for x if there is a numerical coefficient present, as in the following examples:

$3x = 6$ or $x / 2 = -5$ (dated 13/9/00).

- A question in calculation of angles, yielded this answer:



There is confusion between supplementary and complementary angles. Nellie also has difficulty with the following geometrical concepts:

(i) classifying angles according to their measurements, as in $< BCD = 45^{o}$ and classified as acute when a reflex angle is illustrated (Appendix E9).

(ii) identifying angles, formed when parallel lines are cut by a transversal, and their properties, for example: adjacent supplementary angles or corresponding angles (Appendix E).

(iii) the measuring of angles using a protrator.

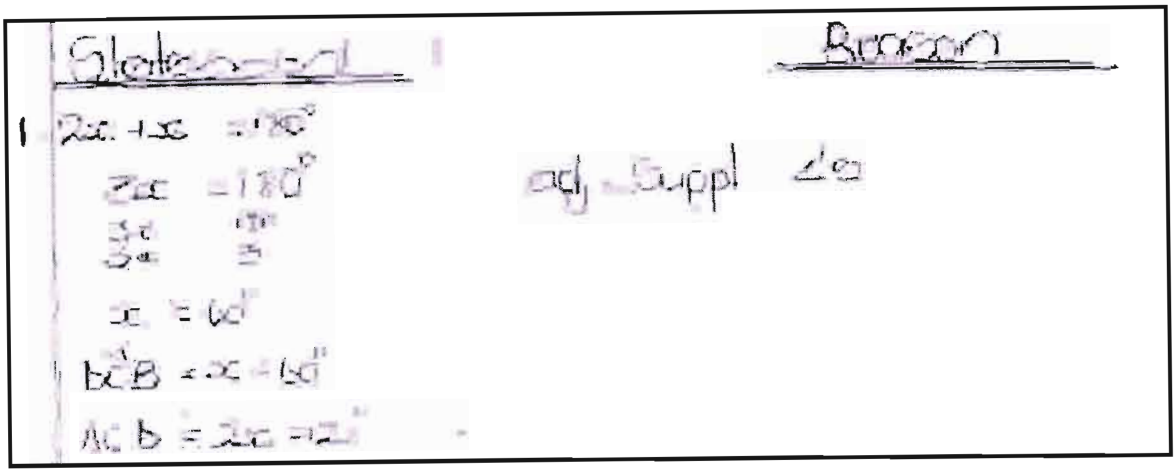
- Other conceptual errors observed in Nellie's work were:

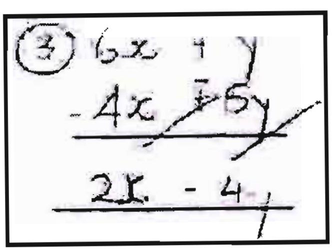
(i) her inability to determine the highest common factor or lowest common denominator.

(ii) the confusion in determining the multiples, factors and prime numbers of any given number.

(iii) her failure at applying the distributive property, for example: $2(x + 3) = 8$ is expanded as $2x + 5 = 8$. (see Appendix E for examples).

Not all of Nellie's worked out examples are incorrect. Below are selections of correctly completed tasks. More examples appear in Appendix E.





6.6. CONCLUSION

After my interview with Nellie, I sat back and counted my blessings. I now viewed my own pupils through a new set of lenses. Hundreds of learners had passed through the doors of my classroom, how well did I know any of them? I thought of Wiseman in the classroom at Thuthukani and wondered: how would he fit into this classroom?

Having narrated the classroom experiences of Wiseman and Nellie in chapters 5 and 6, I will, in chapter 7, conduct an analysis of the data collated.

CHAPTER 7

ANALYSIS, DISCUSSION & RECOMMENDATIONS: LESSONS LEARNT AT THE FEET OF CHILDREN

Before sunlight can shine through a window, the blinds must be raised.
American Proverb

7.0. INTRODUCTION

The transition from darkness, in Chapter 1, which began with my visit as a masters student to Thuthukani, to sunlight has finally arrived. The interaction of three variables, namely: youth at-risk, teachers of mathematics and the mathematics content, lasted for a period of four weeks. The story unfolds from two different contexts, as the study examines the mathematics education of the two learners at the margin, Wiseman and Nellie. In this chapter, the data is interrogated through the analysis of the learners' background, the mathematics content, teaching practice and learning experiences. The analysis of these categories is deepened in terms of themes that have emerged from the stories by examining the data across the two cases. A discussion and cross-case analysis is incorporated into this chapter. My final comments and recommendations conclude the chapter.

7.1.THE LEARNER AT THE MARGIN

7.1.1. Disruption and Discontinuity

There is evidence that Wiseman and Nellie have attended primary school (sections 5.1. & 6.1). Nellie has had a disruptive primary school career (three different schools). This, together with her high rate of absenteeism and her falling off to sleep in class on the days that she was present (section 6.1) could account for her poor performance at school, in general, and mathematics, in particular. She would have missed out on sections in the mathematics syllabus. This may have impacted on her ability to master certain operations in the consequent years and resulted in the development gaps in her reasoning, because of inadequate prior knowledge (van Wyk 1991). It appears that these gaps in her knowledge were not identified and corrected timeously, resulting in her not being able to cope with the mathematics being presently taught.

The level of education that Wiseman has completed has not been established. He is grouped into a unit of older boys at the shelter. Wiseman shows a great affinity for school and an enthusiasm for mathematics, science and sport (section 5.1). His previous experiences at school (section 5.1) has not deterred him, he wants to improve himself academically (as indicated in his intention to receive a secondary school education). Taking ownership of the subject may be one of the reasons for his performance (Well's Pre-empt and Prevent Strategy – section 2.2.1.3). Research by Howie (1997) reveals a positive correlation between liking mathematics and achievement in the subject. Wiseman's statement (in his reflections) "*...I like sience and mathematics...*"(section 5.1) explains his positive performance in the subject as opposed to Nellie's "*...it's hard for me...I like maths...*" (N: interview) (section 6.1), which appears to counteract Howie's finding. Work completed by Nellie reveals that she does perform better in geometry (section 6.4). This may be the result of the practical aspect of geometry, for example, where she physically measured angles (Appendix E9) as opposed to work on negative numbers that are not tangible to her.

I realise the frustration that I experienced every time I met with an interruption in the course of data collection. As a researcher I am able to change the course of direction of the study. Nellie and Wiseman are not in a position to do the same. I can only begin to understand what these learners are experiencing.

7.1.2. Emotional and Physical Needs

Youth at-risk generally manifest, inter alia, the following behaviour patterns:

- *troublesome in class*
- *do not integrate easily into a group*

- *inclined towards isolation and alienation*
- *often absent / play truant*
- *have feelings of inferiority / poor self-concept*
- *highly sensitive and emotional* (Booyse 1994:126)

The two learners at-risk in this study do display some the above characteristics, Nellie to a greater extent than Wiseman. Neither of the learners is troublesome or disruptive in the classroom. However, both Nellie and Wiseman keep very much to themselves both inside and outside of the classroom (sections 5.1. &. 6.1). They choose to work independently of the other learners in the class unit. As Nellie has indicated, even when she goes home after school, she prefers being alone in her room (N: interview) (section 6.1). Despite this gravitation toward isolation, Nellie is more willing to hold a conversation with other people provided she establishes a trust in the individual (section 6.1). Wiseman finds this more difficult to do. The fact that he cannot speak English too fluently may be part of the reason that he did not really want to talk much to me, but that does not provide an excuse for his stilted conversation with his peers and teacher. The inability to interact with other learners deprives Nellie of the opportunity of learning from her peers. Perhaps a different arrangement of furniture / grouping of learners in the classroom may create the opportunity for interaction to enhance the learning process.

Although Nellie may not be troublesome in the classroom, she does lose concentration and is easily distracted (section 6.5), which inevitably affects her progress in mathematics. Wiseman, who may on the rare occasion, drift into his own world, is better able to gather his thoughts and return to the lesson on hand (section 5.5). Both these youth attend school diligently. This may be so because Wiseman likes school and would like to become a better himself by attending secondary school (section 5.1). Nellie may be attending school regularly because of the rules governing absenteeism at her school (section 6.1), (although she says she likes school, her actions speak differently, for example: falling off to sleep in class, playing with her pen) (section 6.5). The need to be with people does not appear to be the reason for her attendance at school, as she prefers being alone (section 6.1).

Both these learners are highly sensitive to their situations, Nellie, to the fact of being singled out (section 6.1) and Wiseman, by virtue of the fact that he is a "street kid" (section 5.1). Nellie's sensitivity extends to her refusal to participate in discussions in the mathematics classroom for the fear of being *'teased'* (section 6.5). She seems to lack self-confidence, which is evident in her hesitance to answer questions (section 6.1) and possesses a low self-esteem, apparent in her fear of being ridiculed (section 6.5), both of which are stumbling blocks in her academic achievement. Wiseman, on the other hand, is very self-assured and does not display traits of an inferiority complex - *at times I have noticed an air of dignity about him* (RJ: 12/9/00-Lesson 3) – especially when asked to demonstrate his knowledge on the chalkboard. Mwamwenda (1994: 271) is of the contention that *"self-concept is not innate, but is acquired through learning"*. Effective learning is influenced by the beliefs of both learners and teachers (Mwamwenda 1994). A teacher can, therefore, play an important role in facilitating learner's self-concept as suggested by Meggert (1989) in her Self-Esteem Enhancer Model (section 2.2.1.4). This is likely to improve her/his academic performance. Mr Xulu's practice of setting learners tasks, which most of them are able to complete successfully, is in keeping with findings on the facilitation of self-concept, which claim that by allowing pupils to experience success in the classroom, the teacher helps improve their self-concept (Mwamwenda 1994).

Any human being has to satisfy the basic physical needs of hunger and keeping warm in order to be able to concentrate in the classroom. Nellie comes to school attired in full school uniform with the home, at which she is resident, providing her with her meals. Wiseman will be served meals at the shelter provided that he is there at mealtimes. Since the shelter depends on clothing to be donated to them, the residents have to make good with whatever is given to them. The children also have to take precautions with these rations as they may be stolen by others and sold. Hence Wiseman cannot be certain of keeping warm on a winter's day (he does not have the shoes that were given to him). Wiseman is therefore at a greater risk of not being able to satisfy his basic needs, and therefore not being able to concentrate in the classroom. However, this is not demonstrated in this case, as Wiseman appears to be better able to cope in the classroom than Nellie is. How is this so? The answer may lie in the fact that Wiseman has learnt to deal with his circumstances in a different manner from Nellie. Life on the street has taught him how to cope and survive with the little he has. Nellie has not been exposed to life as a "*street kid*" which makes her "*at-riskness*" different to that of Wiseman, placing them at different positions on McWhirter"s At-Risk Continuum (section 2.1). The explanation to Nellie's poor concentration may lie in the fact that she is emotionally taxed. Other reasons for Nellie's behaviour are given in section 6.5.

7.1.3. Shared Identities

The learners at Thuthukani hail from a common background. They are children at-risk and share a common identity as a group. They understand each other's fears and anxieties. The teachers at Thuthukani are aware of this although they may not question the children about their backgrounds. The learners, however, may volunteer information about their lives, if they so desire. The teacher and pupils find a common ground and learn how to interact with one another. Hence the children who are at the margin are now given a centre stage opportunity. Wiseman is comfortable with the situation in the classroom and is able to grow as an individual at his own pace in his own space since all learners are given equal opportunity to learn. The fact that the teacher calls each child by name, gives the child a sense of identity. Wiseman is not *just* one in a group. These issues help the learner re-establish faith in mankind, which, in turn, impacts positively on his performance in the classroom.

At Sanville Secondary School Nellie is the only child in the class that has been identified as a learner at the margin, on the grounds that she lives in a home for youth at-risk. Other students at the school are aware of her place of residence, but Nellie does not really discuss the details of how she came to live at this home (N: interview - section 6.1). She and the other learners in her class cannot identify with each other. She, therefore, feels left out and '*different*', as expressed by her in her interview (section 6.1), an outsider sitting amidst a group of forty 'other' learners. The irony is that Nellie is one of the most centrally seated learners in the room (Section 6.1), yet she feels so marginalized and alone. The teacher in the classroom treats her as she would any other learner in the class (section 6.4). She does not want to make Nellie feel out of place. No special attention is given to children's personal needs. Entrenched in this scenario is a double bind: it does not matter how the teacher treats Nellie, as one of the group or 'special', this child will still feel *'different'*. Nellie's individuality is not taken into account in this classroom, she is merely one in a group. Treating everybody alike does not result in the same outcome for all. Sue Willis (1998) refers to this as the *'remedial'* perspective of disadvantage (section 3.1.3), where the 'fault' of poor performance in mathematics lies with Nellie and not the school curriculum nor the teaching practice. In this instance, the learner is at a greater disadvantage and feels isolated.

7.2. THE LEARNING ENVIRONMENT

7.2.1. Classroom Setting.

In both the classrooms the desks are arranged in cinema style, facing the chalkboard, as in any traditional classroom (sections 5.2 & 6.2). This type of arrangement suits the teacher-centred learning situation but cannot accommodate group work. The smaller number of learners in a class unit at Thuthukani allows for a more informal atmosphere to prevail in the classroom. At Sanville Secondary, the setting is regimental, with no allowance for movement. Despite Wiseman's class unit being based in a large, cold, doorless room there is warmth that surrounds the learners. This allows the enthusiastic learner to work under more pleasant conditions. A re-arrangement of classroom furniture may facilitate learner's group work and encourage interaction amongst the pupils. This is likely to be beneficial for learners such as Nellie and Wiseman, who may be drawn into the group. Wiseman may also be able to help other learners through his mathematical acumen, propelling him to the centre. This may also promote discussion and communication amongst pupils. According to Olivier, et al (1991: 36), the role of discussion among pupils

"*...promotes reflection...leads to improvement in strategy...*

helps prevent errors…and …eradicates misconceptions".

Propert (1993) acknowledges this with:

> "*…It is not using the rule that solves the problem, it is thinking about the problem that fosters learning. Good discussion promotes learning.*"

The learning environment usually depicts the type of teaching and learning that transpires within its confines. The classroom at Sanville Secondary School captures this through the charts that appear on the walls. The purpose of these charts is discussed in section 6.2. The information, recorded on these charts, appear to be lost to Nellie as they illustrate the very information that she does not understand, for example, complementary and supplementary angles. Does the learner see no utility value in the charts presently in the classroom? Does Mrs James, herself see any purpose in the charts, as she has out-dated data on these walls? I also noted that she did not make any reference to the chart on angles when correcting learners' misconceptions about classifying angles (during the oral presentations), despite the fact that it illustrated the ideas clearly (video recording: 07/09/2000- lesson 2). Should the teacher ask learners to make charts for the classroom that they perceive as useful? A poster competition, with the best posters being posted on the wall, may motivate the learners.

Does the fact that Wiseman belongs in a single-sex class and Nellie in a co-educational class, result in his performance in mathematics being apparently better? Would Nellie be more comfortable in answering questions, were she in a single-sex class? Feminists argue that single-sex classes in mathematics can provide a more appropriate curriculum in schools (Willis 1998:9). She, however, found little evidence to substantiate this. Having teachers who are the same sex as the learners does not seem to impact on learning either. The teachers in both the classes are of the same sex as the youth at-risk yet there is a difference in the manner in which each of the learners performs in mathematics (sections 5.5 & 6.5). Neither Nellie nor Wiseman share any special kind of relationship with their teachers (sections 5.4 & 6.4) to help make a conclusive remark.

7.2.2. Resource Materials

While each pupil in Nellie's mathematics class receives a mathematics textbook (section 6.2), there is just one book for the educator at Thuthukani (section 5.2). Learners at Sanville Secondary are also exposed to worksheets, mathematical instruments, reference books in the school library, and are computer literate (section 6.2). Many of the learners at Thuthukani may have never heard of a protractor, they have no form of mathematical reference, not even a workbook to carry out of the classroom. They have no contact with their mathematics books outside of lesson time, hence no form of revision or reinforcement of concepts learnt exists. What does this mean to the learner? According to Sethole (2001:13),

- The pupil is denied the opportunity to "see" the written mathematics and become familiar with mathematical symbols and definitions.
- The teacher becomes the sole "custodian" of the mathematics in the classroom.
- The learner is not exposed to any other examples and procedures outside that which is given by the educator.

One may argue that the teacher should not be dependent on the textbook and that s(he) should be innovative. This is especially so when one examines the type of problems illustrated in the textbook. Volmink (1994:61) is of the view that most of the school textbooks are "*written in a style which emphasises drill and practice or routine exercises*". The problems, that follow these tasks, are generally routine in nature, the solutions of which are obtained through the use of standard recipes. Many of the pupils in schools cannot relate to the situations cited in the problems because they do not fall within the realm of their reality, resulting in them not being able to determine the solution. According to Rasekoala (1999), the textbooks (and other resources) written, for the teaching of mathematics reinforce racist stereotypes, through the situations and illustrations. Evidence of this appears in illustrations in the textbook used by Nellie (section 5.2). The textbook that Mr Xulu uses, "*MATHEMATICS 5*" has among its authors Naidoo (an 'Indian') and Njisane (a 'Black'). Although the names used in the textbook are representative of all race groups and both sexes, for example: Govan and Sipho (page 11), Jane (page 231) and Zandile (232), the illustrations are still biased toward the 'Whites', for example: (page 263). *"Classroom Mathematics Std 6"*, the textbook used by pupils in Nellie's class, is written by a set of 'White' authors. Illustrations and names used throughout this textbook are reflective of the authors, an example of which appears on page 181 with the names Keith and Mary. A worksheet, given to learners in Nellie's class, carries a cartoon (Appendix E10) that is also illustrated similarly to the textbook. How much more difficult, is it, for the learner at the margin to understand and identify with these problems? Outcomes-based education places emphasis on learning being relevant and connected to real-life situations. Hence, the solution to these shortcomings seems to lie in the development of worksheets that will provide children, like Nellie and Wiseman, with a source of reference in mathematics that they can identify with. On the other hand relevance can become problematic if learners' experiences are associated with poverty, violence or abuse. No individual wants to relive the pain that is associated with such memories. As a result relevance in this situation may have an adverse effect. Nellie appears to contradict Sethole's comment about pupil's being denied the opportunity and becoming familiar with mathematics if not being exposed to textbooks, since she has a textbook yet performs poorly.

7.2.3. Distractions and Disturbances

Both the schools are situated in areas that are not conducive to learning (sections 5.2 & 6.2). Teaching and learning in a classroom that is plagued by the sound of airplanes and heavy traffic can become very frustrating to any individual when one's trend of thought is disturbed and concentration, broken. Characteristics displayed by youth at-risk, in general, are *"poor concentration and underachievement, lack of motivation and short attention span"* (Booyse 1991:127), which is evidenced by Nellie's act of falling off to sleep in class (section 6.1).

The disturbances that invade the classrooms at both Thuthukani (section 5.2) and Sanville Secondary (section 6.2), coupled with the other social, emotional and psychological issues that these learners at the margin experience, compound their problems in the classroom. It becomes all that more difficult for these learners, especially Nellie, who manifests all of the above characteristics, to remain focused, as the sound of aeroplanes interrupts the lesson.

"Today one of the pupils presenting her topic was interrupted twice in a space of under five minutes, by the sound of airplanes. As a result pupils became restless as they lost concentration in what was being transmitted" (RJ: 7/9/00-lesson 2).

In the case of Wiseman, it is difficult to tell whether he is an underachiever, as Mr Xulu does not have any form of assessment for him. Despite the disturbances and distractions, he is able to concentrate and pay attention without being easily distracted. The need to want to improve as an individual, helps him cope in the classroom.

7.3. THE MATHEMATICS CONTENT

Effective learning is not just the acquiring of knowledge prescribed in a school curriculum. The depth and accuracy of the content and the utility value it holds for the learner is significant. Merely skimming the surface of topics, recommended by the Department of Education, to complete a syllabus does not constitute good teaching and learning practice. If relevance of the curriculum to real-life problems is prescribed by the Education Department, then is it possible for learners at-risk to be accommodated in a curriculum set for the learner in the mainstream school?

7.3.1. The Curriculum

The curriculum in operation at the time of data collection (1999 – 2000) prescribed a content-based syllabus which was examination driven within a given time-frame. The principles upon which the outcomes-based education is founded, for example, learnercentredness, were already being experimented with, by many an educator in an informal manner. Nonetheless, completion of the syllabus was the aim of most teachers. Mrs James, at Sanville Secondary, is no exception to this rule. The aim of the exercise is to assess the learners' mathematical ability at the end of a given section in the syllabus. There is a flow in the sequence of topics, for example: the section on angles (divided into classification and measuring) was followed by supplementary and complementary angles, to enable pupils to build on their knowledge of concepts. The process of class, revision and remedial exercises culminates in a year-end examination of the learners' knowledge. Where is Nellie in this entire procedure? Why is the measure of an angle or the addition of two integers important to her? Does she understand the difference between complementary and supplementary angles? How did the curriculum accommodate her in this whole process? According to Willis (1989:13), Nellie may be experiencing the curriculum from an *"inclusive perspective"*. As she belongs to the *"non-dominant"* group (being the only child who has been identified as at-risk) in her class, she may be exposed to the curriculum that is associated with the dominant group. Therefore she is forced to learn mathematics that is incongruent with her experiences, interests and cultural practices (Willis 1998; Mellin-Olsen 1987), for example, the problems associated with equations (Appendix E). Hence the attained curriculum is not what the intended curriculum prescribes.

Mr Xulu, at Thuthukani is supposed to be teaching from the curriculum that is prescribed for the mainstream school, as indicated in the proposal document of Thuthukani Harm Reduction Centre. He is not as rigid as his counterpart at Sanville Secondary. As a result, there exists a back and forth movement in the delivery of his lessons, which is evident in the lessons on division of fractions and time conversions (see list of lessons taught under: Chapter 5: The Mathematics Content). Lessons are also repeated (converting minutes to hours: taught on three days). On the other hand, three different aspects on integers have been taught in one lesson (5.3-see list of lessons: 4/11/99). There is no formal curriculum available to the teacher. Although Mr Xulu says that he refers to a textbook, I have only seen him refer to it once when he was confirming whether the operation on hand was division or addition. The textbook that he subscribes to does not contain information on time conversion. Is the teacher following the prescribed curriculum? From a conversation with the teacher (RJ: 9/11/99 – lesson 2) I was given to understand that:

> "...*we were asked to follow the curriculum from the other (mainstream) schools...we have to teach the boys numeracy...nothing is really prescribed...as long as they are learning some mathematics...I can decide what to teach...So I'm following this textbook I have.*"

Questions that arise are: Is it sufficient for learners to be seated in a mathematics classroom "*as long as they are learning some mathematics*". Does the mathematics not have to be of a level that the pupils can understand? Most importantly, of what use is the mathematics being taught to the learner? The view expressed by the teacher, with regard to the content of the mathematics taught at Thuthukani, was reaffirmed by another teacher at the shelter. The aspects taught to learners at the centre may therefore differ to that prescribed by the Department of Education. How then are these learners expected to enter a mainstream school and cope with the mathematics being taught there? A form of communication could be established between these two types of schooling (as Mr Felix Ingatha corresponds with his neighbouring school (section 2.2.2)) if learners at-risk are to be placed in the mainstream school.

The new approach of outcomes-based education accentuates the integration of knowledge and "*what the learner becomes and understands*" (National Department of Education 1997:7). If this is the case, then both Nellie and Wiseman, may follow the same curriculum as learners in the mainstream school. They will be the same content in different contexts (real-life situations). In no way am I implying that the same learning will result, because the in the literature review (section 3.1.3) I mention that not all individuals construct the same meaning nor the meaning the teacher intended.

7.3.2. Relevance vs Mathematical Principles

The majority of students learn mathematics to get placement in jobs, further their education or function in society. Wu (1997: 29) maintains that there is *"a need to learn both the cultural aspects of mathematics and its utility"*. Many learners view the traditional curriculum as irrelevant. The reason for this perception may be the poor integration of mathematical theory and with application. Bishop (1988:189) cites the following as negative effects of pupils experiencing alien cultural products: *meaninglessness, rote-learning syndrome and a general attitude of irrelevance and purposelessness.* Rote-learning is evident in Wiseman's class, in the form of repetition (section 5.4) and in Nellie's class, with the repetition in the type of questions given in written work and tests (section 6.3). These teachers are practicing the principles of behaviourism (section 3.1.1), by exposing the learners to drill work. They are not at liberty to apply their own knowledge. Although drill work may be pertinent to certain aspects of the mathematics syllabus, for example: learning of multiplication tables, it may explain Nellie's inability to apply her knowledge as she does not understand the basics in mathematics. She is able to work the examples in class as she has the examples worked out by the teacher to follow. The retention of information obtained in this manner is short lived since Nellie is not able to internalize the information (section 3.2.2). *Problem solving* and *relevance* have become key words in mathematics education over the past years. The Virginian National Council of Teachers of Mathematics standards (Wu 1997) recommends problem solving as central to schooling. The question that emerges from this: will the details of real-world problem obscure the mathematical skills that the pupils should be learning? Wu (1997) continues to say that problem solving is only a means to facilitate the learning of mathematics. Mathematical discussions of the mathematics underlying a problem need to follow the solution of a problem to make a curriculum cohesive. Mrs James made an attempt at such a discussion during the remedial lesson of the controlled test, but it resulted in explanations rather than discussion (lesson 5 – 14/09/00: section 6.4).

Adler et al (2000:10) states that *"pedagogical motivations revolve around attempts to render mathematics learned in school more meaningful"*. This is based on the assumption that if mathematical concepts taught at school are related to learners' experiences, then the mathematics will make more sense to them. This may hold true to an extent and may work in a classroom like that of Wiseman, where learners share similar experiences, but what happens in a situation such as Nellie's. The real-life problems, which Nellie experiences may be regarded as trivia by the other learners in her group. The other learners may not be able to identify with these situations as they are foreign to their reality, for example, not living in one's own home with one's parents. The mathematical goals from school differ from the goals of everyday mathematics. Many learners view school mathematics as part of a subject package while others see it as a passport to higher education or obtaining employment. Pupils do not see a relevance to the world outside of the classroom, since one does not require written mathematics in everyday life (section 3.1.3). This may be attributed to the fact that school mathematics is too general and abstract (section 3.2.3). This coincides with the reasoning behind the *birth* of street mathematics. Romberg (1992: 435) states that examples given to learners are '*too artificial*' or '*problems that adults think will interest students*'. He suggests the development of a curriculum that is "*filled with social and political issues that will help students understand the complexity of such problems*". According to the National Curriculum Statement for 2002 (section 3.2.1) a mathematically literate individual will be able contribute and participate socially. It envisages a learner who is literate and numerate and whose values are different to those that *"underpinned apartheid education"* (Department of Education 2002: 3). Its goal is to encourage a learner-centred approach to education and develop critical and creative thinkers who are capable of working as a part of a team. The curriculum may vary from place to place, as it will be flexible, and specific to the needs and wants of a community (National Department of Education 1997). Such a curriculum, if implemented effectively, may be beneficial to learners at the margin, like Nellie and Wiseman, as their needs will be catered for. The suggestion for a core curriculum and a group-specific content may work to the advantage of Nellie and Wiseman (v.d. Horst 1993 – section 3.2.1).

The poor performance, in mathematics, of South African students in the TIMSS study reveals that their general mathematics understanding and skills are limited (Howie 1997). This may to an extent affect their effective performance in society. Nellie's fear of participating in lessons (sections 6.1 & 6.5) and not being confident of her answers in mathematics may be as a result of this very issue, as she shies away from people both inside and outside the classroom. If the reason behind learning mathematics is to become good, competent individuals in society, then learners, and especially those at the margin, should be given the opportunity use the type of mathematics that they understand and can communicate. The introduction of 'informal' mathematics (section 3.1.3) or mathematics literacy in schools may assist individuals in becoming functional in society. Pupils, such as Nellie, may be able to demonstrate their mathematical ability using methods that are mathematically sound but not prescriptive. Learners, like Wiseman, who appear to have a flair and understanding for the subject, may be introduced to a higher form of mathematics. While the traditional curriculum only taught the *'how'* in mathematics, the new reform curriculum may be able to teach the *'how'* and the *'why'* of mathematics. Since the traditional curriculum is not catering for individuals, like Wiseman and Nellie, they will have to serve as research samples in a new experiment of outcomes-based education.

7.4. MATHEMATICS LEARNING

Mwamwenda (1994: 121) contends that learning *"is a continuous process"* which *"involves a change of behaviour as a result of what one has experienced"*. It occurs as the result of both conscious and deliberate effort, and subconsciously. How a learner succeeds in learning mathematics depends on the following factors:

- *interest and involvement in problematic questions central to the topic:*
- *teacher attitude to teaching and learning;*
- *the extent to which the learners' own powers are evoked and employed in the teaching and learning;*
- *the extent to which the pupils share the teacher's goals.*

(Mason 1995: 80)

Teacher attitude to teaching and learning and the extent to which the pupils share the teacher's goals will be examined in the section on MATHEMATICS TEACHING.

7.4.1. Interest and involvement

Central to the process of learning is the issue of understanding the subject matter. If the learner does not understand, then s(he) should question the teacher to clarify doubts and misconceptions. Wiseman is confident enough to question the educator in the classroom (section 5.5), ensuring that he understands the content of the lesson. Nellie on the other hand, is afraid to ask any questions (section 6.5 - N: Interview – 15/09/00). Her misconceptions are compounded in this manner.

On comparing the two learning situations, it is noted that Nellie receives homework while Wiseman, does not. At the same time, the quantity of work set by Mrs James, in her mathematics class is greater than that set by Mr Xulu. The fact that Nellie is exposed to a greater variety of mathematical examples should enhance her result in the subject. However, the contrary seems to be true, as it appears that Wiseman better understands the mathematics taught to him (section 5.5) than Nellie does. A finding in the TIMSS study in South Africa (Howie and Hughes 1998) reveals the same outcome. Despite spending a considerable amount of time on homework, pupils still fared poorly in the subject. There may be other contributory factors, one of which may be explained by Willis' *'remedial'* perspective on the curriculum (section 3.1.3). Nellie, by virtue of her race is disadvantaged, since both the teacher and the other learners are 'Coloured' while Nellie is 'Black'. This makes Nellie culturally and racially different. Frakenstein (1995) may attribute Nellie's poor performance to the neutral application of mathematics (section 3.1.3). The implementation of the curriculum does not take into account the social, political and cultural background of the child (section 3.1.3). Strategies adopted by Nellie's teacher, for example: not differentiating between the needs of her learners (section 6.4), may not be effective in conveying the message to Nellie. Therefore Mrs James would need to be more discriminating when teaching her lessons. The TIMSS study (Howie and Hughes 1998) reveals that there is no significant difference in the result of learners who take mathematics at school with those who did not study mathematics. The following question arises: does formal schooling in mathematics not equip the individual with the numerical literacy required in the work place or in everyday life?

Wiseman is at an advantage in that he has a teacher who is bilingual, and with whom he shares a common culture and language. This enhances communication in the mathematics classroom. The teacher is able to switch to Zulu (section 5.4) when the pupils do not understand the concepts being taught. Nellie, however, does not enjoy this privilege. Despite her command of English, she has a problem in expressing herself in mathematical language, as illustrated by

"*....You know this x......and minus those negative things....*" (extracts from N: interview)

This impediment prevents her from questioning, or even answering the teacher. Topic from the mathematics syllabus, such as integers and the solution of problems using equations, generally pose a challenge to the majority of students. Nellie is placed at an even greater disadvantage due to the fact that mathematical language, which has a code of its own (sections 3.1.2 & 3.2.3), is used. Learners, such as Nellie, whose first language is not English encounter a problem in understanding the language in which the question is phrased. A problem-solving question worded as follows may create a dilemma in Nellie's mind:

> *If Mrs Brown is y years old and her husband is 3 years older, how old is he in terms of x?* (From revision exercise given 12/09/00).

Nellie did not even attempt the example (Appendix E13) or any previous task of a similar nature (neither did many of the other learners - I was able to look at pupils' books when Mrs James collected them to initial). This may be the result of not understanding what is required of her in answering this type of question. Could the question not be worded differently to accommodate the learners? The fact that many other pupils in the class (whose first language is English) left the question unanswered may imply a lack of understanding. By making the problem more realistic to the students, by drawing on their experiences may improve the learners' understanding (section 3.2.2).

The type of mathematics that Wiseman has encountered in his class, namely: time conversion, fractions and integers, did not call for problem solving techniques or *"real"* algebra. His teacher is the position to explain any misconception to him through the medium of his first language. Being a learner at Thuthukani allows Wiseman the opportunity of a bilingual teacher, without exposure to problem solving, while Nellie experiences mathematics of greater depth, without the language to solve the problem. Which of the learners is really benefiting from the classroom experience?

7.4.2. Evoking Learner's Own Powers

Pupils need to make sense of what they are learning (as suggested by constructivists). This can be realized through the development of a mental picture associated with the topic being discussed, verbal expression to oneself or a peer (Mason 1995: 78) or through the use of diagrams, especially in the study of geometry and problem solving. Nellie's poor performance in geometry can be attributed to the lack of such associations in her tasks (exercise on Linear Equations in Geometry: 13/09/00 – section 6.5). The correct use of mathematical notation and symbols is also important in the comprehending the mathematics involved. Both Wiseman and Nellie tend to use the equal to sign in a loose manner (many of the exercises in both learners' books are fraught with this type of inconsistency). Processes seem to be confused at times, suggesting the use of drill or rules (which in itself is not necessarily 'bad'), without the understanding of concepts. Nellie's incorrect calculation of the square root of 324 in a test and the inaccuracy Wiseman's task on the multiplication of fractions (22/10/99) point in this direction.

A study by Boaler (1999) suggests that learners generally remembered rules, equations and formulae at the expense of trying to think about what to do in a particular mathematical situation. Instrumental understanding, which may be described as rules without reason, could be linked to behaviourism while relational understanding, which requires pupils to reconstruct forgotten facts and techniques, may be associated with constructivism (Selinger 1995). A comparison of both types of understanding reveals the following:

INSTRUMENTAL	RELATIONAL
Usually easier to understand	More adaptable to new tasks
Rewards are more immediate and more apparent.	Easier to remember
One can often get the right answer more quickly.	

Table 7.1. Comparison between Instrumental and Relational Understanding

If Nellie is employing instrumental understanding only, then this may explain her ability to obtain the correct answers in the classroom but not at home.

In all the tasks that Wiseman has encountered in class, none have required his reading. When an exercise is set, the instructions given by Mr Xulu are basically the topic of the day, for example: convert hours to minutes, addition of fractions. By stating the topic, for example: Convert hours to minutes and then stating that pupils will be converting hours to minutes makes the topic easy to understand. The teacher explains what has to be done in the exercise (section 5.4). Nellie receives more involved instructions, as she has to read the question from a book, worksheet or the chalkboard. She also has to answer word problems. A reading problem may cause a learner, who copes when the instructions are read out to her /him, to perform poorly when s(he) has to read and understand the instruction (van Wyk 1991: 101). This may be an explanation for the difference in the performances of the two pupils in terms of their written exercises. Socio-constructivists are of the opinion that verbal interaction between learners, aids in sharing meaning and formulating mathematical concepts (section 3.1.2). The classroom, in which Wiseman is based, allows for him to consult with other learners if the need arises (section 5.1). However, Nellie is less fortunate in this respect (section 6.4).

Task completion and presentation of work is not of any importance to Nellie, evidence of which lies in the rubber-stamped pages of her book. Semi-worked solutions to questions or merely the transcribing of questions from the chalkboard suggest Nellie's apathy toward the subject. Wiseman, on the other hand, ensures that the task set for him is completed and examined by the educator before he exits the room. Julie (1993:33), in his article on People's Mathematics, speaks of mathematics being extrinsically motivated and intrinsically evolved. This intrinsic need for the subject appears to be absent in Nellie, as a result of her continuous failure in mathematics. She has now resigned herself to the fact that it is impossible for her to succeed, and does not make an attempt to try. The *'Peanut'* cartoon that appeared on the worksheet examining integers (dated 3 March 2000 – Appendix E10), may have an adverse result on Nellie, reinforcing the idea that she is *"stupid"* and incapable of passing or understanding mathematics.

When Wiseman finds himself in difficulty with calculations, he reverts to his own methods, for example, counting on his fingers (RJ: 10/11/99 – Lesson 3 – section 5.5). Although this may appear very insignificant and basic, it is valued by the constructivist approach (section 3.1.2). Wiseman is showing initiative by using his own methods. It implies that he understands what he is doing. This may be a contributory factor to his successful completion of work in the classroom (section 3.1.2). Folk Mathematics (section 3.2.3) also supports this type of learning in mathematics. Nellie has shown no such initiative in finding solutions to mathematics questions.

While the exercise books at Thuthukani are "examined" by Mr Xulu daily, Mrs James conducts irregular checks on her learners' books intermittently. Many incorrect answers (in the books of learners at Thuthukani) were given a tick. The question that came to mind when scrutinizing the books belonging to Wiseman and Nellie, was: *what is the purpose of these checks?* Is this a requirement of the respective schools? Is a tick placed at the end of an answer to denote a correct answer or merely to motivate the learner? The students at Sanville Secondary check solutions to questions as the teacher calls out the correct answer. Nellie indicates the incorrect answer with an 'X'. However, both the learners, do not correct these answers. As a result, these children are recording inaccurate information which, in Nellie's case, is reproduced in examinations and tests.

7.5. MATHEMATICS TEACHING

Volmink's (1994) comment in his article *"MATHMATICS BY ALL"* is *"to know and to understand is a basic human right..."*. The teacher in the classroom can either deny or uphold this right through her/his teaching practice. S(he) is the '*socializing force in helping the student become a mathematically literate adult*' (Richards 1994:30). He contends that the essence of good teaching is for both the teacher and the students to be prepared to learn.

7.5.1. Teachers' Attitudes Toward Teaching and Learning

Both the teachers in the study hold qualifications in education, with a specialisation in mathematics. What Mr Xulu lacks in experience, he compensates for in enthusiasm. From my observation in the two class settings, I perceived a set format in each of the educators' presentation of lessons, which did not vary greatly from each other. The reason for the format may be the result of their own past experience and beliefs that such a presentation is effective (Nickson – section 3.2.2). Both the educators stood at the front of the room when addressing the learners, using very traditional methods of teaching (refer to section 5.5 and 6.5). However, Mr Xulu tends to use repetition and drill to reinforce concepts. This trend places him back many a year to the practice of behaviourism, the filling up of an empty vessels does not promote mathematical understanding (section 3.1.1). There is evidence of more interaction between teacher and learners during the entire lesson in the classroom at Thuthukani than at Sanville, which provides for a one-on-one communication between learner and educator. Constructivists (section 3.1.2) and the proponents of the social, political and cultural approach to education (section 3.1.3) favour communication as it leads to independent thinking. With all the technology and innovations in education that have taken place over the years, neither of these teachers utilises exciting methods to motivate learners and inculcate an affinity for the subject. Ollerton (1995:65) suggests that the teacher should find *"ways of causing the learner to make connections and provide opportunities for the transfer of skills"* to promote the effective learning of mathematics. Some researchers are of the opinion that the effective way to introduce a rule, formula or algorithm is through the use of concrete materials thereby allowing students discover the rules for themselves (Ollerton 1995). However, neither of Mr Xulu nor Mrs James, used any such materials in their lessons. This is a problem for all learners but perhaps more so for those at the margin who are coping with other issues in their lives.

Muthukrishna and Rocher (1999) believe that all mathematical activity could be presented as problems to be solved. In this way, learners can invent and use their own strategies. Problem-solving skills, which Thuthukani set down as one of its aims, is foreign to its learners. Although the pupils at Sanville Secondary are exposed to problem-solving, the teacher's role is not that of *'critical mediator'* (Muthukrishna 1994: 40). Therefore, both these learners at the margin are not given the opportunity to use common sense to develop critical thinking.

The planning and preparation of lessons is essential for success in the classroom (Butler et al 1970:48). Although all lessons do not always go according to plan, a prepared teacher is more confident in the classroom. In the planning of the lesson the teacher should find tasks that:

- *are a suitable starter for everyone in the class to work on*
- *create opportunities for students to explore ideas and ask questions*
- *draw upon 'real' cross-curricular type contexts, such as using information from a newspaper, or problem-solving contexts.*

(Ollerton 1995:64)

Although the educator at Sanville Secondary does not carry any evidence of a preparation file, she always appears to come into the classroom prepared for her lesson. This is evidenced by the fact that she knows exactly what she is to teach for the lesson and is confident in the delivery of her lesson. She also makes reference to what she has taught and what she is going to teach (lesson 4: 13/09/00 – section 6.4). This gives structure, direction and purpose to the lesson. Her years of experience make it easier for her to handle any change in the plan for the day. Despite her preparation, the individual needs of learners are not catered for. Mr Xulu, however, displays little lesson planning. The confusion that arose regarding multiplication and division of integers (day 3 – 10/11/99) and converting minutes to hours (1/11; 2/11; 5/11/99) bear testimony to his lack of preparation (section 5.4).

The teacher's content knowledge of the subject plays an important role in instruction and learning (Zaslavsky: 1994 – section 3.2.2). If the educator is not familiar with the content of the mathematics curriculum, s(he) will disseminate inaccurate information, as is the case with the lesson: converting minutes to hours. Webb (1998: 34) states that a mathematics teacher needs " *to be an authority on the subject*" or else her/his "*ignorance is exposed*". Teachers who are not in command revert to drill and convey a lack of confidence (Webb 1998). This may be one of the reasons why Mr Xulu repeated his statements and questions so often.

In both the learning sites the educators use questions to get the learners involved in the lesson. The type of questions asked in the Thuthukani classroom are basic while Mrs James asks more involved questions that require the pupils to think. Neither one of these teachers ask questions that require detailed explanations. The type of question that Mr Xulu asks is: *How many minutes make one hour?* (section 5.4) while Mrs James would like to know: *How does your denominator get rid of four?* (section 6.4). Teachers use questions to control discussions through subtle cues (Richards 1994). Questioning should serve as a process to "*force learners to elaborate, clarify and re-organise thought* (Muthukrishna 1994: 40). This can be one of a teacher's most powerful tools. It can be used to determine the weak links in a learner's mathematical knowledge or pupil's background knowledge. If the educators at both the schools use questions effectively, they will be able to develop and correct the mathematical ability of their learners.

Questioning promotes critical thinking and creates a more learner-centred environment. This type of environment is emphasized by the socio-constructivist (section 3.1.2) and social, cultural and political (section 3.1.3) approaches.

The teacher's attitude toward both his/her learners and subject is of paramount importance in the classroom. Breen (1998: 32) suggests that ' *teachers should learn to make an effort to understand difficulties facing each pupil in the class and to place their development as a principal teaching priority'*. By interacting with learners in his class on a one-on-one basis, Mr Xulu is able to get pupils to open up to him, as illustrated

> "*You have to be like a father ....and like a friend....The boys....they must trust you...you must joke with them...make them feel comfortable.. ... Some boys will talk to you ...tell you about the life on the street..... others won't....we cannot question them ...*" (RJ: conversation with teacher- 10/11/99)

He also speaks to his learners in a manner that demonstrates his acknowledgement of their individuality, for example, mentioning each one by name. His tone of voice reassures them, gives them a sense of faith in their teacher. According to Wells' strategy (section 2.2.1.3) respect for learners and a positive atmosphere are essential in creating a successful at-risk programme. This may attribute to Wiseman's success in the classroom. Mr Xulu is practicing what Welhage et al (1987) refer to as teacher culture, where the 'whole child' (section 2.2.1.3) is taken into consideration.

Mrs James, on the other hand, maintains a strict discipline in her classroom. There does not exist the same type of rapport between this educator and her students. Nellie is afraid to approach her teacher with any type of problem or query, as she indicated in her interview. The tone of her voice and use of words, when addressing learners, for example: "*hey! Thank you*" is a paradox. Bly (1989) comments:

> *If, in a rule-bound classroom you do something wrong, it leads to shame. In a playful classroom, with a set of guidelines, something done differently, leads to conversation. Shame is used as a form*

of control. (Breen 1998: 32)

This is true, as in the classroom at Sanville Secondary when Nellie fell off to sleep (section 6.5). She awoke with embarassment, when Mrs James asked out aloud as to whether she was asleep. On the other hand, it is accepted that a child at Thuthukani who places his head on the desk is tired/ unwell/ not interested. He is left alone or questioned quietly by the teacher (as was the case of a pupil in the pilot class).

As Mr Xulu walks around the classroom, he is aware of the behaviour of the learners. Mrs James sits at her table marking while her learners are working. What messages are these two teachers sending out to their pupils? The attitude that each of the teachers displays toward the work in the classroom will be detected by the learners. The learners at Sanville will sense disinterest, on the part of their teacher, and approach mathematics with the same attitude.

In the mainstream school Mrs James undertakes to remedy the errors that were identified during the term test (section 6.4). An attempt is made, by the teacher, to highlight and rectify these errors. She explains the need for the correct layout of the problem and the accurate use of mathematical symbols, for example: the equal to sign. This is to provide the learners with a better insight into what they learning. Emphasis is laid on the format of the problem-solving question. Pupils have to follow a set of steps illustrated by the teacher. They are not afforded the opportunity to use their own methods of solution but are taught how to answer the question according to what the teacher deems fit. Her preference influences the thinking patterns of the children (section 3.2.2). This defeats the idea of critical thinking and learning through discovery. This goes against the idea of problem-centred learning as suggested by socio-constructivists (section 3.1.2).

Although the teacher at Thuthukani realised his error (conversion of time: minutes to hours) and rectified it in the following lesson (hours to minutes) (section 5.4), he did not inform the learners that the initial conversions were incorrect. Therefore in the mind of the learner he is able to convert minutes to hours as he was taught. The teacher is content with the learners simply understanding the concepts and executing the arithmetic. No form of remediation takes place in Wiseman's classroom. Mr Xulu is representative of the educator who accepts incorrect answers because of his own deficiency in knowledge (Zaslovsky 1994 – section 3.2.2). Prolonged periods of teaching in this manner may have a detrimental effect on a learner like Wiseman, which may result in his losing interest in mathematics (Webb 1998 – section 3.2.2).

The learners at the mainstream school are exposed to mathematical games, olympiads and challenges which are held regionally or nationally. The idea is to inculcate in the learner an increased interest in the subject and afford the mathematics enthusiast an opportunity to extend himself (Teacher: interview – section 6.4). However not all learners are motivated by such challenges, Nellie being one of them. At Thuthukani the learners are not given such exposure, hence learners such as Wiseman (who have a flare for the subject) are deprived of the opportunity. Questions that may arise are: If a learner at the margin has difficulty in coping with mathematics in the school curriculum, how would she cope with the type of problem solving that appears in these challenges? Is Wiseman really being disadvantaged by not being exposed to these challenges at this stage in his life?

7.5.2. Whose goals are these?

What are the goals of these mathematics teachers in the classroom? The learners at Sanville Secondary School subscribe to a curriculum that is examination-driven. The teacher has to ensure that she has completed certain sections of the syllabus within a given time-frame. The process may lead to intensification whereby only what is essential to the task is accomplished (Apple 1992: 426), sometimes resulting in quality being sacrificed for quantity. The learner, whose goal is to be promoted into the next grade, need not pass mathematics to achieve this goal. Do the learners and teacher then share the same goal? The teacher at Thuthukani is not driven by a curriculum, tests and examinations in the classroom. He can work at a pace that will suit the learners needs. Unfortunately, the high turnover of children does not permit such teaching practices. This teacher wants to develop numeracy skills, as prescribed by the Thuthukani proposal, that will make these learners mathematically literate. Are these the same goals of the learners? If they are, then the learning that takes place in this classroom will be effective? Are Wiseman's goals the same as his teacher's resulting in him succeeding in the classroom? Does this mean that Nellie and Mrs James do not have the same outcome in sight? Does the fact that Nellie not construct the same meaning as her peers in the mathematics classroom imply that she is an ineffective learner (section 3.1.2)? Could the result be different for Nellie if Mrs James allowed her pupils more flexibility in the manner in which they answer questions?

7.6. WHERE TO FROM HERE?

The study of Wiseman and Nellie examines how learners at-risk achieve (or do not achieve) in the mathematics classroom. From the study of two very different teaching and learning contexts, many similarities and differences emerge. The teacher in any classroom has to take cognisance of the individuality of each learner in his classroom. In the event of the teacher having learners at the margin in her class, she has to employ approaches in mathematics that will accommodate their psychological needs. Learners at the margin are further marginalised in the mainstream school. From my study, I recommend that these learners are first placed in schools such as Thuthukani. When they have acclimatized to their surroundings and developed confidence in their educational abilities and self-esteem, then they could be mainstreamed into schools. At the end of the day the powers that be together with the Department of Education need to acknowledge the existence of these learners who are at risk. Policies will have to be put into place to accommodate them in our education system. While special consideration is to be given to their plight, authorities have to be guarded against pushing these learners further to the periphery of both education and society.

Since a teacher will never know when she may have to teach an at-risk youth in her classroom, consideration could be given to the idea of providing teachers or trainee teachers with some training in teaching these learners. This may take the form of in-service training for practitioners or internship for the trainees.

7.7. CONCLUSION

In concluding this study I focus on the issues, that I consider most important, as a result of having carried out this study. They are the mathematics curriculum and at-risk youth and the factors that influence the mathematics education of learners at the margin.

My visit to the Thuthukani Harm Reduction Centre as a Master of Education student combined with my belief that no child should be regarded as incapable of learning, resulted in my undertaking this study of at-risk youth. Being in a classroom with street children has given me a new perspective to both mathematics education and life in general. The limited information available on learning programmes for these youth made the study all the more interesting as it presented the opportunity to discover the needs of these learners in the field of mathematics. As the study progressed it became evident that there exists a critical need for learners at the margin to be accommodated in the field of mathematics if South Africa wishes to become a nation that is mathematically literate. With the number of street children on the increase, curriculum developers will soon have to consider a core curriculum that may be adapted to accommodate the differences that exist socially, politically and culturally amongst the people of the country. A flexible and relevant curriculum is to be developed in order to achieve the goal of numeracy. The two teachers in the study implemented the curriculum in the way in which they interpreted it. At Thuthukani the teachers were asked to follow the curriculum that was being implemented in the mainstream school, a curriculum that made no provisions for the learner at the margin. In the opinion of the teachers, they were doing the best they could to accommodate these learners in their classroom since neither had any previous experience with learners at the margin.

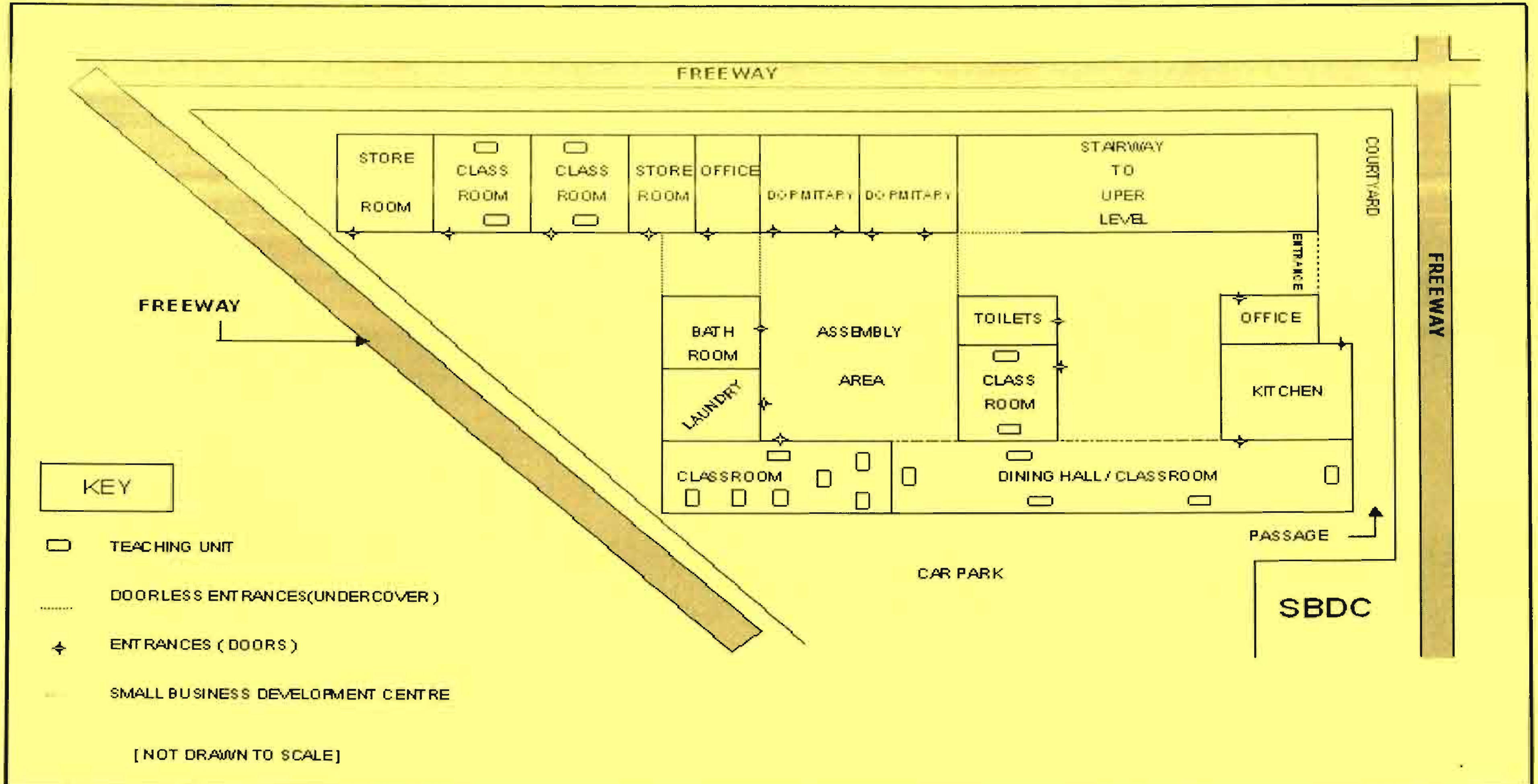
Having a curriculum that serves the needs of the populace is only effective if the factors that influence the mathematics education of at-risk are also considered. In my opinion, the learner, teacher and learning environment are important factors in ensuring that mathematics education takes place. The physical environment, distractions and resources unite to create an atmosphere conducive to work. However, no matter how inviting the environment or how resourceful the school is, no teaching and learning can occur without the learner nor the teacher being present. This becomes apparent when one looks at the physical situation of Thuthukani, with its lack of resources. Nevertheless, the enthusiasm on the part of both educator and learners compensate for the environment. The atmosphere that exists within the walls of this classroom encourages the at-risk youth. Interest, involvement and the will to achieve on the part of the learner result in successful learning. The attitude of the teacher toward teaching and learning, and toward the learner helps the learner succeed. Considering these factors it becomes evident that Wiseman teamed with Mr Xulu will form a winning team. This leaves me with the question: If Nellie had had MrXulu as her teacher and Wiseman, Mrs James, would each of their performances in the classroom have been any different?

Appendix A

CHARACTERISTICS OF OVERALL SUCCESSFUL AT-RISK PROGRAMS
[Source: Wells 1990]

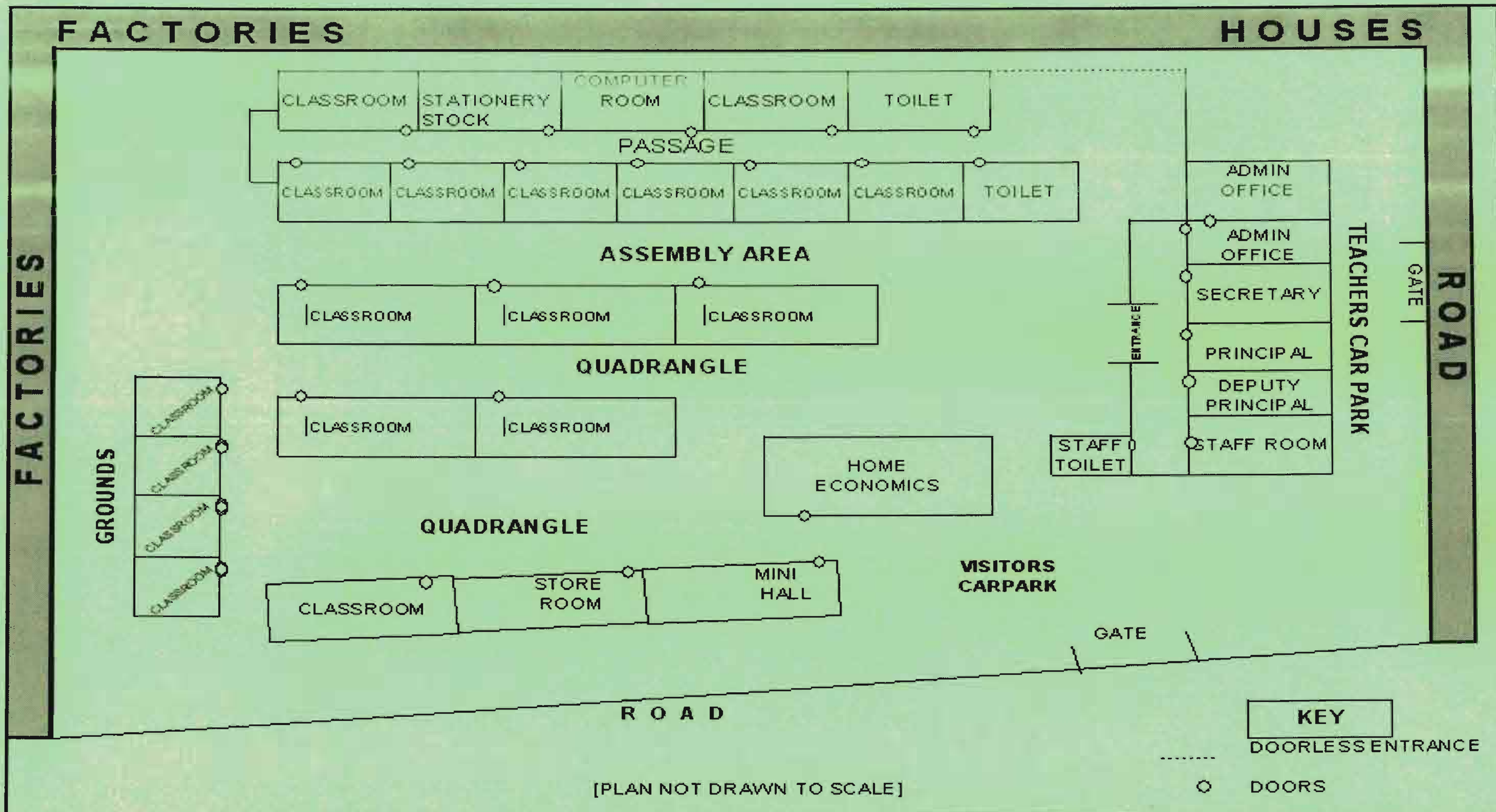
- Preschool early childhood intervention programs
- Small classes
- Program flexibility
- Experience-based education
- Improved curriculum and improved school climate
- Functional and academically challenging curriculum
- Study skills at all levels
- Self-concept development, student empowerment
- Counseling
- Systematic attendance procedures
- Defined discipline procedure
- Mentor programs
- Interpersonal and life skills
- Systems to address "transition" from home, school, grade level, and beyond
- Vocational/technical/adult education programs
- Work/study programs
- Work attitudes and habits
- School-directed alternative educational programs
- Staff development to better teach all at-risk children, including cultural sensitivity
- High student expectations by teachers
- Hispanic role models in the classroom (teachers, counsellors, business and community leaders)
- Parental involvement
- Student access to schools of their choice
- Student assistance programs to address substance abuse, teen pregnancy and young parenthood, suicide prevention, and other mental and physical health issues, health centres
- Quality after-school care and /or extended day programs
- School-community partnerships
- Business partnerships that smooth the school-to-work transition
- Business incentives to young employees to stay in school
- Community-based youth activities, community service

Appendix B



THUTHUKANI LOCATION AND GROUND FLOOR PLAN

Appendix C



SANVILLE SECONDARY LOCATION AND GROUND FLOOR PLAN

Appendix D 1

12 October 1999

Maths

Change improper to mixed fractions

① $\frac{24}{3} = 8\frac{1}{3}$ ② $\frac{33}{2} = 16\frac{1}{2}$ ③ $\frac{29}{9}\ 3 = \frac{2}{9}$

④ $\frac{36}{4} = 9\frac{1}{4}$ ⑤ $\frac{40}{3} = 13\frac{1}{3}$

13 October 1999

Maths

Change improper to ~~mixed~~ decimal fractions

① $\frac{1}{5} = 0{,}2$ ② $\frac{7}{10} = 0{,}7$ ③ $\frac{3}{5} = 0{,}6$

④ $\frac{10}{20} = 0{,}5$ ⑤ $\frac{6}{10} = 0{,}6$

14 October 1999

Addition fraction mathematics

With common ~~Multiplicat Division of fractions~~

denominator

① $\frac{2}{4} + \frac{6}{4}$, $\frac{2+6}{4}$, $\frac{8}{4} = 2$

② $\frac{8}{3} + \frac{1}{3}$, $\frac{8+1}{3}$, $\frac{9}{3} = 3$

③ $\frac{6}{8} + \frac{10}{8}$, $\frac{6+10}{8}$, $\frac{16}{8} = 2$

④ $\frac{9}{3} + \frac{6}{3}$, $\frac{9+6}{3}$, $\frac{15}{3} = 5$

⑤ ~~$\frac{10}{2} + \frac{5}{2}$, $\frac{10+5}{2}$, $\frac{15}{2} = 14\frac{1}{2}$~~

⑤ $\frac{10}{2} + \frac{5}{2}$, $\frac{10+5}{2}$, $\frac{15}{2} = 7\frac{1}{2}$

Good

Appendix D 2

15 OCTOBER 1999

MATHEMATICS CLASS WORK

ADDITION OF FRACTIONS

① $\frac{6}{3} + \frac{8}{6}$

$\frac{12 + 8}{6}$

$\frac{20}{6} = 3\frac{2}{6}$

② $\frac{9}{2} + \frac{3}{4}$

$\frac{18 + 3}{4}$

$\frac{21}{4} = 5\frac{1}{4}$

③ $\frac{6}{4} + \frac{9}{8}$

$\frac{24 + 9}{8}$

$\frac{33}{8} = 4\frac{1}{8}$

④ $\cancel{\frac{12}{5} + \frac{6}{10}}$

$\cancel{\frac{60 + 6}{10}}$

$\cancel{\frac{66}{10}} = 6\frac{6}{10}$

⑤ $\frac{7}{2} + \frac{8}{4}$

$\frac{14 + 8}{4}$

$\frac{22}{4} = 5\frac{2}{4}$

④ $\frac{12}{5} + \frac{6}{10}$

$\frac{24 + 6}{10}$

$\frac{30}{10} = 3$

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17 OCTOBER 1999

MATHEMATICS CLASS WORK

SUBTRACTION OF FRACTION.

WITH COMMON DENOMINATOR.

Appendix D 3

① $\frac{6}{\cancel{8}} - \frac{4}{3}$

$\cancel{\frac{6-4}{3}}$

$\cancel{\frac{2}{3}} \rightarrow$

① $\frac{6}{3} - \frac{4}{3}$

$\frac{6-4}{3}$

$\frac{2}{3} \rightarrow$

② $\cancel{\frac{30}{2} - \frac{4}{2}}$

$\cancel{\frac{20}{4} - \frac{4}{4}}$

$\frac{30}{2} - \frac{4}{2}$

$\frac{30-4}{2}$

$\frac{26}{2} = 13$

③ $\frac{20}{4} - \frac{4}{4}$

$\frac{20-4}{4}$

$\frac{16}{4} = \cancel{16}\,4$

④ $\frac{12}{8} - \frac{8}{8}$

$\frac{12-8}{8}$

$\frac{4}{8} = \rightarrow$

⑤ $\frac{10}{5} - \frac{5}{5}$

$\frac{10-5}{5}$

$\frac{5}{5} = 1$

V. Good

19 OCTOBER 1999

MATHEMATICS CLASSWORK

SUBTRACTION of FRACTIONS

① $\frac{3}{4} - \frac{2}{3}$

$\frac{9-8}{12}$

$\frac{1}{12}$

② $\frac{9}{4} - \frac{2}{2}$

$\frac{9-4}{4}$

$\frac{5}{4} = 1\frac{1}{4}$

③ $\cancel{\frac{6}{3} - \frac{2}{6}}$

$\cancel{\frac{24-4}{12}}$

$\cancel{\frac{20}{12} = 1\frac{8}{12}}$

③ $\frac{6}{3} - \frac{2}{6}$

$\frac{12-2}{6}$

$\frac{10}{12} =$

④ $\frac{7}{3} - \frac{2}{2}$

$\frac{14-6}{6}$

$\frac{8}{6} = 1\frac{2}{6}$

⑤ $\frac{4}{5} - \frac{2}{15} - \frac{1}{3}$

$\frac{12-2-5}{15}$

$\frac{5}{15}$

V G 90

Appendix D 4

20 OCTOBER 1999

MATHEMATICS CLASS WORK

MULTIPLICATIONS OF FRACTION

① $\frac{5}{1} \times \frac{1}{2}$

$\frac{5}{2} = 2\frac{1}{2}$

② $\frac{3}{1} \times \frac{1}{2}$

$\frac{3}{2} = 1\frac{1}{2}$

③ $\frac{5}{1} \times \frac{4}{3}$

$\frac{20}{3} = 6\frac{2}{3}$

4 $\frac{2}{3} \times \frac{6}{1}$

$\frac{12}{3} = 4$

⑤ $\frac{7}{1} \times \frac{3}{10}$

$\frac{21}{10} = 2\frac{1}{10}$

21 OCTOBER 1999

MATHEMATICS

Multiplication of fraction

① $\frac{1}{2} \times 3$

$\frac{1}{2} \times \frac{3}{1}$

$\frac{3}{2} = 1\frac{1}{2}$

② $4 \times \frac{2}{3}$

$\frac{4}{1} \times \frac{2}{3}$

$\frac{8}{3} = 2\frac{2}{3}$

③ $\frac{7}{8} \times 7$

$\frac{7}{8} \times \frac{7}{1}$

$\frac{49}{8} = 6\frac{1}{8}$

④ $\frac{3}{4} \times 13$

$\frac{3}{4} \times \frac{13}{1}$

$\frac{39}{4} = 9\frac{3}{4}$

⑤ $9 \times \frac{5}{6}$

$\frac{9}{1} \times \frac{5}{6}$

$\frac{45}{6} = 7\frac{3}{6}$

Appendix D 5

22 OCTOBER 1999

① $\frac{2}{4} + \frac{6}{4}$

$\frac{2+6}{4}$

$\frac{8}{4} = 2$

② $\frac{8}{3} + \frac{1}{3}$

$\frac{8+1}{3}$

$\frac{9}{3} = 3$

③ 1 0 0 $\frac{6}{3} - 6$

1 0

③ $\frac{6}{3} - \frac{4}{3}$

$\frac{6-4}{3}$

$\frac{3}{2} = 2\frac{1}{2}$

④ $\frac{2}{2} \times \frac{6}{2}$

$\frac{2 \times 6}{2}$

$\frac{12}{2} = 6$

⑤ $\frac{8}{4} \times \frac{2}{2}$

$\frac{8 \times 4}{8 \, 4}$

$\frac{16}{4} = 4$

⑥ $7 \times 1\frac{2}{9}$

$\frac{7}{1} \times \frac{11}{9}$

$\frac{77}{9} = 8\frac{5}{9}$

25 OCTOBER 1999

MATHEMATICS CLASS WORK

Division of FRACTION

① $4 \div \frac{1}{2}$

$\frac{4}{1} \times \frac{2}{1}$

$\frac{8}{1} = 8$

② $6 \div \frac{1}{3}$

$\frac{6}{1} \times \frac{3}{1}$

$\frac{18}{1} = 18$

③ $\frac{4}{2} \div \frac{1}{2}$

$\frac{4}{1} \times \frac{2}{1}$

$\frac{8}{1} = 8$

④ $\frac{9}{4} \div \frac{3}{4}$

$\frac{9}{1} \times \frac{4}{3}$

$\frac{36}{3} =$

③ $\frac{4}{2} \div \frac{1}{2}$

$\frac{4}{2} \div \frac{2}{1}$

$\frac{8}{2} = 4$

④ $\frac{9}{4} \div \frac{3}{4}$

$\frac{9}{4} \times \frac{4}{3}$

$\frac{36}{12} = 3$

⑤ $\frac{7}{2} \div \frac{3}{4}$

$\frac{7}{2} \times \frac{4}{3}$

$\frac{28}{6} = 4\frac{4}{6}$

Appendix D 6

① $\frac{9}{3} \div \frac{8}{9}$ ② $\frac{10}{10} \div \frac{8}{8}$

$\frac{9}{3} \times \frac{9}{8}$ $\frac{10}{10} \times \frac{8}{8}$

$\frac{81}{24} = 3\frac{9}{24}$ $\frac{80}{80} = 1$

26 OCTOBER 1999

MATHEMATICS CLASS WORK

Division of fraction

① $4 \div 1\frac{1}{2}$

$4 \div \frac{3}{2}$

$\frac{4}{1} \times \frac{2}{3}$

$\frac{8}{3} = 2\frac{2}{3}$

② $6 \div 1\frac{1}{4}$

$6 \div \frac{5}{4}$

$\frac{6}{1} \times \frac{4}{5}$

$\frac{24}{5} = 4\frac{4}{5}$

③ $8\frac{1}{9} \div 1\frac{1}{4}$

$\cancel{\frac{1}{17}}$

③ $8\frac{1}{9} \div 1\frac{1}{4}$

$\frac{1}{13} \div \frac{5}{4}$

$\frac{1}{79} \times \frac{4}{5}$

$\frac{4}{365}$

$=1$

④ $\frac{3}{2} \div 2\frac{3}{3}$

$\frac{3}{2} \div \frac{9}{3}$

$\frac{3}{2} \times \frac{3}{9}$

$\frac{9}{18}$

$=1$

⑤ $6\frac{6}{6} \div 6\frac{6}{6}$

$\frac{6}{42} \div \frac{42}{6}$

$\frac{6}{42} \times \frac{6}{42}$

36

⑤ $6\frac{6}{6} \div 6\frac{6}{6}$

$\frac{42}{6} \div \frac{42}{6}$

$\frac{6}{42}\frac{42}{6} \times \frac{6}{42}$

$\frac{176}{176} = 1$

③ $8\frac{1}{9} \div 1\frac{1}{4}$

$\frac{73}{9} \div \frac{5}{4}$

$\frac{73}{9} \times \frac{4}{5}$

$\frac{292}{45} = 6\frac{22}{45}$

Good

Appendix D 7

21 OCTOBER 1999

MATHEMATICS CLASS WORK

Division of fraction

① $8 \div 1\frac{6}{8}$

$8 \div \frac{14}{8}$

$\frac{8}{1} \times \frac{8}{14}$

$\frac{64}{14}$

$= 4\frac{8}{14}$

② $1\frac{9}{9} \div 2\frac{8}{4}$

$\frac{18}{9} \div \frac{16}{4}$

$\frac{18}{9} \times \frac{4}{16}$

$\frac{72}{144}$

$= 144$

③ $2\frac{2}{4} \div 1\frac{1}{3}$

$\frac{10}{4} \div \frac{4}{3}$

$\frac{10}{4} \times \frac{3}{4}$

$\frac{30}{16}$

$= 1\frac{14}{16}$

④ $10\frac{9}{8} \div 10\frac{9}{8}$

$\frac{89}{8} \div \frac{89}{8}$

$\frac{89}{8} \times \frac{8}{89}$

$\frac{712}{712}$

$= 712$

⑤ $7\frac{8}{7} \div 7\frac{9}{3}$

$\frac{57}{7} \div \frac{21}{3}$

$\frac{57}{7} \times \frac{3}{21}$

$\frac{171}{168}$

$= 1\frac{3}{163}$

25 O[illegible] 1999

[illegible]

Time C[illegible]

1. 2 min + 3 SEC
2 [illegible] (3X60) min
2 min + 180 min
= 180 min

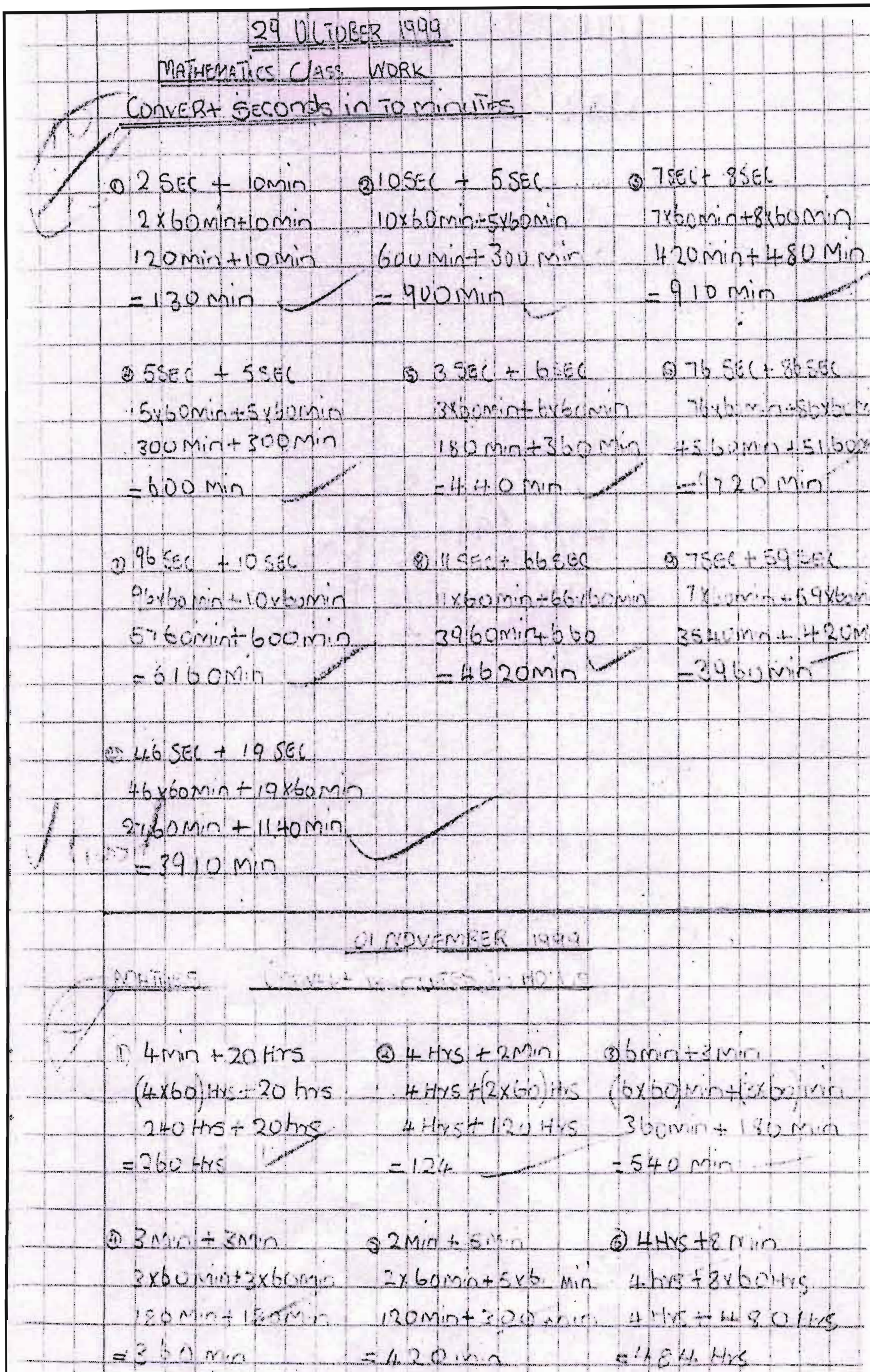
② 10 min + 2 SEC
10 min + (2X60) min
10 min + 120 min
= 130 min

③ 5 SEC + 5 SEC
5X60 min + 5X6 Min
300 min + 300 min
= 600 min

④ 1 min + 1 SEC
Min + (1X60) min
1 min + 60 min
= 61 min

⑤ 15 min + 5 SEC
15 min + (5X60) min
15 Min + 300 Min
= 315 Min

Appendix D 8



29 OCTOBER 1999

MATHEMATICS CLASS WORK

CONVERT SECONDS IN TO MINUTES

① 2 SEC + 10min
2x60min+10min
120min+10min
=130 min

② 10SEC + 5SEC
10x60min+5x60min
600min+300 min
= 900Min

③ 7SEC+ 8SEC
7x60min+8x60min
420min+480 Min
= 910 min

④ 5SEC + 5SEC
5x60min+5x60min
300Min+300Min
=600 Min

⑤ 3SEC + 6SEC
3x60min+6x60min
180 min+360 Min
=440 min

⑥ 76 SEC + 86 SEC
76x60min+86x60min
+560min+5160min
=1720 min

⑦ 96 SEC + 10 SEC
96x60min+10x60min
5760min+600min
=6160Min

⑧ 11 SEC + 66 SEC
11x60min+66x60min
3960min+660
=4620min

⑨ 7SEC + 59 SEC
7x60min+59x60min
3540min+420Min
=3960min

⑩ 46 SEC + 19 SEC
46x60min+19x60min
2760min + 1140min
=3910 Min

01 NOVEMBER 1999

MATHS CONVERT MINUTES TO HOURS

① 4min + 20 Hrs
(4x60)Hrs+20 hrs
240 Hrs+20hrs
=260 Hrs

② 4 Hrs + 2Min
4 Hrs +(2x60)Hrs
4 Hrs+120 Hrs
=124

③ 6min+3min
(6x60)min+(3x60)min
360min + 180 min
=540 min

④ 3Min + 3Min
3x60min+3x60min
180Min+180Min
=360 min

⑤ 2Min + 5Min
2x60min+5x60 min
120Min+300 min
=420 min

⑥ 4Hrs +8 min
4 hrs + 8x60Hrs
4 Hrs + 480 Hrs
=484 Hrs

Appendix D 9

03 November 1999

① $1 \div \frac{1}{3}$ ② $\frac{4}{6} \div \frac{2}{3}$ ③ $2 \div \frac{1}{5}$ ④ $\frac{4}{3} \div \frac{2}{3}$

$1 \div \frac{3}{1}$ $\frac{4}{6} \div \frac{3}{2}$ $2 \div \frac{5}{1}$ $\frac{4}{3} \div \frac{3}{2}$

$\frac{1}{1} \times \frac{3}{1}$ $\frac{4}{6} \times \frac{3}{2}$ $\frac{2}{1} \times \frac{5}{1}$ $\frac{4}{3} \times \frac{3}{2}$

$\frac{3}{1} = 3$ $\frac{12}{12} = 1$ $\frac{10}{1} = 10$ $\frac{12}{6} = 2$

04 November 1999

Mathematics class work

Intergers

① Intergers are the number as 1st demonstrated in the number line including negatives and positive numbers

Eg ← 5 4 3 2 1 0 1 2 3 4 5 →

NB − × − = +
+ × + = +
− × + = −
+ × − = −

04 November 1999 04 Addiction of Intergers

① $4 + 2 = 6$
② $-6 + 2 = -4$
③ $-10 + 5 = -5$
④ $16 + (-2) = 14$
⑤ $10 + (-5) = 5$
⑥ $17 + 4 = 21$
⑦ $98 + (-98) = 0$
⑧ $104 + (-116) = \cancel{12}\ -$
⑨ $172 + (-30) = 142$
⑩ $216 + (-300) = \cancel{174}\ \cancel{184}\ -$

Good!

Appendix D 10

05 NOVEMBER 1999

MATHEMATICS CLASS WORK

Convert Min To Hours

① 2 Min + 2 Hrs
2X60 Hrs + 2 Hrs
120 Hrs + 2 Hrs
= 122 Hrs

② 3 min + 3 min
3X60 min + 3X60 min
180 min + 180 min
=

③ 3 Min + 3 Min
3X60 Hrs + 3X60 Hrs
180 Hrs + 180 Hrs
= 360 Hrs

③ 3 Hrs + 4 Min
3 Hrs + 4X60 Hrs
3 Hrs + 240 Hrs
= 243 Hrs

④ 5 Hrs + 5 Min
5 Hrs + 5X60 Hrs
5 Hrs + 300 Hrs
= 305 Hrs

⑥ 2 Min + 5 Min
2X60 Hrs + 5X60 Hrs
120 Hrs + 300 Hrs
= 420 Hrs

12 NOVEMBER 1999

MATHEMATICS CLASS WORK

DIVISION OF FRACTION

① $1\frac{3}{4} \div \frac{1}{2}$
$\frac{7}{4} \div \frac{1}{2}$
$\frac{7}{4} \times \frac{2}{1}$
$\frac{14}{4} = 3\frac{2}{4}$

② $\frac{5}{3} \div \frac{5}{6}$
$\frac{5}{3} \times \frac{6}{5}$
$\frac{30}{15} = 2$

③ $2\frac{1}{5} \div 1\frac{1}{2}$
$\frac{11}{5} \div \frac{3}{2}$
$\frac{11}{5} \times \frac{2}{3}$
$\frac{22}{15} = 1\frac{7}{15}$

④ $6 \div 1\frac{1}{7}$
$6 \div \frac{8}{7}$
$\frac{6}{1} \times \frac{8}{7}$
$\frac{48}{7} = 6\frac{6}{7}$

⑤ $\frac{3}{5} \div 1\frac{2}{3}$
$\frac{3}{5} \div \frac{5}{3}$
$\frac{3}{5} \times \frac{3}{5}$
$\frac{9}{25}$

Appendix E 1

Exercise 1

SUBTRACTION OF ALGEBRAIC EXPRESSIONS

NB. ONLY LIKE TERMS CAN BE SUBTRACTED.

EXERCISE 1 SUBTRACT

(1)
$$\begin{array}{r} 3x - 5 \\ \mp 5x \pm 2 \\ \hline -8x - 7 \end{array}$$

(2)
$$\begin{array}{r} -4x - 12y \\ 3x - 8y \\ \hline -7x - 20y \end{array}$$

(3)
$$\begin{array}{r} 6x + y \\ -4x \mp 5y \\ \hline 2x - 4y \end{array}$$

(4)
$$\begin{array}{r} -4x + 11 \\ -x \mp 5 \\ \hline 5x + 16 \end{array}$$

(5)
$$\begin{array}{r} x - y \\ \pm 2x \mp y \\ \hline +1 \end{array}$$

(6)
$$\begin{array}{r} 2x - 3y - 4z \\ -x \mp 2y \mp 5z \\ \hline 1x - 5y + 1^2 \end{array}$$

(7)
$$\begin{array}{r} 8a \quad + 2c - 6 \\ -4b + 7c - 3 \\ \hline 8a + 4b - 5c + 3 \end{array}$$

EXERCISE 2. - SUBTRACT.

(1)
$$\begin{array}{r} 2x^3 - 4x^2 - 5x \\ 2x^2 - 3x - 4 \\ \hline 2x^3 \; 6x^2 \; -2x \; 14 \end{array}$$

(2)
$$\begin{array}{r} 2x^3 - 3x^2 + 7 \\ -6x^3 \mp 3x^2 \pm 1 \\ \hline -4x^3 - 6x^2 + 8 \end{array}$$

(3)
$$\begin{array}{r} 6a^2b + 4ab^7 - 1 \\ -4a^2b \pm ab^7 \mp 5 \\ \hline 2a^7b + 6ab^7 - 6 \end{array}$$

(4)
$$\begin{array}{r} x^3y - 7xy^3 + 6 \\ \pm x^3y \mp 2xy^3 \mp 1 \\ \hline 2xy - 9xy^3 + 5 \end{array}$$

(5)
$$\begin{array}{r} -3a^2 - 4a + 7 \\ \pm 3a^2 \pm 4a \mp 7 \\ \hline \end{array}$$

Appendix E 2

Multiplication of Terms

1) $a^2 \times a^3 = a^5$
2) $k \times k^3 = k^4$
3) $m^4 \times m^5 = M^9$
4) $b^2 \times b^2 = b^4$
5) $c^5 \times c^2 d = c^7 d$
6) $2dy \times 3y = 6dy^2$
7) $-3ab \times -3ab = 9a^2b^2$
8) $-6a^3 \times -5a^2 = 30a^5$
9) $2a^2 \times -2b^2 = -4a^2b^2$
10) $-8ca \times 8c = -64c^2a$

(11) $(3k)(5k)(6k) = 90k^3$
(12) $(-3p \times 4) + 2 = -12p + 12 = -12p + 2$
(13) $-7x^3y^2 \times 5x^6y'z^3 = -35x^9y^3z^3$
(14) $-5x^3 \times -10y^6 = 50x^3y^6$
(15) $2x^2y \times 3x^2 = 6x^4y$
(16) $8ab^2 \times -5a^2b = -40a^3b^3$
(17) $-3m^3k^2 \times 2m^2k = -6m^5k^3$
(18) $-2x^2 \times 8x \times -5x^2 = 80x^5$
(19) $-5a(-3a^2b^3) = 15a^3b^3$
(20) $-20x^2y \times -12x^3y^4 = 240x^5y^5$

good

Example:

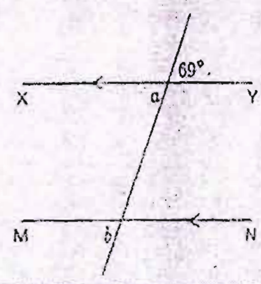
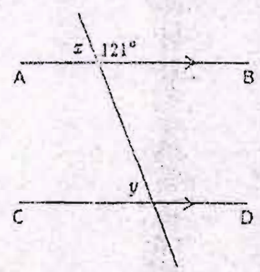
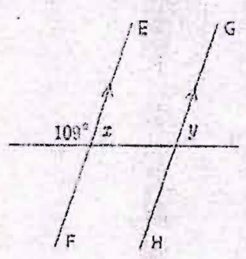
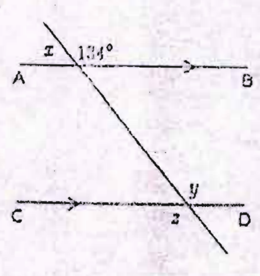
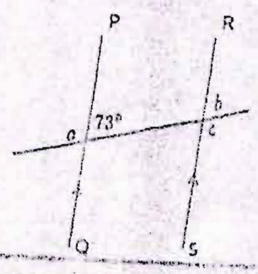
1. $-3(a+4b)$
$= 3a - 12b$

2. $-2a^2(-2a^3b^2 - b^3a^2)$
$= 4a^5b^2 + 2a^5b^3$

Corrections

1 $8a - 4ab$
$16p + 12q$
$6p - 8q$
$30d - 12b$

Appendix E 3

	Statement	Reason
2. 	b=69	XY||MN Corrs ∠s are eq
	b+69=180°	∠s on a str line
	b+69−69=180°−69	
	b=111	
3. 	x=121	~~AB||CD Corrs ∠s are equ~~
	x+121=180	~~∠s on a str line.~~
	x+121−121=180°−121	AB||CD adj suppl ∠s are
	x=59°	equal.
		∠s on a str line
4. 	x 109	~~EF||HG corr ∠s are eq~~
	x+109=180°	~~∠s on a str line~~
	x+109−109=180°−109°	EF||HG adj suppl ∠s
	x=71	are equal
	y=x 71	
5. 	x=134°	AB||HG Corrs ∠s are eq
	z+134=180°	∠s on a str line
	z+134−134=180°−134	
	z=46°	
6. 	c=73	PQ||RS Corrs ∠s are eq
	c+73=180°	∠s on a str line
	c+73−73=180°−73	
	c=107	

Appendix E 4

Name ________________ 13 September 2000 $\frac{13}{40}$

Grade 8⁵ **Mathematics Controlled Test.**

1. Zonke is x years old. Her mother is three times her age and her sister is half her age.

a) What is the mothers age in terms of x? (1)

$x \times 3 = \frac{x}{3}$

b) What is the sister's age in terms of x? (1)

$x = 19$

c) Write down the sum of their ages in terms of x. (2)

$x = 19 \div 2 = 9{,}5$

A A A A A A

2. John thinks of a number. He multiplies it by 5 and then subtracts 3. The answer he gets is 7. What is the number that he was thinking of? (5)

3. Solve for x by inspection:

a)	$x + 4 = 10$	$x =$	6 ✓
b)	$x + 8 = -2$	$x =$	−10 ✓
c)	$5 + x = -5$	$x =$	−10 ✓
d)	$3x = 6$	$x =$	−9
e)	$x - 8 = 1$	$x =$	9 ✓
f)	$x + 3 = 0$	$x =$	−3 ✓
g)	$\frac{x}{2} = -5$	$x =$	−3
h)	$-5x = -20$	$x =$	−15
i)	$2x + 1 = 5$	$x =$	~~3~~ 2 ✓
j)	$3x - 3 = -18$	$x =$	−12

(1[illegible]

Appendix E 5

13 September 2000
linear Equation in Geometry

Statement	Reason
1. $2x + x = 180^\circ$	
$3x = 180^\circ$	adj. suppl ∠'s
$\frac{3x}{3x} \quad \frac{180}{3}$	
$x = 60^\circ$	
$D\hat{C}B = x = 60^\circ$	
$ACD = 2x = 120^\circ$	

Statement	Reason
2 $2y + y + 120^\circ = 180^\circ$	adj suppl. ∠'s
$3y = 180^\circ - 120^\circ$	
$3y = 60^\circ$	
$\frac{3y}{3} = \frac{60^\circ}{3}$	
$y = 20^\circ$	
$D\hat{C}A = 2y = 40^\circ$	
$E\hat{C}B = 2y = 120^\circ$	

Statement	Reason
3 $2z + z + 3z = 180^\circ$	adj suppl ∠'s
$6z = 180^\circ$	
$\frac{6z}{6} = \frac{180}{6}$	
$D\hat{C}E\ 180^\circ - 30^\circ = 150 = 150 - 30$	
$= 120^\circ\ D\hat{C}E = 120$	
$DCA = z = 30^\circ$	
$ECB = 2z = 30$	

Appendix E 6

AME: [redacted] GRADE: 5

13/40 33% FF Poor!

ARITHMETIC TEST

List M_{12} {12, 24, 36, 48 ...} (2)

2. List F_{12} {1, 2, 3, 4, 6, 12 ...} (2)

b Circle all the composite numbers in 2a above. (2)

List the prime numbers between 20 and 30 21, 23, 25, 27 (2)

What is the L.CM of 4 and 5? ~~45~~ 2 (2)

What is the H.C.F of 32 and 48? 56 (2)

. State whether true or false : $\sqrt[3]{1} = \sqrt{1}$ True (2)

7. Prime factorise (a) 300 (b) 84

(a)	(b)
$2^2 \times 3 \times 5^2$ =	~~2×2×11~~ $2^2 \times 11$ = 2×7 = ~~4 62~~
2 | 300; 3 | 150; 2 | 50; 5 | 25; 5 | 5; | 1	2 | 84; 2 | 42; 2 | 21; 7 | 7; | 1
(3)	(3)

8. Determine (using prime factors) (a) $\sqrt{324}$ (b) $\sqrt[3]{3375}$

(c) $\sqrt{625}$ (d) $\sqrt[3]{5832}$

(a)	(b)
$2^4 \times 3^2$	$3^3 \times 5^1$
2 | 324; 2 | 162; 2 | 81; 3 | 27; 3 | 9; 3 | 3; | 1	3 | 3375; 3 | 1125; 3 | 375; 5 | 125; 5 | 25; 5 | 5; | 1
$\therefore \sqrt{324} = 24$	$\therefore \sqrt[3]{3375} =$ 405

Appendix E 7

18 August 2000

Subtraction

In algebra substitution implies that we are going to replace letters with a given value to evaluate an algebraic expression

Example

If a=1 and b=-2 and c=0, evaluate the following

a) $2a + 3b$

$= 2a + 3b$

$2(1) + 3(-2)$

$2 - 6$

$= -4$

$2a^3 - 3c$

$2(1)^3 - 3(0)$

$2(1) - 0$

$= 2 - 0$

$= 2$

b. $2a^2b^3$

$b = 2(1)^2 (-2)^3$

$= 2(1) \times -3$

$= -18$

Exercise

If x = 1, y = 2, z = 3 and w = 0, Evaluate

$2y^2$

$(2y)^2$

xyz

$((xyz)^2)$ xyz

$(xyz)^2$

$x^2 + 2x + 3$

$xy + xz + xw$

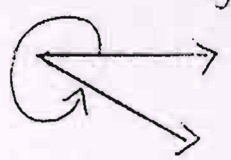
$\frac{x+1}{z}$

xy^2z

Appendix E 8

me ____________________ $\frac{11}{15}$ Grade. 8

hat kind of angles are shown below.



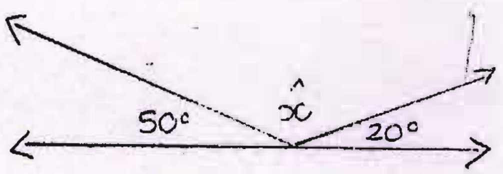
(b)

2

reflex Angle (1) ~~OBtuit~~ OBtuse Angle (1)

alculate the values of the angles below. Give easons

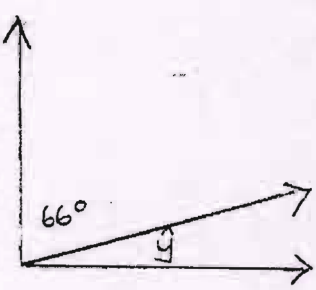
a)



$\hat{x}$ ~~= 180° − 70 = 110~~ 50° + 20°
= 70 180° − 70° = 110°
Adj Suppl ∠'s

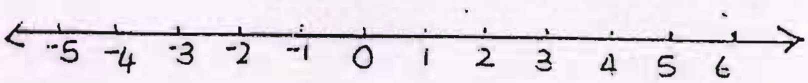
4

b)



$\hat{y}$ = 180° − 66 = 114
adj suppl ∠'s

ndicate on the number line integers less than −3



(1

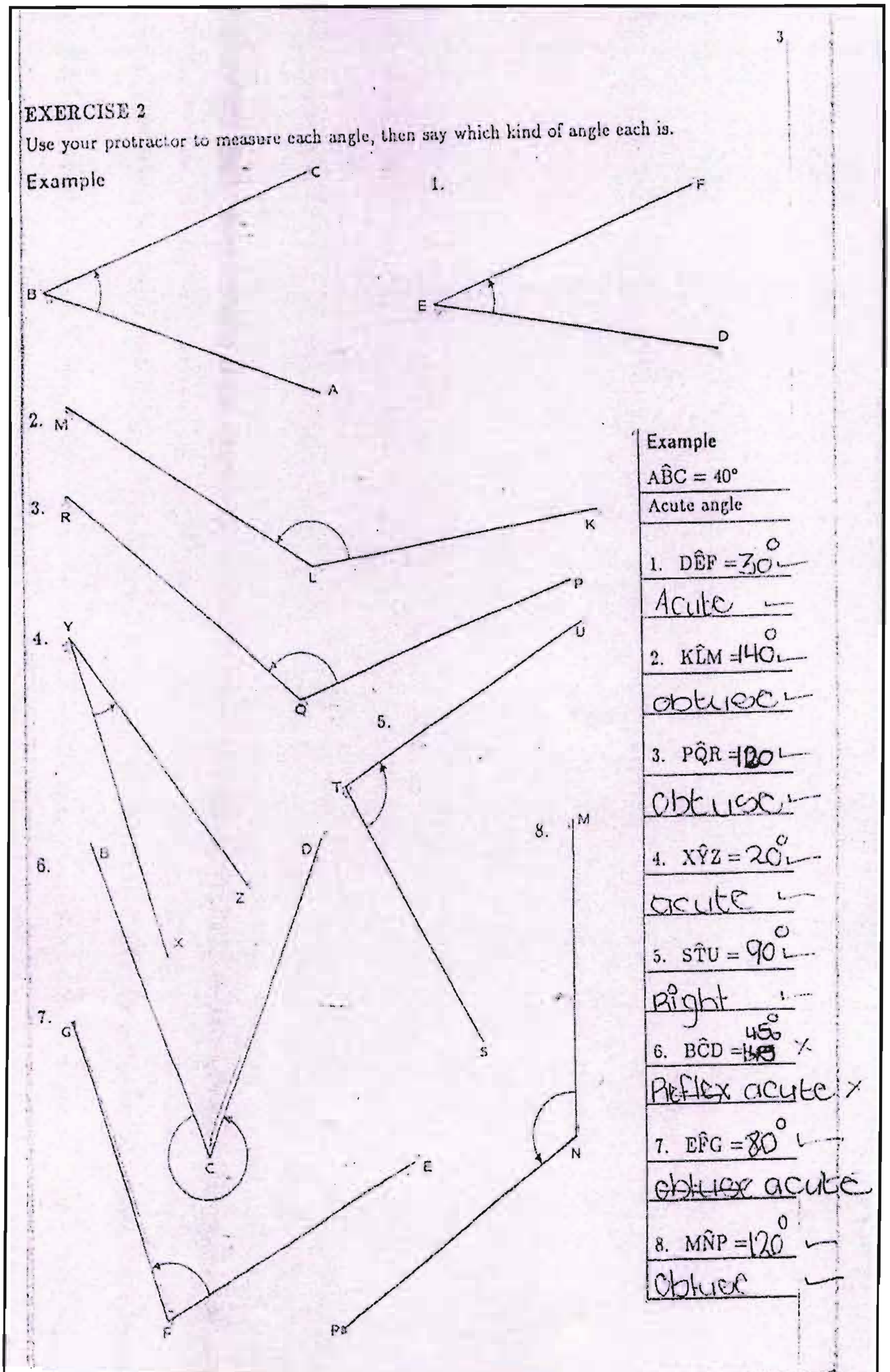
Fill in > < or =

−10 > −15
6 > −6
0 > −10
2 > −8
0 < 5

5

(5)

Appendix E 9



Appendix E 10

Grade 8 3 March 2000

Worksheet: Integers

1. Arrange the following integers in order of size as they would appear on the number line.

a) −5 ; 12 ; −3 ; 4 ; 0 ; 2 ; −7

-7 -5 -3 0 2 4 12

b) −45 ; 36 ; 42 ; −31 ; 12 ; −16

45 -16 -13 12 36 42

c) 3 ; −7 ; −11 ; −2 ; −1 ; 5

-11 -7 -2 3 5

2. Which would you prefer?

a) − R12 or −R8 — -R8

b) −15 cents or 5 cents — -5

c) 20°C or −25°C — 20°C

3. Write the next three numbers in each of the following patterns:

a) +3 ; +2 ; +1 ; 0 -1 -2

b) +2 ; 0 ; −2 ; -4 -6, -8

c) +10 ; +4 ; −2 ; -8, -4, 20

d) −2 ; −3 ; −5 ; -8 -12

Something to think about:

Appendix E 11

30 August 2009

Remedial Test

1 In term $16x^2y$ what is:

(a) The exponent/s = 2

b) Literal Co-efficient = x^2y

c) Numeral Coefficient = 16

2 A man is x years old. Write down expressions for: The mans age in 5 years Time - $x+5$

b half the man's age = $x \div 2$

3 Add $-4a^2b + 2ab$; $-3ab + 4 - 8a^2b$

Subtract $2a+5$ from $a^2 - 8a$

(3) $16 - 4a^2b + 2ab$

$4 - 8a^2b - 3ab$

$20 - 12a^2b - 1ab$

(4) $a^2 - 8a$

$\overset{(-)}{+} 2a \overset{(-)}{+} 5$

$a^2 - 10a - 5$

5 Simplify the following

a $-a - x - a - x - 2a \quad = -2a^5$

b $(2x^2y)\ (-3xy) \quad = -6x^3y^2$

$2x^2y^2 \quad \cdot\ 2x^2y^2$

c $6a^2(3ab - c) \quad = 18a^3b - 6a^2c$

Appendix E 12

1 September 2008
Linear Equations

Exercise: solve for x

1. $-x+2=7$ $\quad -x+2$
$-x=7-2$
$-x=5$
$-x=5$ ✓

2. $x-9=0$
$x=0+9$
$x\ 9$

3. $5x=-50$
$\cancel{5}x=-5\cancel{0}^{10}$
$\cancel{5}x \quad \cancel{5}$
$x=10$ ✓

4. $\frac{x}{2}=-2$
$\frac{x}{2}\times\frac{2}{1}=-2(2)$
$x=-4$ ✓

5. $3-x=5$
$-x=5-3$
$-x=2$
$x=-2$

6. $-2x=8$
$-2x=8-4$
$x=-4$

7. $2x+1=5$
$2x=5-1$
$2x=4$
$\frac{2x}{2}=2$

8. $1-2x=3$
$-2x=3-1$
$-2x=2$
$\frac{-2x}{-2}=\frac{2}{-2}$ $=x=-1$

9. $4-3x=2$
$-3x=2-4$
$-3x=-6$
$\frac{-3x}{-3}=\frac{6}{3}$
$x=2$

10. $3x+5=-14$
$-3x=-14-5$
$\frac{3x}{3}=\frac{-19}{3}$
$x=1,33$

Appendix E 13

4

5

12 September 2000

Revision

1 If Mrs

If Mrs brown is y years old & her husband is 3 year older how old is he in terms of x

2 Peter says that if you add -12 to the number he is thinking he get 7. What number is he thinking of.

3 Solve for y by inspection

a $y+3=7$

b $y-4=-6$

c $2y-6=4$

d $3y+1=7$

e $-y-6=-4$

f $\frac{y}{3}+1=4$

4 Solve for x

a $8-3(x+7)=x+5$

b $2x-3(x-1)=15-4x$

c $2(2-x)=3(x+5)$

d

Appendix E 14

ANOTHER CHALLENGE

Have Fun ! ☺

1. Determine the value of $(0{,}3)^3 - (0{,}2)^2$.

2. A $3\frac{1}{2}$hour test starts at 8:42. At what time should the test end ?

3. Determine 24% of R150.

4. What is the total number of rectangles in the diagram ?

5. If $a = -2$, determine the value of $-2a^3 - (-2a)^3$

6. A group of dogs and children are playing together. I count 12 heads and 44 legs altogether. How many dogs are there ?

7. Shari has written 10 maths tests this year and her average mark is 68. What mark must she get in the next test to raise her average to 70 ?

8. A party of 18 people went to a restaurant. They each chose a R21 meal, but four of them forgot to bring money. The bill was then divided equally among those who brought their money. What amount did each have to pay ?

9. Six points lie on a circle. How many different triangles can be formed having three of the six points as vertices ?

10. If $a \updownarrow n$ means a^n and $a \leftrightarrow n$ means $\sqrt{a}$, find the value of $[(2 \updownarrow 6) \leftrightarrow 3] \updownarrow 2$

11. Six bricklayers and one carpenter were hired to do some work. Each bricklayer earned R6 more than the average wage of all seven. How much did the carpenter earn ?

Appendix F

An illustration of the flow of lessons at Thuthukani and Sanville Secondary.

e	Day	Topic	Video	Discussion	Photograph	Pupils Exercises	Pupils reflections	R.J
99	1	Pilot Class	✓	✓		✓		✓
99	2	Pilot Class	✓	✓				✓
99	3	Pilot Class	✓	✓				✓
99	4	Convert mins to hrs	✓	✓		✓		✓
99		No lessons	-	Diwalii				✓
99	5	Convert hrs to mins	✓	✓	✓	✓		✓
\99	6	Division of fractions	✓	✓		✓	✓	✓

Fig.1. Lessons at Thuthukani.

	Day	Topic	Video	Discussion	Photographs	Exercises & Tests	Interview	R.j
)	1	Oral Presentation		✓				✓
)	2	By Learners	✓	✓				✓
)		Teacher Absent						✓
0		:Unwell						
0	3	Revision Ex for test	✓	✓		✓		✓
0	4	Linear equations in geometry	✓	✓		✓		✓
0	5	Remedial work on tests	✓	✓	✓	✓		✓
)	6	No lesson	teach er	absent			✓	✓

Fig.2. Lessons at Sanville Secondary.

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