

An exploration of mathematical concepts embedded in Xhosa beadwork artifacts through an intervention programme for Grade 9 learners.

This thesis is submitted in partial fulfilment of the requirements for the degree of Master of Education of Rhodes University

by

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DEDICATION

To my late “mha” mother Nolonji Nogobinamba for the encouragement she gave me when I started the research. Although she loved to see me visiting her while she was ill, she would insist on asking how far I was with my beadwork and learners.

LIST OF ABBREVIATIONS

AM	Albany Museum
C2005	Curriculum 2005
MWP	Masithandane Women's Project
PTD	Primary Teachers' Diploma
RUMEP	Rhodes University Mathematics Education Project
RNCS	Revised National Curriculum Statement
ZPD	Zone of Proximal Development

ABSTRACT

Mathematics has become increasingly important, as it is a pre-requisite for careers like architecture, science, engineering and medicine. Therefore it becomes imperative for the learners to understand and love it. In other words a sound foundation of mathematical skills and knowledge in the early stages is required. Often we hear learners asking questions like “*when and where are we going to use these symbols x and y in our lives?*” These questions might indicate that learners cannot link mathematics with daily life occurrences or even their own background experiences.

This study is an exploration through hands-on activities of mathematical concepts embedded in beadwork artifacts. Learners’ background experiences on beadwork artifacts are acknowledged and explored for mathematical understanding. It is a case study, consisting of 44 learners in Grade 9 in two schools in Grahamstown. An interpretive approach is used.

In order for the learners to be able to explore beadwork artifacts, they visited the Albany Museum (AM) and Msithandane Women’s Project (MWP) in the community. Learners gathered information from these two sources. Beadwork artifacts in this study were used as a mediation and integration tool between culture and mathematics. Beadwork artifacts are found in the learners’ cultures serving different purposes. In this study the focus was on Xhosa beadwork artifacts.

The hands-on activities posed challenges to learners because of their different background experiences. Some were able to draw designs but were unable to thread what they designed, whereas others were able to thread beads but were unable to draw designs. In this study learners had to use both completed beadwork artifacts and drawn up designs for the investigation of mathematical concepts. Learners were able to identify symmetries in dress and in South African flag designs. Number patterns discovered were linked to their prior number pattern knowledge. The economic value of beadwork artifacts linked mathematics to the economics learning area.

This study ties up with the new curriculum (C2005) and RNCS, which advocate the inclusion and integration of learning areas. In this instance, art and culture were used

in mathematical activities. The study also encouraged the inclusion of participants' cultural background as a starting point for motivating them towards utilizing mathematical resources existing in their real life situations. The purpose was to make them aware that mathematics is found everywhere around us.

Pencil, ink marks and
highlighting ruin books
for other readers.

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CHAPTER 1

1.1 INTRODUCTION

Mathematics has been a problem since I was a student. During that time we used to learn mathematics on our own, as there were no qualified teachers to teach us. As the result I chose teaching in order to alleviate that problem. In my twenty years mathematics teaching experience I can identify with the above statement. I have taught mathematics for twenty years in different grades. I started teaching Grade 7, 8 and 9 where mathematics is regarded as formative. I further taught Grade 10, 11 and 12 where I discovered that the number of learners taking mathematics as their major subjects decreased.

Many learners, who managed to do mathematics in Grade 11 and Grade 12, did it at standard grade instead of higher grade. I used to ask my students for the reasons they choose standard grade mathematics instead of higher grade. They would give different reasons, one being that standard grade mathematics is easier than higher grade. They would mention theorems and graphs in higher grade which they find difficult to understand. During this stage, learners would ask questions like “what is the use of x and y in our real life situation?” They could not connect these variables with the problems they encountered in their lives. Also educators at some point encouraged learners to change from higher grade to standard grade when they encounter problems.

I later moved on to lecture at a College of Education, where my learners were trainee teachers undertaking a Primary Teachers' Diploma (PTD). I experienced more or less the same problems with these students, as they were expected to do mathematics as one of their teaching subjects, although some of them had not taken mathematics in grade 12. Students, who had not chosen mathematics as a subject at high school, were also expected to do mathematics because they were supposed to teach all subjects including mathematics at their schools.

As some learners had problems in relating mathematics in the classroom to real life situations, this study is intended to investigate mathematics present in our culture. It explored its contribution towards motivating our learners to recognize the importance of mathematics in our Xhosa beadwork artifacts and its usefulness in our daily lives. The study focused on Xhosa beadwork specifically.

In this study, beadwork artifacts were explored with the intention of using them as learning material. The learners were required to investigate mathematical concepts embedded in Xhosa cultural beadwork artifacts. Dabula (2000) conducted a similar study where college students investigated different transformations found in different beadwork artifacts. The results were interesting because her students were further motivated to investigate more mathematical concepts embedded in cultural artifacts.

The difference between my study and the one above is that I engaged my learners in doing practical work by threading the beads. In other words they all designed patterns and later threaded them. Although this study focuses exclusively on Xhosa beadwork artifacts, I noticed Zulu and many other Nguni tribes commonly use similar beadwork artifacts (Broster, 1976). These tribes use beads to decorate their clothes, which are of significant value in certain rituals. These decorations display beautiful patterns, designs and skills.

Learners explored these patterns in order to enrich their beadwork knowledge and also to help them in planning their own designs. In so doing I had hoped to motivate some readers, educators and learners to further see the importance of mathematics in our Xhosa traditional attires. In trying to relate mathematics and beadwork, learners might become interested in the history of mathematics as it relates to our culture and its value.

1.2 PURPOSE OF THE RESEARCH

This study stems from the notion that mathematics is a human activity and is also found around us. Since it can be defined as a human activity and is around us, then in my view, it could be influenced by different cultures and experiences. The purpose of the study is to allow participants to investigate mathematical concepts embedded in Xhosa cultural beadwork artifacts through hands-on-activities. Participants designed and threaded their patterns and thereafter investigated mathematical concepts emanating from those patterns in order to understand how mathematics is embedded in Xhosa cultural beadwork artifacts.

1.3 FRAMEWORK OF THE RESEARCH

Chapter 1 involves background information about different experiences encountered when teaching mathematics, and an outline of the purpose of the research.

Chapter 2 examines the context of the study. It gives a brief discussion on the history of mathematics, a definition of ethnomathematics and a rationale for the use of this ethnomathematical approach. It also discusses underpinning philosophical assumptions of ethnomathematics.

Chapter 3 describes the research methodology employed in this qualitative study.

Chapter 4 discusses the research findings.

Chapter 5 is the concluding chapter and the limitations of this research are discussed. In addition, suggestions for further research are made.

CHAPTER 2

LITERATURE REVIEW

2.1 INTRODUCTION

“A common trend in many countries is that the number of students who pursue mathematics beyond the compulsory classes and tertiary level is fast decreasing” (Dabula, 2000:1). South Africa also encountered the same problems.

For example, research conducted in the Eastern Cape Province in 1999 and 2000 revealed that 14739 and 9744 learners respectively wrote standard grade mathematics compared to 1085 and 1089 higher grade candidates who wrote mathematics in the same years (South African Statistics 2002: 5.9). Nationally in 2000 and 2001 research revealed that 79 631 and 72 301 learners wrote standard grade mathematics compared to 19 327 and 19 504 for higher grade (South Africa. Department of Education (DoE), 2003:25). According to the above findings, standard grade mathematics seems to be preferred by learners.

My greatest task was to find strategies of dealing with that situation. I started consulting my colleagues to find out about their situations and their challenges concerning mathematics with their learners. I also read up on research about mathematics teaching problems. In this exploration I came across research on “ethnomathematics” (D’Ambrosio, 1985; Bishop, 1988). This research investigated the extent to which “culture and mathematics” could influence the mathematical understanding of learners (Ascher, 1991). Some experiments with ethnomathematics had results that motivated learners into understanding mathematical concepts present in their daily life (D’Ambrosio, 1985; Saxe and Gearhart, 1988; Gerdes, 1999). The research and perspective on ethnomathematics motivated me to conducting this study and explore the possibilities of methods and strategies of teaching mathematics to our learners using Xhosa cultural artifacts as the starting point.

This study investigates the extent to which Xhosa cultural artifacts can contribute towards motivating our learners to value the importance of mathematics and its usefulness in

every day life. Xhosa Beadwork artifact patterns will be the focus for investigating mathematical concepts found in different cultural artifacts.

Although my study focused primarily on Xhosa beadwork artifacts, it must be pointed out that Zulu and many other Nguni tribes also use similar beadwork artifacts (Broster, 1976). These tribes use beads to decorate their clothes, which are of significant value in certain rituals; also as a source of income, they sell them to tourists and local people. These decorations display beautiful patterns and designs. Learners in my study were also encouraged to explore these Nguni patterns in order to enrich their designs.

2.2 THE NATURE OF MATHEMATICS

It would appear that how one defines mathematics or views mathematics has a material influence on how one might use it, how it might be taught, but also to whom it might be taught. It also has an influence on student perceptions of its relevance, usefulness and difficulty. What stance one takes on the nature of mathematics would also shape the options that might be perceived to be open to, say teachers, to make it more accessible to students. For these reasons, it seems necessary and appropriate to explore in this literature review – however briefly – some of the different views on the nature of mathematics.

In this study, the cultural and ethnomathematics perspectives will emerge as the perspectives that will most strongly shape my approach to the design and analysis. But first a review of the wide range of different perspectives on mathematics.

What is mathematics? There is no single concept of how people perceive mathematics. Kline (1967) defined mathematics as an art, science and branch of culture. He further argued that mathematics has qualities similar to those found in art, like the stamina to wrestle with a problem until it is successfully solved. In other words mathematics meets an art criterion in providing emotional satisfaction when a problem is successfully solved. Gower (2002) supports the notion of mathematics as an art, using words like “elegant, beautiful or even witty” when describing a successfully solved mathematical problem.

Shaw, cited in Schaaf (1963) confirmed that many mathematicians said that mathematics is art, in the sense that pure art is abstract as is mathematics.

According to Zaslavsky (1973), Bishop (1988), Joseph (1991), and Barton (1995), the nature of mathematics cannot be restricted to written information or records only. Joseph (1991) refers to mathematics that existed before written records as “proto-mathematics”. Proto-mathematics is based on the different, culturally influenced methods used by different societies. For example, in South America knotted strings were used for counting with a system called *Inca Quip* which recorded numbers on knotted strings. It also served as a means of keeping records for household censuses.

Other countries had their own methods of dealing with mathematics. For example, the Egyptians and the Babylonians wrote mathematics on papyri, an early paper-like product made from papyrus and on hard clay tablets (Joseph, 1991). Egyptians further used mathematics during their agricultural activities as a means of measuring the fields to be cultivated. In other words Egyptian and Babylonian mathematics was predominantly utilitarian in nature. Babylonians invented place-value number systems, while Arabians contributed towards the development of measurement techniques in mathematics (Joseph, 1991).

However, those activities were not necessarily viewed by later purists as being mathematical in nature because they were more of a practical tool than of intellectual pursuit. Thus Ancient Greeks viewed mathematics as nobler if it is in the form of enquiry rather than practical mathematics (Joseph, 1991). As a result an elite few were engaged in mathematics, while the rest were required to do practical work.

In the Maori society in New Zealand, mathematics is more integrated into other areas of knowledge when taught in the classroom today. For example, in their mathematics lessons practical daily occurrences examples are utilized namely “investigating bubbles (mathematics and science), investigating rhymes (mathematics and language) and investigating celebrations (mathematics and social studies)” (Fraser, 1994). The examples here were drawn from what children experienced when playing with water “bubbles”;

during their story telling time when children used “rhymes” some of which included mathematical language; and lastly their birthday decorations. Also kowhaiwhai patterns are commonly used in mathematical pattern study because they are part of their cultural decorations (Barton, 1995).

Bishop (1988:182) viewed mathematics as a “cultural product, which has developed as the result of various activities”. According to his understanding, there are six activities which appeared to be carried out by every cultural group ever studied. Each and every society had a form of counting or matching, locating, measuring, designing, playing and explaining objects. (My own Xhosa culture has similar examples of everyday and recreational activities involving mathematics, such as: counting objects (using stones and sticks), designing patterns (letima on our thatched houses) and games (*upuca*). *Upuca* is a game played by children using small stones, throwing them up and catching them again, and counting up to twenty to win a game. Shirley (1995:38) referred to these kinds of activities as “everyday mathematics, recreational mathematics, academic mathematics and ...” Everyday mathematics and recreational mathematics involved basic counting and arithmetic used in different cultures. For example, when children are playing their games and puzzles counting is used. These activities are later refined at school during their formal schooling.

But mathematics has also been more rigorously examined in terms of the philosophical assumptions that appeared to underpin it. This has added new perspectives and understanding of its nature, which I briefly discuss below.

2.2.1 Philosophical assumptions

According to Gehrke, (1994), philosophers particularly Platonists argued that mathematics existed independently of intelligent minds. This “absolutist philosophy” depicts mathematical knowledge as neutral and value-free. It is independent of human thought and action. In other words mathematical knowledge is an external entity, which needs only be “discovered” or understood by humans (Fisher, 1990; Ernest, 1991; Nickson, 1992). Because it is viewed as independent of human thought, it is referred to as

objective, certain and consists of unchallengeable truths. For example, the sum of the angles of a triangle is 180° . This has been mathematically proved to be true. These are mathematical axioms and definitions on which absolutists base their assumptions. The axioms, according to Blanche (1966), are considered to be basic truths that need no justification, beyond their own self-evidence.

Also some mathematics educators and cognitive psychologists view mathematics as “existing only in intelligent minds” (Gehrke, 1994:359). Mathematics is envisaged as “pure knowledge” where learners are expected to interpret factors and symbols that are detached from their social or daily life experience (Visser, 1991; Grimison, 1995; Furinghetti and Somaglia, 1998). On the other hand, Goldin (2002) tried to highlight problems encountered by the absence of a theoretical framework in mathematics education research. According to Goldin (2002:199), two camps were formed, traditional and reformist. The traditional camp advocates for clearly identified mathematical skills at each grade level, whereas reformists place more emphasis on abstract or formal mathematical methods.

The “dualism philosophy” on the other hand refers to mathematics as a fixed body of knowledge, permanent and infallible. It is characterized by dichotomies and relies heavily on absolutes and authority as the source of truth (Ernest, 1991:112). This philosophy also views mathematics as culture-neutral and value-free, relying on algorithms for problem solving (*ibid*). Fraser (1994:173) views mathematics as a collection of facts and skills, which are difficult to understand.

The failure of the absolutist view to account for the nature of mathematical knowledge led to the development of a number of schools. Among those schools three were formulated, namely: logicism, constructivism and formalism (Ernest 1991; Dossey, 1992).

The logicism school viewed mathematics as pure and part of logic (Ernest, 1991:8). According to this perspective, mathematics is the result of logical thinking. It is out there

to be discovered. The logicism school failed when it was unable to provide a certain foundation for mathematics knowledge.

The constructivist strand in the philosophy of mathematics viewed mathematics as occurring in the mind (Ernest, 1991). Brouwer believed in the reconstructing of mathematical knowledge rather than the reliance on proof by contradiction. However, constructivist views had problems of inconsistency with classical mathematics.

Formalism was founded by the German mathematician Hilbert (*ibid*). In formalism, mathematical knowledge is seen as consisting of “immutable” truths and unquestionable certainty. Ernest (1991:10) refers to it as “a meaningless formal game played with marks on paper, following rules”. In other words, mathematics is detached from everyday life.

According to Ernest (1991:13), the failure of the three schools of thought “to provide a foundation for full range of mathematical truths” led to the introduction of a new view of mathematical knowledge, namely the fallible view. In this view, mathematical truth is regarded as fallible and corrigible (Ernest, 1991). Mathematical knowledge is therefore seen as liable to revision. The fallible view arguably allows for the inclusion of different ideas and activities. In so doing it supports the modern view and Freudenthal’s concept, where mathematics is accepted “as a human activity” (Dossey, 1992; Gravemeijer, 1994).

In contrast to seeing mathematics as a natural and almost universal “human activity”, some countries in Europe, the USA and Africa use mathematics as a means of selecting brilliant children (Taylor, 1993). These children are sorted into different post-school courses, which lead to privileged positions in the job market. In this context, mathematics is seen as a special subject, which is not suitable for every learner to study. Volmink (1994:72) contends that this has led to mathematics being perceived to be “the domain of the select few” that are powerful and influential. Burton (1994:72) viewed mathematics as reinforcing the

...social views of mathematics as belonging only to a very particular set of people, a closed club who subscribe to the same rules and speak the same language.

In other words, mathematics is perceived by some as reserved for a certain group, with special ability. It is not for everyone in the society. This reminds me of my own schooling experiences, where we were given a mathematical entrance test. The test was used to eliminate a number of learners who wanted to do mathematics, but could not obtain the required mark in order to do it.

Despite the evidence (some would argue the reality) that mathematics is a “human activity” and forms part of everyday culture, school mathematics remains a subject that is considered difficult by many educators and learners alike. As a result, many learners in South Africa are encouraged by their teachers to do mathematics on the standard grade instead of higher grade (my experience as mathematics educator). In my view this further reinforces a negative attitude towards mathematics and higher grade and even participation in mathematics as a learning area.

Fasheh (1994:281) suggests that mathematics should include culture and not be taught “as true facts alone”. I now examine culture in relation to mathematics as a human activity.

2.3 CULTURE AND LANGUAGE IN THE LEARNING OF MATHEMATICS

Kline (1967) defines mathematics as a living, flourishing branch of culture. In order to understand the contribution of culture to mathematics we need to define culture and its function in the society.

Bishop (1988) defines culture as interconnections found in peoples’ daily practices, language and ideologies. He further explains culture composition as made up of four factors, ideological, sociological, sentimental and technological factors. The technological factor encompasses mathematics. In other words mathematics is a component of culture.

Also, Charbonneau and John-Steiner (1988) affirm that in each and every culture, children engage in activities that have numerical and visual-spatial relationships. The family life and the environment have an influence on how children grasp mathematical concepts. For example, the sorting of harvest crops in American communities aided their children to be able to categorise and classify in early stages of representational development. These activities provided a strong background for understanding some basic mathematical concepts. In that vein mathematics might be viewed as a cultural product found in different cultural activities.

Ascher (1991:2) defines culture:

as where people share a language; place; traditions; and way of organizing, interpreting, conceptualizing, and giving meaning to their physical and social worlds.

In other words the function of culture is to relate man to his environment as well as man to man.

Grimmett and Crehan (as cited in Fullan and Hargreaves 1992:58) define culture as “constructed reality, known by its representation, consisting of values and norms”. In the Western languages culture is associated with “civilization” found in art, education and literature. Jenks (1993) and Desmond (1996) described culture as “the way people do things”. In my view Bishop’s definition of culture is what mathematics is.

Nickson (1992) refers to culture as having invisible aspects, which learners and educators bring to the classroom. These aspects are beliefs and values. She further defines culture as “the contents of the socialization process that differs from one society to another” (Nickson, 1992:101). She suggests that these aspects need to be recognized during tuition. Knijinik (1993) defines culture as belonging intrinsically to those who are in power and their influence on groups of people. On the other hand Fasheh (1994) and Day (1999) view culture as behaviour practiced by a group of people.

Gerdes (1999:911) confirms the importance of understanding learners' cultural background as a good foundation in the teaching and learning of mathematics or any learning area. In that regard, teachers are required to provide hands-on activities which convey social meaning to their learners since the use of practical strategies seems to help the learner.

If educators can include culture in mathematics learners' might have different views about mathematics and culture. For example, if the educator can utilize cultural artifacts or any culturally used games and activities to introduce some mathematical patterns and formulas to the learners it might help them. As much as culture can be used in aiding children to understand mathematics, caution should be taken to test carefully the different methods to be used.

Trentacosta and Kenney (1997:40) affirm that culture plays an important role in understanding mathematics:

Culture is important in reading because if the mathematics is embedded in a context that bears no relationship to anything in the student's experience, it is a barrier to comprehension.

In other words, culture might play an important role in aiding learners to understand mathematics. Culture can be defined in various ways within the three cultural perspectives: of the anthropological, sociological and psychological perspectives.

2.3.1 The anthropological perspective

Anthropologists view culture as the part of their discipline concerned with similarities and differences in human behaviour across all societies (Spradley and McCurdy, 1988). Anthropologists employ the activities of description, classification, and comparison to explain similarities and differences in human behaviours. These three activities according to Bishop (1988) are those found among the six mathematical activities present in all cultures and mentioned earlier in this chapter (page 9).

Kottak as cited in Berger (1995:136) defines culture as:

Culture encompasses rule-governed, shared-symbol based, learned behavior and belief transmitted across the generations. Everyone is cultured, not just people with elite educations. Culture relies on the human capacity for cultural learning, use of language and symbols. Culture refers to customary belief and behavior and to the rules for conduct internalized in human beings through education.

From the anthropological perspective, learners are considered to bring some cultural aspects into the classroom, for example customary belief and behaviour. In other words education mediates between the learner and his or her culture. Cultures differ from society to society; in that regard I will be looking at how society influences mathematics.

2.3.2 The sociological perspective

“The sociology of mathematics concerns itself with the influence of forms of social organization on the origin and growth of mathematical conceptions and methods, and the role of mathematics as part of the social and economic structure of period” (Struik, 1967:57).

The major socialization settings in which cultural meaning is transmitted to learners are: the school setting (such as the curriculum as well as the relationship with peers and teachers), the family and the society surrounding both family and school. Fairchild (1961:80) further emphasizes the important part of culture as being “the patterns embodied in the social traditions of the group,” that is the knowledge, ideas, beliefs, values, standards and sentiments prevalent in the group. For example in order to identify Xhosa from Thembu and Mfengu tribes certain colours used in beadwork patterns are significant. Xhosa use blue, pink, red and white in their beadwork. The Thembu use deep turquoise blue, red, white and navy for their artifacts, while the Mfengu use pink, blue and white with deeper blue and pink (Costello, 1990).

2.3.3 The psychological perspective

From the psychological perspective, culture and cognition are viewed as the shaping of human behaviour (Mishra, 2001). This view holds that cultural factors can influence cognitive processes through, for example, categorizing, learning, problem solving, spatial cognition, verbal reasoning and creativity. The link between problem solving and culture can be demonstrated through the following example: Chinese culture placed greater emphasis on the development of numerical skills, as result their children perform much better than American children in simple addition problems (Mishra, 2001).

The different definitions of culture from the anthropological, sociological and psychological perspectives share the following common terms: patterns embedded in culture, transmission of belief, and shared symbols that are regarded as the core part of culture (Struik, 1963; Spradley and McCurdy, 1988; Mishra, 2001). It points to that which is common but also to that which separates people. For example, beadwork is found in all three of the Xhosa, Thembu and Mfengu cultures but it is made in different patterns and colours. The learners also have different values, norms and ideas. Therefore it is imperative that educators at least understand the different cultures of learners in their classrooms. Knowledge of learners' cultural backgrounds might assist educators in understanding how they construct meaning in mathematics; how the learners use their prior cultural knowledge to understand new mathematical knowledge.

Language is also considered an aspect of culture; it is also a mediator of concept formation and concept development (Dawe, 1995; Charbonneau and John-Steiner, 1988). Below I highlight the role played by language in constructing knowledge.

2.3.4 Language

Language is a means of communication. It involves a variety of forms with which people communicate. For example, speech would vary in terms of pitch, tone, accent and body language. In mathematics, language is dominantly characterized by the extensive use of

symbols and numbers. In that sense it makes mathematics to be unique. For example, in defining shapes, a corner is referred to as an angle in mathematics.

Kline (1967:95) argues that the use of symbols and numbers enabled mathematicians to write lengthy expressions in a compact form. In so doing it assists the eye in seeing quickly and the mind in retaining what is being said and also gives more clarity and avoids ambiguity.

Grimison and Pegg (1995:10) refer to the problem of language or communication in the teaching of mathematics:

students are often quite talented in mathematics; their ability can be overshadowed by an inability to understand the language teachers use.

For example, if the language used to teach a learner is his or her home language, the learner might perform well. The reason being that, he or she has to understand content and not the language first. Mahn and John-Steiner (2002: 46) support the above statement saying “second language learners do experience cognitive and emotional challenges as their learning involves both a new language and a new culture.” A mathematics teacher is therefore also a language teacher in the sense that he or she has to use a mathematics language to communicate with the learners.

The following example illustrates the difficulty learners might encounter when faced with a symbolic problem:

“ $2 \div 8$ and $8 \div 2$ ” (Dawe, 1995:232).

In this instance learners knew that the solutions to the problems were not the same, but could not work it out. The reason, according to Dawe, was that symbols were used instead of concrete objects, like apples or sweets that could be counted. What seemed to be missing was the link between the symbolic and the real world.

In this study I explored the potential of cultural artifacts as one of those potential bridges. More specifically, beads, as they are found in many cultures.

2.4 THE SIGNIFICANCE OF BEADWORK IN DIFFERENT CULTURES.

Dubin (1987) says beads are part of every culture in the world. They are used for diverse purposes, for example decoration of traditional clothes. The same type of beads might have different meaning depending on that culture's usage. For example, in West Africa beads are used for distinguishing royal status and also as coverings for high stools. In Asia beads are used for invocations of a bountiful harvest. In Colombia, like in Africa, they are used as part of ritual offerings to ensure the future safety of newly built houses. Philippines and Africans also use them in marriage ceremonies (Dubin, 1987).

Beadwork artifacts reveal the different cultures of people, as well as the differences between groups of the same culture. For example, Xhosa girls wear certain types of beads to identify their developmental stages. Beads reveal the social, political, economic and religious status of people who wear them. I will examine Xhosa beadwork and its significance to the Xhosa.

2.4.1 Xhosa beadwork

Beads were important in South Africa well before European colonization. Xhosa culture has features such as beadwork artifacts, songs and dance that distinguish it from other cultures (Broster, 1976). The generic term for beads in Xhosa is "ubu-hlalu" (Soga, 1931). Special kinds of beads and colours have special significance. For example, red beads are used to signify the king. As a result the red necklace is the symbol for chieftainship.

The witchdoctors (izangoma) use white and blue beads for their traditional attire. The white beads are associated with purity and ancestors. The blue beads are associated with water or rivers or sea (umlambo). In Samburu culture, blue beads are associated with the

sky and the high God and the white beads are associated with pure things or milk (Dubin, 1987).

Beadwork is culturally aligned initially with girls. Girls who are able to thread beads are considered to be mature and ready to be called adult (Costello, 1990). Beadwork designs are geometric in nature with certain common patterns, for example zig-zag, lozenge, v-shaped, straight lines and occasionally square (Nettleton, Ndabambi and Hammond-Tooke, 1989:42). The different designs contain important information for the society, for example, zig-zag designs represented many rivers, which wound through the country (*ibid*).

The use of beads differs depending on the value it carries in the context. For example, when a child is two weeks old, her mother makes an ornamental girth (kotso), which is a waistband of three strands of coloured beads (Costello, 1990). The purpose of that band is to measure the baby's growth and it is regularly lengthened and the number of beads added indicates the growth of the child. Each developmental stage is characterized by a different kind of beadwork. Women and children are taught to thread beads for different purposes. Also messages were conveyed through beadwork letters which were made out of symbols of triangular and v-shaped pictures (Broster, 1976).

Beadwork is simple and colourful, but it captures the imagination of society. Broster (1976) refers to beadwork as having a strange attractiveness and a scientific significance, which attracts the mind. These beautiful designs captivated the teacher trainees under the lecturership of Dabula (2000) who discovered number patterns, symmetry and tessellating designs in the beadwork artifacts they were researching.

Beadwork artifacts might be used in the teaching and learning of mathematics as it appears to cut across different cultural activities. This study uses the information gathered by the teacher trainees to further investigate the relationship between culture and mathematics.

Barta (1995) defines the relationship between culture and mathematics as ethnomathematics. I will look at some ethnomathematics research next.

2.5 RESEARCH AND ETHNOMATHEMATICS

The field of ethnomathematics research emerged when there was discourse among people engaged in mathematics, education, culture and politics (Powell and Frankenstein, 1997).

According to Gerdes (1985:337), a range of names were proposed for different types of mathematics practiced by different groups. For example, socio-mathematics (Zaslavsky, 1973), spontaneous mathematics (D'Ambrosio, 1985), hidden or frozen mathematics (Gerdes, 1999) and implicit and non-professional mathematics (Zaslavsky, 1994) were referred to as out-of-school or informal mathematics. "Informal mathematics" is defined as mathematics that is transmitted and learned outside the formal school system of education (Gerdes, 1999; Shirley, 1995).

The Brazilians were the forerunners of ethnomathematics research, with D'Ambrosio (1985) the founder and the father of the ethnomathematics program. The ethnomathematics program looked at mathematics from the cultural point of view. The program involved the study of mathematics developed by all cultures in accordance with their needs and interests. In other words it is the manner in which people observe and use material and instruments in order to know and understand mathematics in relation to their environment and culture. Ascher (1991:1) defines ethnomathematics as the study of mathematical ideas of traditional peoples.

D'Ambrosio (1985) approached mathematics from a socio-cultural stance, where he claimed that children in the world become "matherate". He compares the different performances of learners in school mathematics (formal mathematics) and that of out-of school mathematics (informal mathematics). According to his findings, learners failed to solve school mathematics whereas they were able to solve out of school mathematical problems. It was a challenge to all mathematics educators who joined D'Ambrosio in the

ethnomathematics research program. Their concern was: “how could the same population experience failure in school mathematics and be quite skilled in jobs that often involved mathematical skills?” (de Abreu, 2002:323).

In other words children are able to use numbers and quantities way before they are taught at school. He discovered that the learned math literacy eliminates the indigenous or spontaneous mathematics. He further urged educators to integrate the learner’s societal background information (informal mathematics) into the new classroom information (formal mathematics) as a starting point.

On the other hand Nunes et al. (1993) approached the same challenge from the stance of developmental psychology. In his investigation, he used two groups of children from different backgrounds. The first group came from people selling in the street and counting money (commercial activities). The second group came from agricultural activities, measuring crop fields, time and seasons for planting crops.

As the two groups were from different sectors, he expected different performance in solving arithmetic problems. His prediction proved to be true. The commercial group performed better than the agricultural group. The two groups were then exposed to the same situation, where their performance tended to be the same or equal.

Nunes’s (1992) view of these findings suggested that the mathematical knowledge acquired outside school could be incorporated into the teaching and learning of mathematics in school. For example, the counting of knots on strings, notches on sticks or the 1-1 assemblages of pebbles were identified as the mathematical knowledge acquired in out-of-school mathematics.

Other mathematical examples were discovered in practical work carried out by women, when weaving and knitting socks, which was not regarded as mathematics. The argument being that no formal schooling involving mathematical calculations was essential in those

activities (Harris, 2002). In other words women learn the skill through observing and demonstrations; no mathematical calculations were involved.

Gilmer (2000) used different hairstyles as examples where different mathematical patterns could be observed, like triangular braids, box braids and tessellations. Because of her extensive investigation on hairstyle patterns, she further described ethnomathematics as a discipline that includes the study of varieties of patterns. Gilmer interviewed some hair stylists and their customers about the mathematical concepts present in those hair braids. She discovered that braiders and weavers could not relate braiding and weaving to mathematics. She tried to uncover the ethnomathematics embedded in hair braiders, also to alert people about mathematics around them, of which they were not aware.

She further investigated beadwork done by Yuutaa (Utes) and Iroquois Indians, which originated from their quillwork. Blocks, crosses and triangles were the common shapes present in their different designs. The dominating shapes were different kinds of triangles, namely equilateral, isosceles, and right angled triangles.

Barkley (1998) reported on symmetric patterns found in beadwork. These Indian tribes later used the glass beads brought by Europeans. The Utes' beadwork designs are visible in their artifacts and include the shapes of blocks, crosses and triangles.

The third investigation was that of street arithmetic. It occurs when people become involved in tasks requiring problem-solving skills that they have not learned at school. In other words, the study suggests that there are many factors to be considered when solving mathematical or arithmetic problems.

In Southern Africa, a Mozambiquan by the name of Paul Gerdes (1999) was involved in ethnomathematics and the history of mathematics in African research projects. He wrote a research proposal called "Empirical mathematical knowledge among the Bantu populations in Mozambique" (Gerdes, 2001: 2). The objectives of the project were to analyze mathematical thinking in African cultures, specifically the Mozambican culture

with the intention of incorporating it into mathematics education. The challenge involved the society, culture and mathematics education.

Proponents of ethnomathematics, Zaslavsky (1973), Bishop (1988), Martin, (1997), and Gerdes (1999) support the view that “mathematics is a product of society”, which is influenced by the culture of a particular group. Examples can be found in the geometrical patterns exhibited by different cultures, such as tellem in woollen textiles, symmetries found in litema (painting on the wall done by women), and chokwe sand drawing designs leading to the discovery of the Pythagorean theorem (Gerdes, 1999).

According to Bishop (1988:179), “all cultural groups generate mathematical ideas” In other words, each cultural group is capable of generating its own mathematics or mathematical activities. These mathematical activities need not necessarily be the same from one culture to another culture, as cultures differ in languages, in religious beliefs and values. For example, children when playing use counting songs and counting stones in their games. Riddles narrated to children help them in logical reasoning which is required when solving mathematical problems. In Xhosa riddles fall under what we call “intsomi” where the elderly sit around the fire at night narrating “intsomi” to children and the family at large.

Other cultures like that of the Buganda use different ways of counting, like “tic-tac-toe” which stands for three in a row (Zaslavsky, 1973). In these cases mathematics is no longer viewed as static, neutral or even culture-free, as the absolutists and dualists define it. According to Barta (1995), mathematics is no longer ‘culturally free’, but is seen as a contribution made by different cultures.

Fasheh (1994:282) supports the idea of cultural influence when he argues, “culture influences the way people see things and understand concepts”. He further suggests the inclusion of culture, societal sources and personal experience in mathematics teaching thus making it more effective and meaningful to learners. Further, Barton (1995) views the inclusion of culture in mathematics as a means of enriching mathematical knowledge.

During the process of cultural inclusion, learners should be encouraged to be critical and to apply their mathematics knowledge to solve their daily life problems. Caution should be taken that mathematics should not only be taught as a set of rules and formulas that students have to memorize (*ibid*). Instead, mathematics needs to be taught in such a manner that learners are able to use what they have learnt in their real life situations.

For example, the problem of using a pattern when knitting a sock could be viewed as a mathematical problem involving counting and generalization like any mathematical problem. Gerdes, as cited in Harris (2002), gave women a problem referred to as “a non-standard problem” to solve. They were able to solve it with ease as compared to the members of the international mathematics community, who could not solve it at first because it did not have numbers linked to it (mathematics).

A similar situation was observed by Carraher, Schliemann and Carraher, as cited in Mogari (2002). Brazilian street market children were able to solve practical arithmetic problems when selling their goods but could not solve them using pen and paper. They concur with the need to bridge the gaps between school mathematics (academic) and outside school mathematics (ethnomathematics), because of the problems children encounter when required to solve problems using pen and paper. In other words, learners should be able to transfer knowledge and skills from one situation to the other. This might be attributed to the influence of culture on learners when trying to understand arithmetic and mathematics.

In this study I shall utilize the above experiences, findings and recommendations of ethnomathematics research to pursue research on beadwork activities in the classroom. For example, Dabula (2000) conducted her research with college students using Xhosa beadwork from the Mthatha museum to extract mathematical concepts. Stoker (2001) discovered some interesting mathematical patterns in traditional Xhosa beadwork using information from in-service teachers' work at Rhodes University Mathematics Education Project (RUMEP). The beadwork used in this study came from the Albany Museum,

Grahamstown. Several mathematical concepts were identified, the most important of which were the generalization of mathematical patterns, symmetry rules and formulae.

In one practical activity more mathematical problems were generated and mathematical concepts derived. Traditional Xhosa beadwork is one of many traditional activities found among women which, according to my mathematical experience, are not included in the curriculum. Instead, they have until now been considered as decorative artifacts only for arts and culture purposes.

Mogari (2002) conducted a study in the construction of a miniature wire toy car with Grade 10 pupils. The aim of his study was also to connect the street mathematics (out of school) and school mathematics. They were to calculate the length of wires to be used for different car models.

The aim of this study was to find ways of incorporating ethnomathematics into the classroom environment. The participants in my study were Grade 9 learners. In Grade 9 learners are allowed to choose some of their learning areas, according to the specific careers they intend to pursue. Through this research some challenges and problems in problem solving and formula derivation were identified. I will now discuss some theories of learning and teaching, which inform ethnomathematics.

2.6 THEORIES OF LEARNING AND TEACHING THAT INFORM ETHNOMATHEMATICS.

Social constructivists such as Ernest (1991) assert that mathematics educators need to incorporate their learners' cultural experiences into their lessons. These cultural experiences assist learners in making their own constructions and meanings in mathematics.

Fraser (1994), suggests that in order to make mathematics accessible to everyone, it should be linked to other curriculum areas. Linking mathematics to other areas broadens

its relevance, its meaning and its power. For example, when linking mathematics with the art learning area, learners enjoy mathematics because it becomes fun. Although that teaching and learning approach might require plenty of materials at hand and lots of time for learners to experiment, learners will be able to use different approaches in solving problems and share their successes and challenges.

Schunk (1996), too, supports the notion of using learners' experience and says that learners make more meaning of what they are learning when it is related to their immediate environment, for example, mathematics found around us in decorations on our clothes and homes. The use of mathematics found at our homes, kitchen and gardens might help learners to understand and love mathematics.

Also the involvement of parents in mathematical programmes might alleviate the challenges learners encounter when solving mathematical problems. Vygotsky's (1978), Zone of Proximal Development (ZPD) advocates for the involvement of parents in knowledge construction (Mishra, 2001; Mahn and John-Steiner, 2002). In the ZPD supports the inclusion of learners' cultural experience as a prior knowledge to be utilized. In ZPD programmes, parents, educators and learners are expected to work together where an adult-child interaction is created. As a result the child is assisted in solving a problem. For example, Korean children performed well and better than other groups with the involvement of their parents in solving mathematical problems (Mishra, 2001).

The beadwork artifact intervention programme in this study might assist in social interaction and interpersonal scaffolding among learners, parents and educators. As parents work with learners in threading beads, learners will be using their mathematical knowledge to discover more out of beadwork artifacts. This goes hand in hand with the Revised National Curriculum Statement 2003 (RNCS), currently used, which states that:

Mathematics is the construction of knowledge that deals with qualitative and quantitative relationships of space and time. It is a human activity that deals with patterns, problem solving and logical thinking, in an attempt to understand the world and make use of that understanding. This understanding is expressed,

developed and contested through language, symbols and social interaction.

(South Africa. DoE, 1997)

The above quote emphasises the role of human activity in pattern formation and its role in mathematics teaching, learning and understanding. This study thus tried to relate mathematical concepts present in beadwork artifacts and patterns with the learners' experiences and understanding of classroom mathematics activities. In so doing, I had hope to encourage learners to make links between abstract mathematics with practical mathematics.

Duke (1999) suggests a service learning strategy as a way of linking school mathematics with real life. In service learning programmes, learners are exposed to real life problems or community based programs where they are required to apply what they have learnt at school to the community or a real life situation. Service learning programmes in the USA are reported to have higher mathematics achievement scores for both the tutors and those being tutored (*ibid*).

Although service learning programmes seem to assist learners in connecting mathematics to real world activities, it requires thorough planning and creativity in order to motivate learners to be highly involved and co-operative. Sometimes service learning programmes become tedious or time consuming but at the end learners achieve more in the activities.

According to Harris (2002), many mathematical activity problems are discovered in women's work. These mathematical activities serve as mathematics resources for learning, as the designs have tessellations, and different decorative shapes forming translations. The activity might serve as a link between school mathematics and real life occurrences. Traditionally, women's involvement in practical work, like needlework, was seen as a harmless, practical and non-intellectual activity (*ibid*). The mathematics embedded in these women's cultural activities needs to be analysed and unfrozen as proposed by Gerdes (1999) and the mathematical concepts in them extracted. In so doing

we might be able to link school mathematics with outside mathematics, which might be more meaningful to the learners.

Cherinda (2002) supports the use of practical activities to motivate learners to do mathematics. She used twill boards for mathematical activities in her classroom. She suggests more research should be done on this type of classroom activity. My research is in line with that of Mogari (2002), Dabula (2000) and Cherinda (2002) in trying to bring ethnomathematics into the classroom situation.

As much as culture is vital to the understanding of mathematical concepts, Dukepoo (1990) cautions educators against getting carried away and laying too much emphasis on culture in explaining mathematical concepts. In other words, when dealing with cultural programs, care should be taken that the personal needs and interests of the learners should be considered first.

Dukepoo (1990:2), does however, emphasize the importance of culture in relation to mathematics.

Culture and mathematics influence each other. The two are closely intertwined, interdependent and inseparable. Both are dynamic and both evolve.

His point can be illustrated by the farmer who could not count but was able to check on his sheep using a traditional method where the sheep were represented by an equal number of stones. Every time a sheep entered the kraal a stone was inserted into a small bag until all the stones were in the bag. If there were left-over stones, he knew that some sheep were missing. The farmer could not count, but culturally he had a method of checking, apart from counting. This method of counting is widely used in one-to-one correspondence in mathematics.

Munetsi (1995) supports Dukepoo in cautioning educators against relying too heavily on “culture” when trying to explain some mathematical concepts. He suggests that educators should know the cultural world of the learners and be sensitive to it. In so doing the

educator might be able to better understand the behaviour of the learners. The next section will integrate ethnomathematics into curriculum 2005.

2.7 ETHNOMATHEMATICS AND THE REVISED NATIONAL CURRICULUM STATEMENT (RNCS 2003)

In 1994, South Africa became a democratic country with the introduction of a number of social, political and economic changes. Among these changes was transformation in education. The then Minister of Education Professor S Bengu launched a new education system, Curriculum 2005 (C2005) referred to as “Lifelong learning for the twenty-first century” (Hoadley and Jansen, 2002). This curriculum policy is in line with the South African constitution. A number of changes in the old curriculum were introduced in accordance with the political changes. The main aim of the new curriculum was to redress the inequalities created by the past apartheid education system.

The previous curriculum was content-based and teacher-led. Teachers had control over “selection, spacing, and evaluation of learning” for learners (Hoadley and Jansen, 2002). The new curriculum claims to address the legacy of apartheid by being relevant and appropriate to the current political situation and suitable for the needs of the learner, society, commerce and industry. The new curriculum as an integrated approach is encouraged instead of the rigid division between theory and practice. The integrated approach emphasizes skills development, understanding and construction in mathematics knowledge by learners.

Among the features of the new curriculum, the newly introduced Revised National Curriculum Statement (RNCS) follows C2005’s attempts to make a better link between theory and practice; greater integration between different learning areas is emphasised. For example, the patterns and decorations in art lessons might be used in mathematics lessons and also learners’ prior knowledge in facilitating meaningful learning. In other words learners will be able to see mathematics in art and in other learning areas. Also in C2005, methods teaching were revisited, and the goal was to change from teacher-

centeredness to learner-centeredness (Hoadley and Jansen, 2002) and a strong emphasis was placed on accessing the learners' prior knowledge in facilitating learning.

In the RNCS, each learning area has its own definition and unique feature. The mathematics definition states:

Mathematics is a human activity that involves observing, representing and investigating patterns and quantitative relationships in physical and social phenomena and between mathematical objects themselves. (Revised National Curriculum Statement R – 9, 2003: 4)

An emphasis has been placed on the development of learning programs suitable for the learners' needs using socially available resources, like patterns found in real life situations such as the symmetry found in plants, leaves and clothes.

The curriculum underlines that the main purpose of teaching and learning mathematics is to develop learners who are confident and competent to deal with mathematical problems and who can thereby relate mathematics to their social, environmental, cultural and economic situations. In order to achieve the above mathematical aims, learners need to be involved in constructing mathematical knowledge where their prior knowledge (cultural knowledge) is linked to the new knowledge. My research endeavoured to link mathematical concepts embedded in Xhosa beadwork, where beadwork is part of the prior cultural knowledge of the learners.

2.8 CONCLUSION

Mathematics in my study is viewed as a cultural product and a human activity, encompassing the six fundamental activities – counting, locating, measuring, designing, playing and explaining.

The study advocates a strategy for contextualized teaching and learning of mathematics through the use of cultural artifacts.

The new curriculum currently calls for integrated learning, where learners' background knowledge is used as the starting point. The understanding of the different cultures the learners would open opportunities for using features of these cultures to facilitate the teaching and learning of mathematics.

It is argued that the perspective of an ethnomathematics approach in teaching can play a positive role in the teaching and learning mathematics.

CHAPTER 3

THE RESEARCH PROCESS AND METHODOLOGY

3.1 INTRODUCTION

The aim of the study was twofold:

- (1) to investigate mathematical concepts embedded in Xhosa artifacts such as beadwork using local resources at the Albany Museum (AM) and the Masithandane Women's Project (MWP) and
- (2) to find out through hands-on-activity what types of mathematical patterns can result in the process of threading beads.

This research emphasizes the importance of using cultural artifacts found in society as background or prior knowledge that frames the learning process in a classroom situation. It is in line with the Revised National Curriculum Statement (RNCS) currently introduced in our schools. The new curriculum requires teachers to acknowledge and use learners' background knowledge (Gultig et al., 2002). It also advocates the inclusion of the learners' cultural background experience as a starting point to learning and teaching all learning areas including mathematics. Learners are encouraged to make use of available resources when solving their everyday life problems with the assistance of the educator.

This chapter explains the research methodology used in this study and describes different instruments that were utilized to generate data. It further explains the procedure followed in the selection of two schools and the participants involved. It also examines how ethical and validity issues as well as limitations of the study were dealt with in the research process.

This research takes the form of a case study. It follows a qualitative approach in order to allow the researcher to gain insight into selected issues (Patton, 1990). The research questions are designed to help capture participants' personal perspectives and experiences of hands-on-activities. The participants made use of the resources available at the AM

together with the practical skills learnt at the MWP. The resources at the AM include a display of beadwork artifacts, such as Xhosa necklaces and waistbands. Other cultural beadwork artifacts were also used so as to expose participants to a variety of beadwork artifacts.

The MWP employs seven Xhosa women in producing beadwork that is sold to passing tourists, students from Rhodes University and to the local community. I selected these two resource areas, the AM and the MWP because of their easy access to both schools (the township school and the one in town). Also, both resource areas provided me with abundant beadwork artifacts to use for my research.

3.2 PARADIGM ORIENTATION

The paradigm orientation of my study is grounded in the following:

- a) The interpretive approach
- b) A qualitative approach
- c) Constructivism

I will briefly discuss each of the above in relation to the research study.

3.2.1 The interpretive approach

Cohen, Manion and Morrison (2000:293) define the interpretive approach as one which:

strives to view situations **through the eyes' of the participants**, to catch their intentionality and their **interpretations** of frequently complex meaning systems and the dynamics of the interaction as it unfolds.

The research took a hands-on and guided discovery approach (English, 2002) that involved exploration using concrete materials such as beadwork artifacts. The main focus in the interpretive approach is about contextualized meaning, where the individuals' interpretation is valued most (Denzin and Lincoln, 1994; Jackson, 1995). Also Cohen,

Manion and Morrison emphasized the importance of allowing participants to interpret their view according to their situation and understanding.

My goal was to understand how participants construct and develop meaning in their natural surroundings. English (2002:200) refers to it as “hands-on, guided discovery teaching methods”. In other words participants were encouraged to explore and model with concrete materials (beadwork artifacts) found around them.

The research adopted an interpretive and qualitative approach, in the sense that it set out to understand participants’ interpretation of what they constructed (Cohen, Manion and Morrison, 2000:23). I had to listen, share and to understand how participants perceive beadwork in relation to what they know in mathematics. For example, were participants able to connect mathematical patterns with those found in their beadwork designs? In order to have a deeper understanding of my participants’ situation, I decided to play a role of being both a co-participant as well as their facilitator.

In my view, an interpretive approach has to do with understanding the way in which ordinary people get things done in their everyday life, their experiences and perceptions. In that sense it concurs with Jenks’ (1993) and Desmond’s (1996) definition of culture as “the way people do things” (Chapter 2). My research utilized beadwork artifacts found in Xhosa culture which is what they do as part of their living. In particular, my research intended to utilize participants’ background knowledge of beadwork artifacts to connect mathematics to real life occurrences. For that purpose, participants were introduced to hands-on activities.

The research study required that participants observe and enquire how beadwork artifacts (cultural artifacts) were threaded by the MWP women. Grimmett and Crehan (as cited in Fullan and Hargreaves, 1992:58) further define culture as “constructed reality, known by its representation”. In other words the MWP were regarded as facilitators in the activity. The interpretive approach accepts the importance of culture as the means of

understanding the world. My research study used cultural artifacts as a means of understanding mathematical concepts embedded in those artifacts.

The interpretive approach used in my study is based on the assumption that there is not always only one method of solving mathematical problems or teaching mathematics (Janesick, 1998). It also acknowledges that meaning emerges through interaction among participants (Rubin and Rubin, 1995). For example, participants worked in groups threading beads. They then calculated the number of beads used in order to be able to calculate the selling price. Also from those patterns, formulas can be derived which can be utilized to calculate the number of beads required to thread belts or necklaces.

Another reason for emphasizing an interpretive approach is because it is useful for a small scale study that involves a small number of participants. In this instance, my study involved forty-four Grade 9 learners, as discussed in 3.4.

The interpretive approach has however been criticized for its subjectivity and lack of ability to generalize the findings (Jackson, 1995). My intention though, was not to generalize. My study focused solely on interpretations and perspectives of the forty-four participants. As a researcher my role was that of a “passionate participant actively engaged in facilitating” the process (Lincoln and Guba, as cited in Janesick, 1998:103).

My theoretical framework is based on Vygotsky’s (1978) ideas that a child is an active learner and able to construct knowledge, through social interaction. In this research study, participants constructed their own beadwork artifacts through hands-on guided discovery with the assistance of the women of the WMP and me.

According to Guba and Lincoln (1985) and Patton (1990), the interpretive researchers mostly use qualitative methods, though not exclusively. The following presents an outline of how I employed a qualitative research approach.

3.2.2 Qualitative approach

Denzin and Lincoln (1994) define the word “qualitative” as “implying an emphasis on processes and meaning”. In this case, the role of the researcher “is to seek answers to questions that stress how social experiences are created and given meaning” (Denzin and Lincoln, 1994:4).

My research study involved participants who:

- Firstly visited the AM and the MWP to be exposed to those places and to observe beadwork and the actual threading of beads.
- Secondly, they were to design their own beading patterns.
- Thirdly, they were to thread beads to make different types of artifacts.
- Fourthly, they were to investigate mathematical concepts present in those artifacts.

Wamahiu and Karugu (1995:116) argue that:

Educational researchers adopting [the qualitative] paradigm attempt to produce data that is holistic, contextual, descriptive – in-depth data that is rich in detail. They are concerned with discovering the inner meanings of social actions rather than just their outward form. They are also interested in describing process instead of simply the outcome or end results. In order to do this, qualitative researchers collect data from the natural setting, using themselves as key research instruments.

The objective of the research study was the involvement of the participants in the process of investigating mathematical concepts present in their natural setting. The AM and the MWP provided a natural setting in this study. Figure 3.1 shows participants observing different patterns present in the beadwork artifacts displayed at the AM glass table.



FIGURE 3.1. Participants together with the researcher are exploring beadwork artifacts at Albany Museum during their visit.

Wellington (2000:133) clearly states features of a qualitative approach such as “involving exploratory activity” and the use of observations, interviews and photographs as methods of collecting the data. In order to enrich their knowledge on beadwork artifacts, participants visited the AM and explored the beadwork artifacts. Photographs were taken at the AM for later reference. In qualitative research, photographs and artifacts can be a source of data collection (Merriam and Associates, 2002).

Foster (1996) further defines the qualitative approach as being flexible with a minimum of prestructuring of the research setting. I used a qualitative approach because of its flexibility and its capacity to allow participants to observe and engage in the process of beading in their natural setting (Wellington, 2000; Gerson and Horowitz, 2002; Addison and Burgess, 2003).

Participants interacted with women from the MWP by asking questions in order to obtain information on how to thread beads. This activity contributed towards the use of their cultural background as their starting point in understanding mathematical concepts. For

example, symmetry and tessellation were found in different patterns of beadwork artifacts.

Participants were given an opportunity to visit the MWP to observe some designs with the intention to learn beading. This part of the research contributed towards the integration of mathematics into the outside world and community. In other words, participants were encouraged to see the link between mathematics and real life occurrences. For example, using patterns and counting done by those women indicated that mathematics is continuously utilized in the community despite the high level of illiteracy amongst the MWP women. Although three out of the seven women were illiterate, they were able to thread their beadwork artifacts and produce them in different sizes which would fit most people who would buy them.

Zaslavsky (1994) refers to parents as being the first teachers before formal education. Many of my research participants were exposed to those activities (threading beads) by their parents in their homes before their formal schooling. As a result they were able to thread and complete them faster than others.

Zaslavsky (1994:137) affirms this by saying, “children enter school with a considerable amount of mathematical knowledge from their families and the environment”. In my research two of my participants happen to have their parents in the MWP threading necklaces. Hence, they were able to thread their necklaces and complete them. Figure 3.2 shows how parents demonstrate beading to learners who wanted to learn to thread their own necklaces and anklets. Pound (1999) further supports this notion by encouraging adults in demonstrating the strategies used when counting money and writing number operations to their children.

According to Morais, Neves and Pires (2004:6) knowledge is “socially constructed”. In other words, what participants did when they were shown how to thread beadwork artifacts contributed towards their knowledge of construction. This activity is consistent with a constructivist approach, which I will briefly discuss next.



FIGURE 3.2 Masithandane Women’s Project at the Rhodes University Arch entrance showing participants how to thread beads.

3.2.3 Constructivism

Schwandt (1997:19) defines constructivism:

as a philosophical perspective interested in the ways in which human beings individually and collectively interpret or construct the social and psychological world in specific linguistic, social, and historical contexts.

The above philosophical perspective guided me as I conducted my research. The purpose of the research was to understand how my participants’ would construct and interpret meaning from the Xhosa beadwork artifacts. Greene (2000:986) refers to the constructivist approach as a means of understanding contextualized meaning. In this regard, participants were given a task to observe Xhosa beadwork artifacts in the AM and MWP and thereafter design and thread beadwork artifacts.

The task was consonant with a constructivist view that “knowledge of the world is not a simple reflection of what there is, but a set of social artifacts; a reflection of what we make of what is there” (Schwandt 1997: 20). This is also supported by the definition of mathematics in the Revised National Curriculum Statement (RNCS) (2003:4) stating that

“mathematics is a product of investigation by different cultures in the context of social, political and economic goals and constraints”.

According to constructivist and interpretive inquiry, different cultures cannot be ignored. According to Denzin and Lincoln (2000:986) cultures “are intertwined with knowing, as knowing is intertwined with being and acting”. As my participants were from different cultures, there were six coloured, thirty-three black, two Indian and three white participants, I had to take cognizance of their different cultural heritages.

The purpose of locating my research in constructivism was to allow learners to explore numerous avenues for solving mathematical problems. For example, designing their own patterns might promote creativity and the understanding of a variety of mathematical concepts. In the next section, I will elaborate on the methodology used.

3.3 METHODOLOGY

3.3.1 Case study

A case study methodology was adopted because it allows the involvement of the researcher and individuals’ perceptions. (Yin, 1994; Hughes and Hitchcock, 1995; Cohen, Manion and Morrison, 2000). Anderson, Herr and Nihlen (1994:170) define a case study as “narrowly focused on a particular person, site or scene”. In this research, participants from two schools are the main focus. The main aim was to probe deeply and analyze their hands-on-activities of beadwork artifacts that they have threaded. This supports the definition of a case study by Cohen and Manion (1994), which states that a case study is a means of probing and analyzing a certain unit.

Stake (1995:2) on the other hand, defines a “case study” as an “integrated system”. I concur with this definition as my participants form a system working together designing, threading and looking for mathematical concepts in the designs of beadwork (Figure 3.2.).

Stake (1995:4) further stresses that:

Case study research is not sampling research. We do not study a case primarily to understand other cases. Our first obligation is to understand this one case.

In that sense my research focuses on a small sample of learners in two schools in Grahamstown I was not interested in making any comparisons or generalizations.

According to Scott and Usher (1999:89), a case study is “the means of providing us with information that is exempt from manipulation by the researcher and therefore is more likely to be ecologically valid” because social action takes place in its natural setting. Guba and Lincoln (1985) and Anderson, Herr and Nihlen (1994) argue that case study work operates within a naturalistic setting. In this research the natural setting is the AM and MWP.

When I selected participants for this case study, I considered a number of criteria. Time and accessibility to the research site was a major concern. I will elaborate on this in the next section.

3.4 THE RESEARCH SITE AND PARTICIPANT SELECTION

The participants consisted of 44 grade 9 participants (ages 13–15) from two schools in Grahamstown in the Eastern Cape. The schools are located in different areas, one in the centre of the town and one in the township. Since the purpose of the research was to seek to understand the meaning of a phenomenon from the perspectives of the participants, it was crucial for me to select a sample that would provide me with rich data. I thus used purposeful selection in selecting my schools (Patton 2002). Patton (2002:46) described purposeful sampling as a means of selecting information-rich cases whose study will illuminate the questions under study. The proximity of the two schools to the areas of research resources, namely the AM and the MWP was an important criterion in choosing the sample. Also these were both government schools and hence operated with the same curriculum policy.

In keeping with the principle of anonymity, the names of the schools and participants were kept anonymous. The school in the centre of town is a girls' school and was called S1. The participants of this school consisted of 21 girls from different racial backgrounds. The township school was called S2. The participants of this school consisted of 23 participants, 13 girls and 10 boys. The S2 participants were all first language Xhosa speakers and they were from different areas around Grahamstown. Some of the participants' parents worked for the (MWP) as means of earning a living.

In the next section I discuss the research process and data generation tools used in this study.

3.5 THE RESEARCH PROCESS

The research design was divided into four phases. They were:

- a) Questionnaires
- b) Observation at AM and MWP
- c) Learning program intervention
- d) Focus group intervention, analysis of beaded designs

3.5.1 PHASE 1: Questionnaires

Questionnaires were used at the beginning of the research process with the aim of obtaining background information about the participants' different levels of knowledge of beadwork, and to ascertain their exposure to and experience of beadwork. The questionnaires were administered in the classroom to all the participants. They were given thirty minutes to complete the questions (Refer to Appendix A). The information obtained from the questionnaires assisted me to understand the participants' level of knowing and understanding beadwork artifacts. Data was analyzed immediately because of the small sample size (21 in one school and 23 in another school).

3.5.2 PHASE II: Observations at AM and MWP.

The main objective of phase II was to familiarize the participants with the beadwork artifacts from a mathematical perspective. As I learnt from the questionnaires, participants associated beadwork with art and history only. They were to look at different designs and, for example, find any common patterns occurring in those designs. In order to observe beadwork artifacts, they visited the AM. Photographs of beadwork artifacts were taken to be used as references during their beadwork investigation after the AM visit.

The participants also visited the MWP in order to observe the actual process of threading beads necessary to make beadwork artifacts. It is here that participants had an opportunity to ask questions about how women learnt to thread beads and where they had gained hands-on experience of threading beads (see figure 3.2).

3.5.3 PHASE III: Learning programme intervention

This section was divided into three activities, namely:

- A. Learners were given an activity requiring them to collect trademark symbols depicting different kinds of symmetry and transformations.
- B. They were to use these trademarks, together with the traditional beadwork artifacts observed at the AM and the MWP to design their own beadwork patterns.
- C. Thereafter, they were to thread their designs, making different kinds of artifacts.

3.5.4 PHASE IV: Focus group interviews: Analysis of beaded designs.

The activities above generated interesting results, some of which needed further investigation. Interviewing some of the participants in the group was therefore the next step in my research. I interviewed a group of six participants, chosen according to their

different responses to the intervention program. Three participants were chosen from S1 and three from S2. Of the three S1 participants, two completed their necklaces and anklets and one had an incomplete necklace. Of the three S2 participants, three had completed their beadwork artifacts.

The reason I preferred to work with a group of six (focus group) is that some participants feel more relaxed when they are with their peers. It was a purposeful selection. A focus group activity encourages the participants to talk to one another and share their views (Shamdasani and Stewart, 1990; Kitzinger and Barbour, 1999; May, 2001; Patton, 2002). Also it focused on a limited number of issues.

Patton (1990) views interviews as a means of finding out what is in and on a person's mind, and to ascertain from the interviewees things we cannot directly observe. Rubin and Rubin (1995) argue that the interview is one way of uncovering and exploring people's behaviours and feelings. As a researcher I needed more than just what I observed from their beadwork artifacts.

A semi-structured interview was employed. Hughes and Hitchcock (1995:157) state the advantages of using a semi-structured interview:

- It allows depth to be achieved by providing the opportunity on the part of the interviewer to probe and expand on the respondent's responses.
- The interviewer can alter the sequence of the questions to avoid the respondent anticipating questions.
- It can also be used in probing the issues more deeply.

Arksey and Knight (1999) support semi-structured interviews as a means of obtaining more clarity and elaboration on certain issues in the research. Wellington (2000) further argues that interviews can reach aspects other methods cannot reach. For example, through an interview a learner might give more information than when asked to write something down (my experience in teaching).

The six participants were audio taped during the interview. I used audiotaping because I needed to concentrate on what was said and to be able to transcribe the whole conversation verbatim (Arksey and Knight, 1999).

As I was conducting my interviews and administering the questionnaires, ethical issues were considered to be important. In the next section I discuss how I dealt with these issues.

3. 6 ETHICS IN DATA COLLECTION

When conducting research, many stakeholders are involved and so it becomes important to consider the ethical issues relating to each of the stakeholders. In my research the following stakeholders were involved:

- The participants
- The researcher
- The community and schools

Before looking at the ethical issues of the above stakeholders, I need to examine what “ethics” means? According to Soltis (1990), ethics is viewed as ubiquitous and permeating all aspects of our lives. May (2001:59) argues that “ethics is concerned with what is right in the interests of not only the project, its sponsors or workers, but also others who are the participants in the research”.

As my research involved participants from two schools, I had to ask for permission to conduct my research with them. I made an appointment with the school managers of the two schools at which I intended to conduct my research. I explained my research goals and the role they were expected to play in the research. After obtaining permission from the managers, I had to consult the different class teachers

I explained to the class teachers the purpose of the study and explained that this research would lead to my master’s thesis. Cohen and Manion (1994) advocate for the “principle

of informed consent” where participants are free to take part or to withdraw as they wish. Kumar (1999:192) emphasizes “that the consent should be voluntary and without pressure of any kind”. Participants were made aware that they were free to express their views and ideas concerning the research and even to withdraw.

As my research also involved people from the township, for example the MWP, I contacted them in advance to explain the objectives and methods of my research. An informed consent and co-operation with the MWP was obtained in advance. I explained the role they were going to play, which was to assist my participants in threading beads. After the clarifications, they willingly acceded to the request and looked forward to some possible incentives, such as participants buying beads from them. I also asked permission to take photos while they assisted participants in threading beads. I took photographs to document the activities.

The local AM was also approached for permission to use their resources for my research. They were willing to work with me, as it was their contribution towards mathematics teaching in the community at large. They even assisted me in obtaining as much information as possible. I was allowed to take some photographs for reference. I will now briefly discuss how I dealt with validity in the study.

3. 7 VALIDITY OF THE RESEARCH

Salner (1989:36) states that validity is not only based on the methods employed; the researcher’s perceptions and ethical integrity also contribute toward his or her results. In this case, I had to clarify my own assumptions and the theoretical orientation of my study. Initially, I had to guard against being biased as a researcher. On the other hand, Mouton (1998:648) refers to validity as “a term describing a measure that accurately reflects the concept it is intended to measure”. For example, if I intended to investigate mathematical concepts embedded in Xhosa beadwork artifacts and I investigated that, then the investigation is valid.

In order to enhance validity and eliminate bias in my research study, a member check was done (Merriam 1998, Denzin and Lincoln 2002). I went back to the learners involved in the research to check whether the results were a true reflection of what happened. I tried to establish trust and rapport with the interviewees as well as the other participants as I was working with them. I tried to create optimal conditions during their activities and interviews through allowing them to be free to voice their views.

Hughes and Hitchcock (1995) suggest different strategies (triangulation) in data collection as a means of enhancing internal validity in the case study research. The strategies involved in this study included the use of questionnaires, interviews and visits to the AM and MWP to collect data.

Validity is also enhanced when supporting evidence is available (Tschudi cited in Kvale, 1989). I used photographs to document the activities carried out during the research.

3.8 LIMITATIONS IN MY METHODOLOGY

Marshall and Rossman (1999: 42) claim, “there is no proposed research project without limitations”. I agree with this statement and I will highlight some “trade-offs” in my research study.

I commenced my research study with forty-four participants. As they struggled to thread beads, some in S1 gradually lost interest and eventually withdrew.

A similar scenario occurred in S2 where nine participants withdrew. The schools had their different programmes and I was compelled to adjust mine in order to suit those programmes. For example the activities I conducted needed to be recorded for continuous evaluation. Although I had those trade-offs I am confident enough that my research was executed in such a way that could provide me with valid findings.

3.9 CONCLUSION

In this chapter I have described the research process. I have discussed the paradigm orientation and various methods used to collect the data needed to answer the research question.

Ethical and validity issues were dealt with in the different situations, and an attempt was made to highlight their importance when dealing with case study research. In the next chapter I will report on the data analysis and the findings.

CHAPTER 4

FINDINGS AND DISCUSSION

4.1 INTRODUCTION

This chapter deals with the presentation of the findings of the research. It contains what the research is about and concrete evidence of the research. Since my research took an interpretive, qualitative and constructivist approach my findings are presented in a descriptive manner. Verbatim quotes are included where appropriate. Participants' own words are presented to support various evidences where necessary. Pseudonyms were used for different participants. According to Patton (1990:430), "qualitative inquiry involves thick descriptions and illustrations that would allow the reader to enter into the situation and thoughts of the people represented in the report".

Findings and their discussion are arranged according to the following themes:

- Participants' background knowledge of Xhosa beadwork;
- Participants' visits to the AM and the MWP;
- Learning Program Intervention; and
- Interviews.

4.2 PARTICIPANTS' BACKGROUND KNOWLEDGE OF XHOSA BEADWORK

The data collection commenced with an introductory questionnaire which I administered to all 44 participants involved in this research. The objective of using the questionnaire was to look at the participants' background knowledge of Xhosa beadwork as this was going to be used in the research study. The first question on beadwork was intended to find out whether the learners/participants had been previously exposed to any kind of beadwork. For example, the participants were asked whether they had been exposed to beadwork of any kind. If so what was the purpose of that exposure.

The findings were as follows;

Of the 21 participants from S1, 4 had threaded beads at their respective homes. The remaining 17 participants had started threading beads only at school during their art lesson activities; however they had been exposed to beadwork during community cultural activities. In other words all the participants had some form of exposure to beadwork though at different levels. A further exposure had been when they were doing their Science, History, Biology, and Art and Culture projects at the AM.

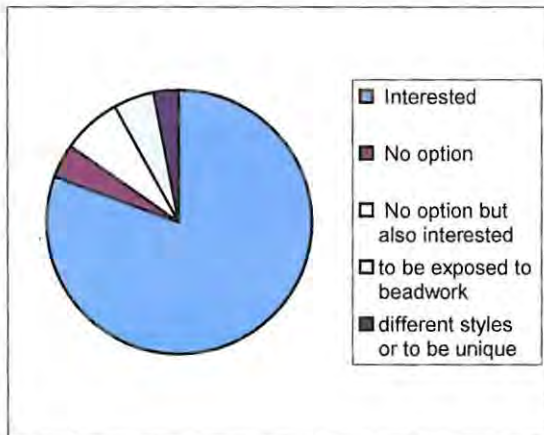
Of the 23 participants from S2, 10 participants had been involved in helping their mothers to thread beads. Two of the ten participants had their mothers working at the MWP. The remaining 13 participants, including all the boys had been exposed to some beadwork artifacts only during community cultural activities.

The findings revealed that all participants had been exposed to beadwork artifacts, many in the Art and Culture lessons. As participants were answering the questionnaire, they were interested and keen to know what the link was between mathematics and beadwork. They became increasingly curious when we visited the AM as they had only classified beadwork artifacts under decoration, art and culture activities before. This is similar to the view I previously held before my exposure to the Rhodes University Mathematics Education Project (RUMEP) and Ethnomathematics Research strand.

The next question was to find out why some participants chose to take part in beadwork activities, because I noticed that not all Grade 9s do practical beadwork. Some were doing art, music and home economics instead.

The information on their responses is clearly depicted in figure 4.1.

(S2)



(S1)

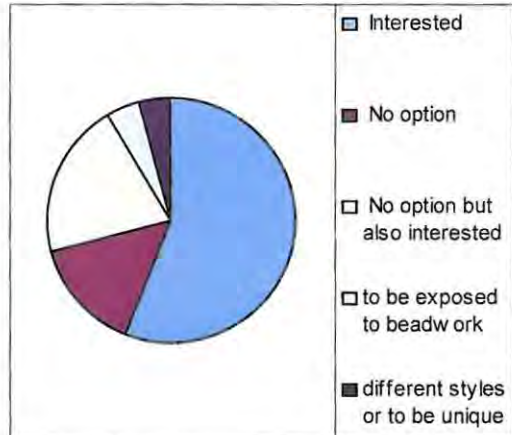


FIGURE 4.1 Pie graphs of participants' interest in participating in beadwork activity.

The S1 participants responded as follows:

52 % were interested in working with beads especially threading them in order to make their own beadwork artifacts. They also mentioned that beads are currently used for craft projects that allow people to make a living. In other words participants were interested in how beads were associated with every-day life and for economic purposes.

21 % had no choice but to do beadwork because there was no other option. As a result they were not really interested in doing beadwork. However, after the visit to the AM and MWP their attitudes changed and they became interested

18% had no option but to do it, and also showed no interest in participating in beadwork threading.

5 % required exposure to further beadwork artifacts for making their own decorations in dress-making, necklaces and belts.

4 % of participants were interested in making their own unique styles of beadwork artifacts, and were keen on exploring other cultures' beadwork artifacts such as Sotho and Ndebele.

The S2 participants responded as follows:

76 % were interested in working with beads. Two of the participants' mothers worked in the MWP as their means of making a living.

8 % had no option but to do beadwork, as other learning areas were full.

7 % of participants had no option but were also interested to thread beads.

5 % of participants required exposure to further beadwork artifacts, as they already had the basic skill of threading beads.

4 % of participants wanted to do something different and unique from what they had previously done.

Some participants indicated that beadwork formed part of their cultural attire. From the participants' responses I learnt that most of them were interested in threading beads and that alone motivated me as a researcher. I assumed that when participants showed interest in threading beads, then participants would also be interested in the activities that would follow. The activity was to find the link between mathematics and beadwork artifacts.

A question was asked concerning the learning area to which beadwork artifacts could be related. Examples of their responses are as follows:

- “beadwork *belongs to arts and crafts because it includes creativity*”
- “*to arts and culture, because it's about cultures and art and a lot of culture use beads to present something*”
- “*mathematics, arts and culture activities dealing with numbers and working with Xhosa culture*”

In bullet one, arts and crafts were mentioned under creativity and decoration. In that instance, participants required some assistance to connect what they referred to as decorations with patterns also occurring in mathematical activities.

In bullet two and three arts appeared with culture. I also concur with the participants that beadwork and culture are interrelated.

In bullet three, mathematics came up with arts and culture. In other words, participants viewed beadwork as a “cultural thing” which involved numbers and patterns. According to Bishop (1988:182) mathematics is a “cultural product which had developed as a result of various activities”. Some participants seemed to have an idea about mathematics in beadwork artifacts. There is however still a need for assistance in discovering further mathematics embedded in those artifacts.

A further probing question was asked to ascertain whether participants see any relationship between the mathematics learning area and beadwork. They responded in a variety of ways, some in a rather superficial manner. See excerpts in Fig. 4.2 containing a few responses which I consider interesting:

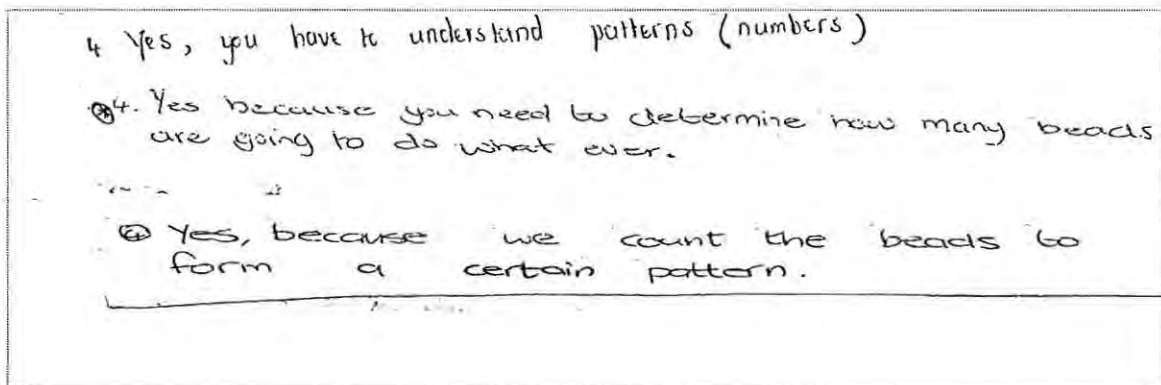


FIGURE 4.2 Samples of selected responses which confirmed that participants did find some relationship between mathematics and beadwork artifacts.

From the chosen samples, patterns and counting numbers seemed to be a common response from the participants. In that instance participants seemed to indicate an understanding that there is mathematics in art and beadwork artifacts. Participants began to understand that patterns in beadwork artifacts are the result of counting a certain number of beads. For example, a triangular shaped pattern found in beadwork artifacts is formed by adding two beads to one bead. Participants’ findings affirm Goldin’s (2002)

assertion that mathematics is about the “study of patterns” found in real life situations (See also Chapter 2).

In my view, I would say that participants began to make mathematical connections with beadwork artifacts. In so doing, participants might be able to find other mathematical concepts embedded in beadwork artifacts using those connections. Participants required scaffolding in order to extract mathematical concepts.

My role as teacher and a researcher therefore is to expose my learners to cultural beadwork artifacts (real life activities) and mathematical activities (school mathematics). To support Gerdes’ (1999) findings, I felt that participants had to be exposed to real life occurrences. Participants thus visited the AM where beadwork artifacts are kept for educational and historical purposes.

4.3 PARTICIPANTS’ VISITS TO AM AND MWP

4.3.1 Observation at the AM

Although the majority of the participants had already previously visited the AM for learning areas other than mathematics, they were now visiting it with the intention of exploring different kinds of beadwork artifacts in relation to mathematical constructs.

During the visit they were to take notes and make drawings of the Xhosa beadwork artifacts they came across. At the beginning many participants experienced difficulty in relating what they saw at the AM with mathematics in the classroom. They needed assistance and guidance from other learners and the researcher. With time they managed to write some notes and draw diagrams. I have chosen an extract from a learner’s notes. The extract contained diagrams and explanatory notes (See Figure. 4.3).

The participant identified **translations** and **reflections** on the necklace. In some instances participants seemed to be confused, for example a participant made mention of

tessellations on the necklace instead of reflection and translations. In my view, the confusion might be a mathematical language problem together with a second language problem as the participants were second language English speakers.

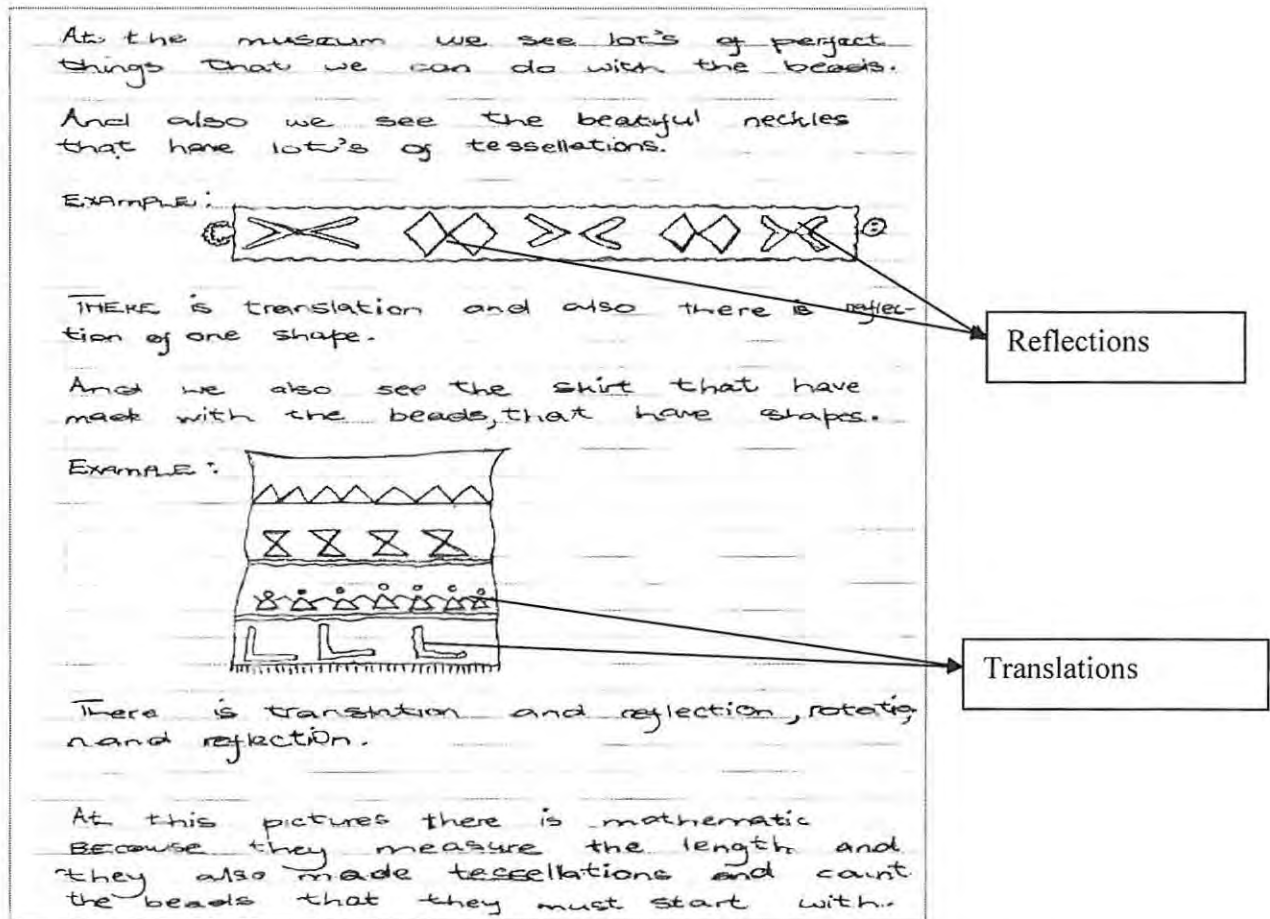


FIGURE 4.3 An extract from the notes written by a participant during their visit to AM.

On the beaded skirt, the participant also identified **translations, reflections and measurement (the length of the skirt)**.

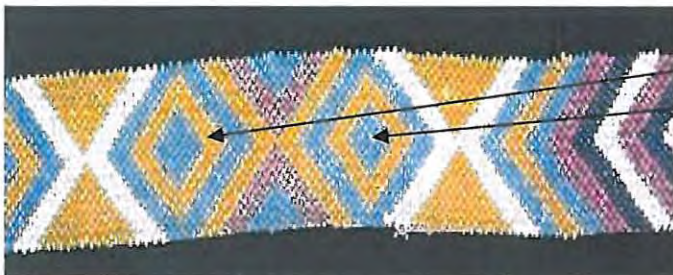
The notes and photographs (Figs. 4.3 and 4.4) taken during the AM visit were utilized when participants came to design and thread their beads in the subsequent classroom activity. For example, in figure 4.4 a) a necklace with translational triangles, b) an anklet with tessellating diamonds and c) a bracelet with translational diamonds.



a) Necklace



b) Anklet



c) Bracelet

FIGURE 4.4 Beadwork artifacts collections taken from Albany Museum.

In other words participants gradually began to understand that mathematics is not only about numbers and angles but can be found in dresses, anklets and necklaces.

Participants were thrilled about their findings about mathematical concepts in beadwork artifacts; as a result they wanted to thread their own beads. They needed guidance from me and other experts in modeling beadwork artifacts. There were people or mothers Masithandane Women's Project (MWP) who were threading those beads making beadwork artifacts nearby the museum. Since the participants were interested in threading beads as part of their mathematical activity we visited the MWP.

4.3.2 Participants observation at the MWP

In order to expose participants to a real-life bead threading context and view beadwork being threaded, they were taken for a visit the MWP. They observed first hand the actual process of threading beads. Participants also had an opportunity to communicate with the women of the MWP on how they go about designing and threading their beadwork artifacts.

An interesting question asked by the S1 participants while they were observing the women threading was "Do you draw the pattern before threading beads?" The response was that they do not draw or draft any design before the actual threading. The S2 participants were familiar with threading of beads and how their mothers threaded them (section 4.2, page 50).

Participants were instructed to look for any mathematics happening in the threading process. In other words, participants tried to "mathematize" the activity. That is, to apply mathematical ideas to real life situations. For example they were encouraged to look for number patterns that occurred in the beadwork artifacts.

Participants further observed how patterns developed as the MWP women threaded the beads. The women from the MWP explained how they learnt the skill of threading beads

from their mothers and grandmothers who were working for farmers. After working in the fields, their mothers would sit around the fire and start threading beads and showed them different patterns. Although one of the women could not count, the remaining four could count but preferred to estimate the amount of beads required.

The patterns which the women made were accurate and precise as if they had first drawn or drafted the patterns to be used. For example, it was interesting to observe that the anklets that were threaded by the women fitted a number of people. At the same time, the MWP women had an opportunity to explain to the participants, how different patterns developed through adding one or more beads. Participants found it very interesting and they further asked how MWP women priced their beadwork artifacts. Their responses revealed that the cost of any given unit of an artifact varies according to the number of beads used and the amount of time taken to thread it. The longer the time taken to thread the beads and the greater the number of beads used, the higher the price of the beadwork artifact. Also, the different colours and types of beads used added more value to the beadwork artifact. For example, glass, silver, gold and transparent beads are more expensive.

The information, knowledge and skills learnt from the AM and the WMP visits were then used in the mathematics activity in the classroom.

4.4 LEARNING PROGRAMME INTERVENTION

The purpose of the learning programme intervention was to enable the participants to apply the knowledge they had gained as a result of the visits to the AM and the MWP to their mathematics activities. As I was preparing the activities I took into consideration how participants were to integrate within and across learning areas. Participants were to use resources which were available in the community, the MWP and the AM. The emphasis was to link the out-of-school and real-life mathematics with the mathematics learnt in the class.

The learning programme intervention required the participants to design bead patterns that they could thread. Thereafter, participants were to investigate any mathematical concepts emanating from the resultant beadwork artifacts. The activity was consistent with the learning outcomes requirements in the Revised National Curriculum Statement (RNCS) currently introduced at schools.

The RNCS requires that:

- learners are able to recognise, describe and represent patterns and relationships, as well as to solve problems.
- learners are able to draw and construct geometric figures and make models of solids in order to investigate and compare their properties (RNCS, 2003:78-80).

Learning outcomes 1, 2, and 3 were relevant to the above curriculum statements.

The three learning outcomes (LOS) to be achieved at the end of the activities were:

- LO1: Number, operations and relationships. The learner will be able to recognise, describe and represent numbers and their relationships, and to count, estimate, calculate and check with competence and confidence in solving problems.
- LO2: Patterns, functions and algebra. The learner will be able to recognise, describe and represent patterns.
- LO3: Space and shape (geometry). The learner will be able to describe and represent characteristics and relationships between two-dimensional shapes and three-dimensional objects in a variety of orientations and positions (RNCS 2002:78-82).

The activity included four learning areas, namely art and culture, technology, mathematics and language. Participants were to integrate those learning areas during their activities. For example learning outcome 3 focused on properties, relationships, positions and transformations of two-dimensional and three-dimensional objects. In order to achieve those outcomes, three activities were carried out with the participants.

4.4.1 Activity A: Trademark collection

- All participants were to collect trademarks (see Fig. 4.5).

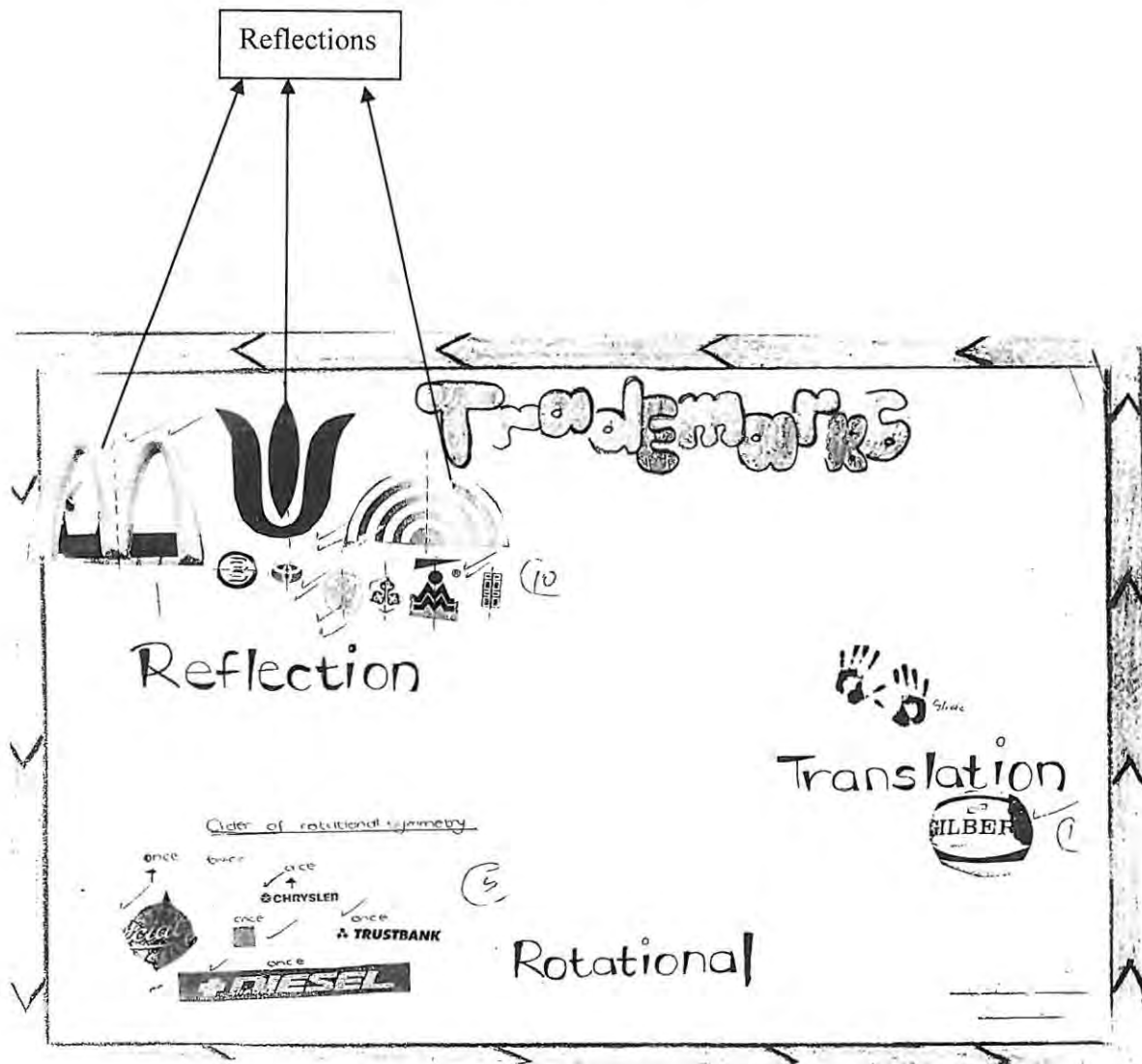


FIGURE 4.5 Example of trademark collections

Participants were asked to identify mathematical concepts in these trademarks. In Fig. 4.5, S1 participants identified reflection, translation and rotational symmetry. In Fig. 4.6, S1 participants identified line symmetries in the trademarks for example, Woolworth, Koo and Sanlam.

S2 participants were unable to collect trademarks. They could not link the activity with mathematics as they associate this activity with art, where they were asked to collect pictures and place them for decorations.

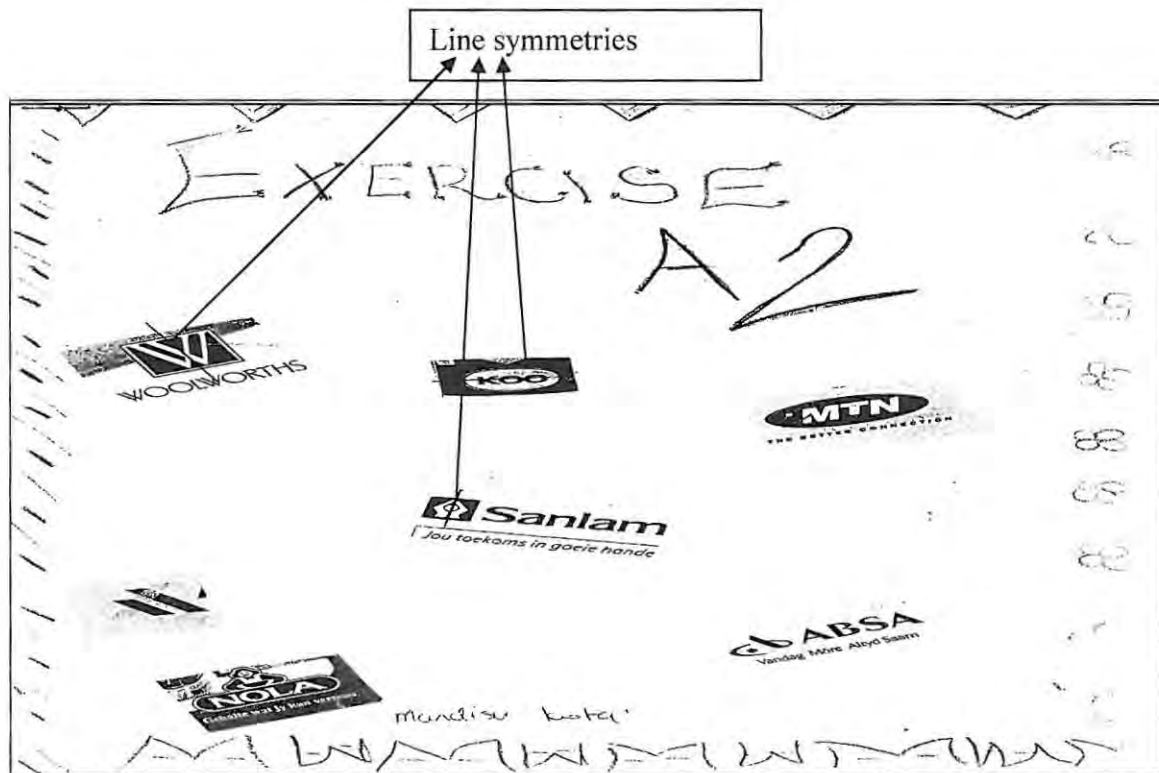


FIGURE 4.6 Examples of Trademark collections.

The main objective was to assist participants to discover the mathematics in many objects found around them. Although most of the participants were not familiar with the exercise, they were able to identify some mathematical concepts in the trademarks. For example, reflections were identified from the (M) of the MacDonal’s trademark and (W) of the Woolworth trademark.

4.4.2 Activity B: Designing patterns using trademarks

- All participants were asked to design and draw patterns to guide them in threading their beadwork artifacts.
- S1 participants used their trademarks to draw patterns.
- S2 participants were unable to design or draw patterns but they used their background knowledge in threading beads without first drawing or designing patterns.

S1 participants were able to identify mathematical concepts on the trademarks which they managed to collect. There were 3 out of 21 (14%) participants who could not associate angles and triangles found in the trademarks decorations with those found in geometry activities in mathematics.

Nonetheless, they managed to come up with mathematical concepts present in different trademarks they had collected. Participants were also asked to identify trademarks which contained tessellations. They could not find such trademarks but decided to draw diagrams to indicate that they understood the meaning of tessellation (See Figure. 4.7).

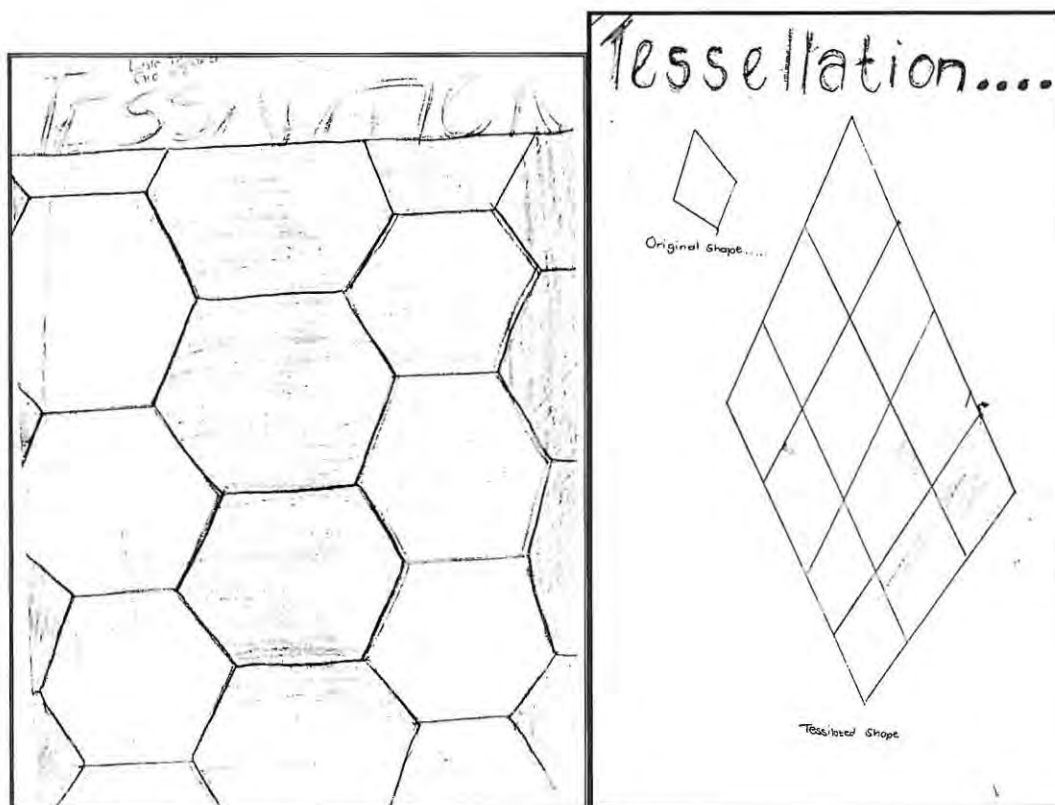


FIGURE 4.7 Diagrams showing tessellating shapes.

The next phase was to thread the patterns.

4.4.3 Activity C: Threading of beads

- Participants were asked to thread their designs.

As I have indicated earlier on, this task was not easy. Of the S1 participants, three out of the 21 had been exposed to threading beads at home, so they used their background knowledge on threading their artifacts. Of the other S2 participants, two participants managed to design the patterns and thread them. Others could not design but were just able to thread the beads. In S2 participants, 13 out of 23 threaded the beads without using designs or drawings

The S1 participants designed patterns such as illustrated in Fig. 4.5. Only 5 out of 23 participants in S2 managed to complete their anklets, but none of them were able to complete their necklaces due to time constraint. In other words only 22% of participants managed to thread beads according to their designs. Participants who could not thread their design were allowed to use their diagrams to investigate mathematical concepts present in their designs (See Fig. 4.8). I will now briefly discuss how they managed to identify mathematical concepts in the dress designs, the South African flag, the anklets, the necklaces and the financial mathematics.

In Fig. 4.8 learners were able to identify symmetry on dresses and the South African flag. Fig. 4.9 illustrates how an understanding of vertical symmetry was developed in one of the dress designs.

Dress designs



FIGURE 4.8 Designs of beadwork artifacts for S2 School.

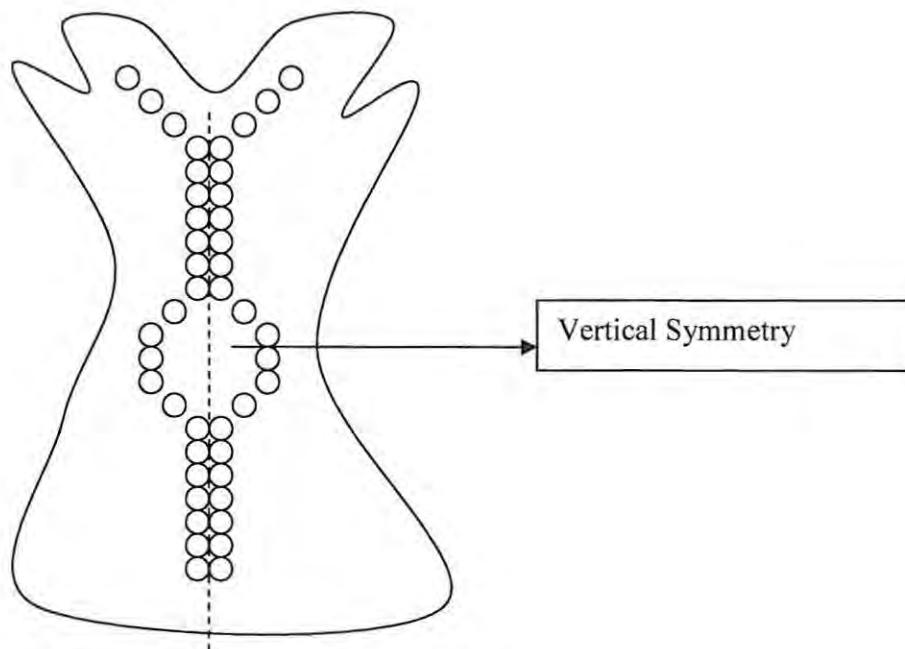


FIGURE 4.9 Diagrammatic representation of Fig 4.7.

The South African Flag

The South African flag was among the designs the S1 participants could not thread because of time constraint, but they were able to identify mathematical concepts such as symmetry and shapes in the design. They used folding to determine the symmetry in the flag (see Fig. 4.10).

On the other hand, the S2 participants were able to thread the flag. S1 participants tried to identify mathematical concepts in it. Initially S1 participants had a problem in identifying symmetry in the South African flag; some identified it as having a vertical line of symmetry. Others argued that the colours red and blue were not the same in order to be

regarded as symmetrical. Others came up with the definition of symmetry, as *“it is when things can be divided into two equal parts or is a mirror image”*.

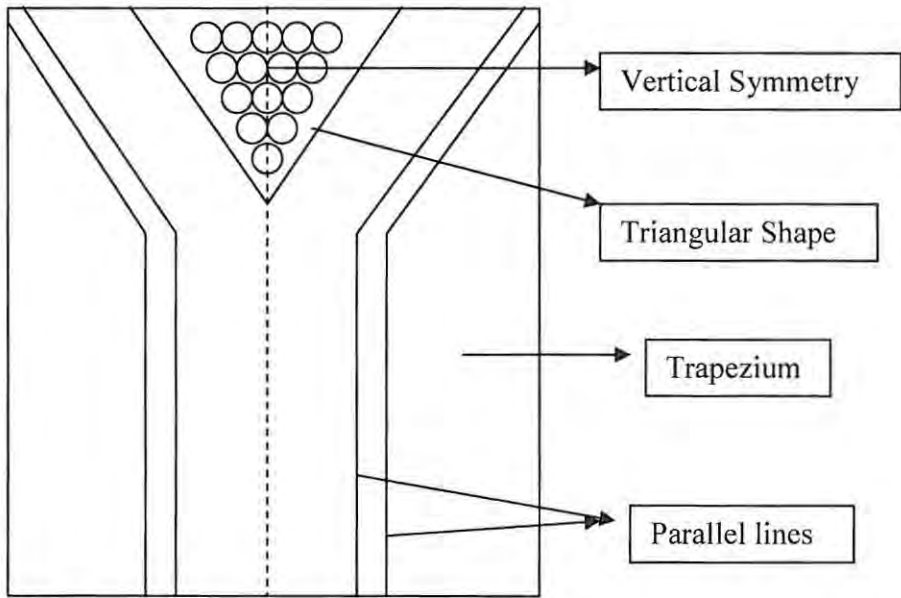


FIGURE 4.10 Drawing of South African flag showing mathematical concepts

Some of them suggested that they should draw the South African flag without indicating the colours, and then fold it in order to find the line of symmetry. They eventually came to an agreement that the flag has a line of symmetry. Participants used different strategies, namely folding the paper design or drawing the flag in order to solve their tensions about the line of symmetry. Besides the vertical symmetry, a number of mathematical shapes were identified using a diagram (see Fig. 4.10).

Anklets and necklaces

The S1 participants identified translations and parallel lines in their anklet design (Fig. 4.11).

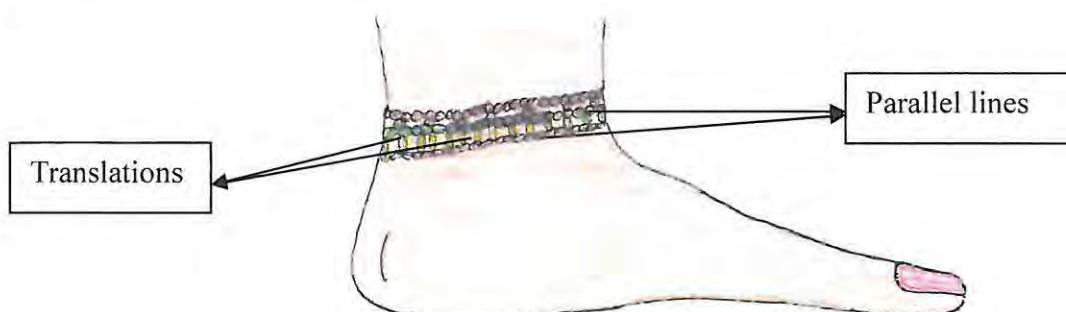


FIGURE 4.11 S1 participants' anklet design

S1 participants came up with the following mathematical concepts in the necklace.

- **Translational** transformation on the necklace (Fig. 4.12).
- **Shapes** on the necklace, namely **triangles** formed by beads, starting with one bead first row. The second row made up of two beads. The third row had three beads.
- **Pentagons** formed by spaces between triangles and **oblong** shapes of the white beads in-between the triangles.

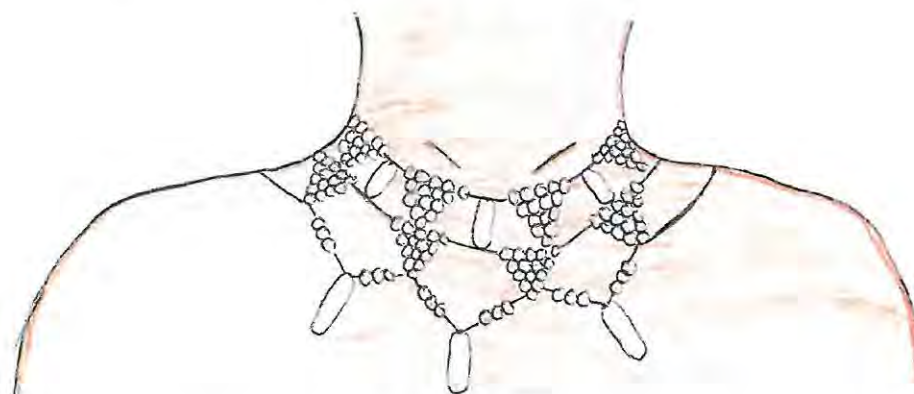


FIGURE 4.12 S1 participants' necklace design

In Fig. 4.13 participants used a diagram to explain their understanding of mathematical concepts in the beadwork necklace design.

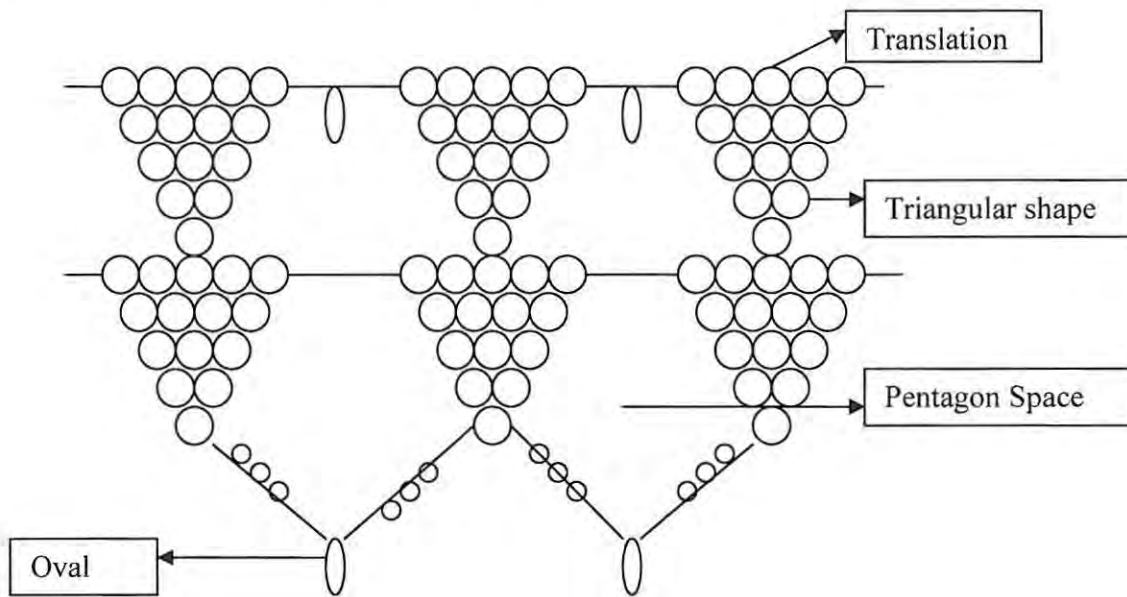


FIGURE 4.13 Necklace design drawing.

Participants also linked patterns and numbers found on the beadwork artifacts to mathematical number patterns in the classroom. They found that beadwork artifacts involve patterns like those found in number patterns.



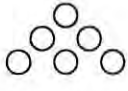
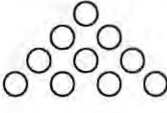

1	$2 + 1 = 3$	$3 + 3 = 6$	$4 + 6 = 10$	$5 + 10 = 15$	No. Pattern (NP)
					Bead-work pattern (BP)

FIGURE 4.14 Diagram drawn from participants' beadwork artifacts pattern to illustrate number patterns developed.

1	$2 + 1 = 3$	$3 + 2 + 1 = 6$	$4 + 3 + 2 + 1 = 10$	$5 + 4 + 3 + 2 + 1 = 15$	NP
					BP

FIGURE 4.15 Diagram drawn from participants' beadwork artifacts pattern to illustrate number patterns developed.

In Figs 4.14 and 4.15 are the diagrams representing the beadwork artifacts patterns. From their findings participants were able to link their mathematical number patterns to their beadwork artifacts patterns. Participants became excited about their work and the relationship between mathematics and beadwork artifacts

Participants were able to estimate the number of beads required from the number of beads in the first row in order to complete a triangular shaped pattern. Participants began to understand how women who were unable to count were able to thread those patterns as if they could count. They discovered that estimation used when calculating mathematics was also vital in our every day life practices. Two participants from S2 came up with the example that even when cooking, estimation is important. For example, when pouring salt into our food we talk of a pinch of salt or even use our hand as measurement. When I asked the S1 participants, 7 out of 21 agreed that they also estimate in some instances, 5 said they use teaspoons to measure salt. The remaining 9 used the two interchangeably depending on the food cooked. Participants began to discover that mathematical activities are also practiced in their every day activities.

In other words, participants could identify with Knijnik (1997) in his definition of mathematics as a "cultural knowledge" linked to human needs. Gerdes (1999) uses different cultural activities to show geometrical ideas inherent in various crafts.

Participants in this study found a link between cultural activities and mathematical activities in general. Gerdes (1999) encourages educators to link mathematical activities to cultural activities as a basis to understand mathematics.

As already indicated the S1 participants threaded their beadwork artifacts without first drawing designs to guide them. When I asked them about the designs, they replied that their parents normally do not draw or design any patterns before threading their beads. As a result they were also taught to thread their beadwork artifacts without drawing designs first. Most of the girls managed to complete a necklace or bracelet, but boys asked to be excused from the activity. Their argument was that beadwork is for girls according to their Xhosa culture. This is supported by Costello (1990) reaffirming that culturally girls were considered mature and ready to be called an adult, if they are able to thread beads. According to Costello (1990:19) "beading is a craft practiced by women... and most beadwork is done by teenage girls and unmarried women". It is a skill which is passed on from mother to daughter and sister to sister. In some instances beadwork artifacts are the means of communication. For example, love letters as mentioned earlier in Chapter 2.

Although there were problems with boys; girls were willing to continue with the activities. The problem experienced by boys made me realize that different cultures might play a vital role in teaching and learning mathematics. In this case the boys were not familiar with threading as Xhosa culture does not cater for boys to thread beads. In other words, cultural stereotypes discouraged the boys from engaging in the activity. Thomas (1997), encountered the same problem when he asked learners to read mathematics embedded in a context that bears no relationship to anything in learners' experience or prior knowledge. Forbes (1994) in New Zealand affirmed that the Maori learners experienced problems when their traditional teaching was forsaken and English became the language of instruction for mathematics and science. Culture and language in Maori culture played a vital role in learners understanding mathematics.

Through these activities participants were expected to look for symmetry, tessellations and any mathematical concepts embedded in those different patterns and threaded

beadwork artifacts. My role as a researcher was that of observing and listening to what they were discussing as they were threading beads. In Fig. 4.15 a group of four was threading their artifacts while one needed some assistance in threading.



FIGURE 4. 16 S2 participants threading their different beadwork designs in the presence of the researcher.

The completed beadwork artifacts were displayed in the classroom for discussion (see Fig. 4.17).

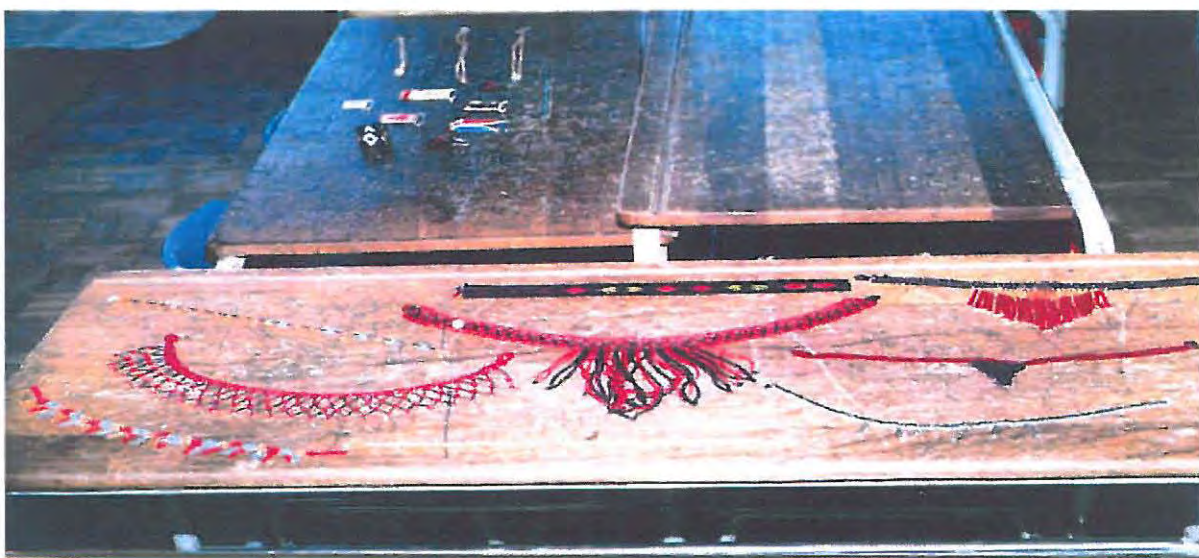


FIGURE 4.17 S2 completed beadwork artifacts

D'Ambrosio (1985) suggested that the mathematics curriculum ought to include children's background knowledge, experience and culture in order to be meaningful to them. In so doing mathematics might become part of their daily life activities. In other words, the use of beads and beadwork artifacts in mathematical activities might assist the learners to understand, own and value mathematics.

The completed beadwork artifacts of S2 were used to identify more mathematical concepts, as illustrated in Figs. 14.17, 14.18 and 14.19. Different types of shapes were identified. A pentagon shape, diamond shape space and triangular shaped space were in Fig. 4.18.

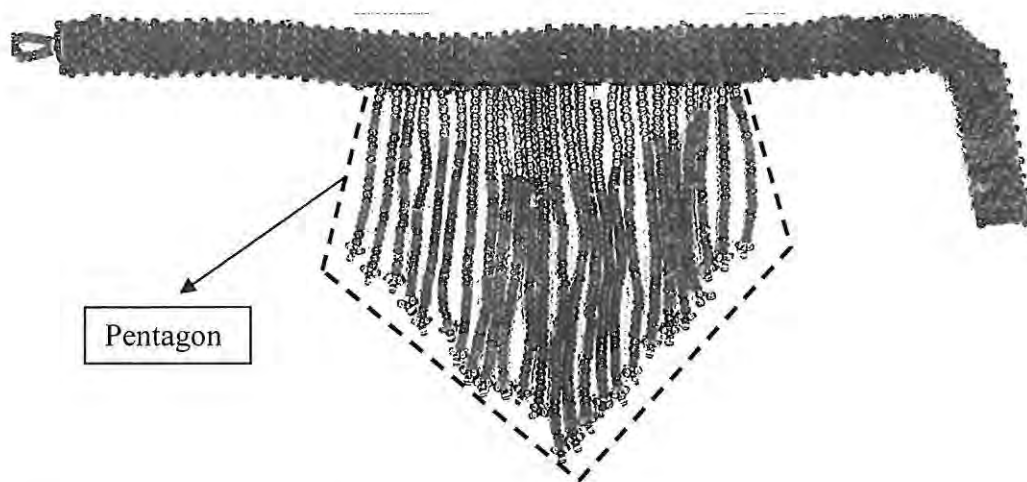


FIGURE 4.18 S2 completed necklace

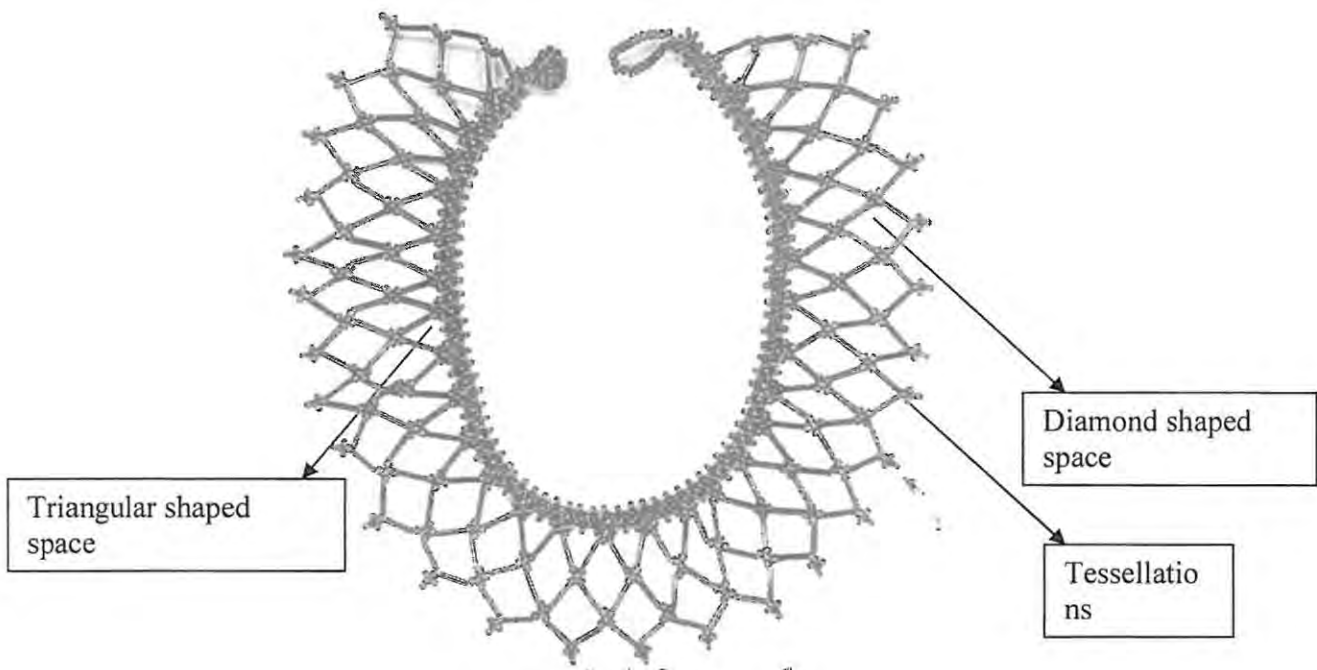


FIGURE 4.19 A sample of S2 completed beadwork artifacts.

Financial mathematics

Participants further explained how they calculated the money when selling their beadwork artifacts

Zukie's response

- **Time** taken to finish threading her necklace was 3 days.
- **Length** = 14 cm, **Breadth** = 2 cm
- **Number of beads** (red = 3 strings, black = 4 strings).

Zukie had to estimate the cost of the beads to be used to complete her necklace (Fig. 4.12). There were two methods of buying beads; the first one was a string of beads called "umngqa".

The string carried approximately 200 beads and costs R6.50. This was a popular method used in buying beads because it was easier for the MWP to buy a number of strings knowing that each string carries 200 beads.

The second method to buy beads was of buying beads using a small container called a “scoop”. The advantage in using the second method was that one had a container for storing beads.

As participants had asked MWP women how they sell the beadwork artifacts, they in turn used that method to price their beadwork artifacts. For example, Zukie calculated the cost of her necklace as follows:

Zukie used 3 strings of red beads, 4 strings of black beads and took 3 days. How much is the necklace?

$$\begin{aligned}\text{Necklace price} &= \text{number of strings} \times \text{time taken} \times \text{R}6.50 \\ &= (3 + 4 \text{ strings}) \times 3 \text{ days} \times \text{R}6.50 \\ &= 7 \times 3 \times \text{R}6.50 \\ &= \text{R}136.50\end{aligned}$$

Zukie’s necklace cost price = R136.50

Monie managed to thread a necklace (Fig. 4.13) with different kinds of beads, which formed diamond shaped patterns on the necklace. The composition of her necklace was as follows:

- Red beads = 872
- Black cylindrical beads = 162
- Time taken to complete the necklace = 2days

In order to calculate the selling price of her necklace, she used the same method as Zukie. The cylindrical-shaped beads were more expensive than the other beads. For example, the cylindrical-shaped beads were in small bottle, sold at R7.50 per bottle.

As both participants S1 and S2 came up with interesting mathematical concepts, I needed to know how some individuals make sense of their beadwork artifacts in relation to mathematics. In order to do that interviewing a focus group was the option.

4.5 INTERVIEWS

Since I had interesting findings from both schools, I decided to select a group of six participants to be interviewed in order to obtain more in-depth information about the activities. The reason I chose six was that interviewing a large number of participants would be expensive and time consuming.

I had 3 participants from each of the two schools. It was a purposeful selection because I wanted to find out more about their different beadwork artifacts and design results. Of the three from S1, one managed to design and thread her beadwork artifact. Two were able to design their patterns but could not thread them. S2 girl participants managed to thread their artifacts and completed them.

The interviews were conducted at one of the participant's home. It was their request as the venue was convenient to all the participants. There were five questions to which each participant was expected to respond. The interviews were audio taped. The following is an excerpt from an interview with Unathi from S1 school:

Educator: Were you able to thread your designs?

Unathi: *Well I only designed my necklace because it has a lot of work I could not finish. But I carry on with the anklet. Yah!*

Educator: Out of your design is there any mathematics present? If yes, explain.

Unathi: *Yes, ah... in the necklace **measurement** of the whole string to be used, and had to **count** how many like the beads to be used.*

Unathi could easily identify mathematical concepts on her beadwork artifact and that alone indicated that she could link mathematics with her beadwork artifact. As the curriculum required learners to integrate learning areas, my next question was to find out whether Unathi could relate beadwork to other learning areas.

Educator: Can you suggest any other learning area where beadwork artifacts can be utilized?

Unathi: *In Grade 9 in Technology, making a waistcoat and in History*

Educator: What can you say about the activity as a whole?

Unathi: *It was very nice, it was enjoyable. It is a skill that one can use as a career.*

Although Unathi could not thread beads, she managed to identify mathematical concepts in the design. Unathi enjoyed the activity. She was able to integrate beadwork to other learning areas like technology and history.

The following is an excerpt from an interview with Mandy from S2 school:

Educator: How did you feel at the beginning?

Mandy: *Well at the beginning I felt like I was panicking, I had so many ideas in my mind. I was panicking but at the end I made my decision and came up with my designs.*

Educator: How did you make your choice?

Mandy: *Oh! Well emh... since I like very much, like designing dresses. I never ran away from my culture, Xhosa culture I design those dresses.*

Mandy used her background knowledge on dress design and interest in her culture in deciding on her design. In this instance Mandy supported the Mogari (2002) notion on using learner's background knowledge as a starting point.

Educator: From your threaded South African flag, can you identify any mathematics present?

Mandy: *Yes, I can identify mathematics **counting** of beads. I depend on my beads I have and the **length** of the string to be used. For, example on necklace I started with **24 beads** on **first row** and...*

Mandy and Unathi mentioned counting of beads, whereas MWP women would use estimation of beads as oppose to counting. Measurement or length was mentioned as opposed to strings of beads.

Educator: Did you ever think of connecting mathematics with beadwork artifacts?

Mandy: *Honestly no, I have never combined them together. Yah!*

Educator: What can you say about the whole activity?

Mandy: *The whole activity has opened a new dimension to me. I can link the two, mathematics and beadwork artifacts.*

The following were excerpts from interviews with three interviewees from S2 school. Interview questions were based on the beadwork artifacts they had threaded:

Educator: Olwethu, you managed to thread your necklace and you finished it. Could you tell us what you have learnt out of the activity?

Olwethu: *I used mathematics when I was doing the choke/necklace, I used **addition** and **subtraction**. When doing my choke I started with one bead and **added** beads to make my **pattern**.*

Olwethu mentioned the basic operations and patterns found in mathematics. Mathematics is about patterns.

Educator: Besides the addition and subtraction you used, what were other mathematics present on your pattern?

Olwethu: *There are different **shapes** on the **pattern**, for example **square**, **rectangles**, **diamond** and heart shapes.*

Educator: Among those shapes which one does tessellate?

Olwethu: *Triangles, rectangles and diamonds.*

Educator: What can you say about the remaining shapes?

Olwethu: *The heart can be cut vertically into half, forming a line of **symmetry**.*

Bulelwa who was the second to be interviewed had the following contribution:

Educator: What can you tell us about your beadwork?

Bulelwa: *I threaded a necklace, my first row consisted of eighty beads (80 beads). In order to finish my necklace I had to **multiply 80 by 3 equals 240**.*

Mathematical language

Educator: Are there any mathematical concepts in your beadwork necklace?

Bulelwa: *Yes, shapes triangles and rectangles*

Educator: What can you say about beadwork and mathematics?

Bulelwa: *Because there are shapes on the beadwork patterns, which are also found in mathematics there is something common. In other words mathematics can also be found in beadwork artifacts.*

Zukie the other participant had a different pattern but had the same features as those of her colleagues. For example her pattern had shapes like rectangles, triangles and pentagon.

Afterwards the participants were asked to comment on the beadwork artifacts they had threaded. They all agreed that a dominating shape for different patterns was a **triangular shape pattern**. Participants made mention of calculations involved in beadwork artifacts, namely:

- **Time** taken to complete their beadwork artifacts which included **hours** and **days**
- **Cost price** of the beads, different types of beads had different prices. For example the white, red and blue colour beads are less expensive than the gold and silver beads. In that sense the **selling price** of beadwork artifacts depends on the types of beads used.
- Variety of **lengths** used in different artifacts, namely necklaces and anklets.

4.6 CONCLUSION

In this study, I would say the practical part, where learners were to draw or thread the beads was what they enjoyed mostly. Through that enjoyment they were able to link their mathematical findings with other learning areas, art, and economics and most importantly with their culture.

Participants commented about time constraint, as they were interested in making more beadwork artifact, and wanted the opportunity to discover mathematical concepts in

different beadwork artifact patterns. They even suggested that it should not be taken as an optional subject but should become part of the mathematics activities in the geometry section.

Some participants suggested that beadwork artifacts should be included in mathematics as practical mathematics. In practical mathematics, they mentioned beadwork artifacts, and games involving strings and stones (*upuca*). In other words participants wanted mathematics to be part of their prior knowledge and for mathematics learning to be fun.

CHAPTER 5

RECOMMENDATIONS AND CONCLUSION

5.1 INTRODUCTION

The challenge facing South Africa is a lack of skilled people and the decreasing number of professionals such as doctors, engineers and mathematics teachers. Also there is a decrease in the number of learners taking mathematics as their major subject. As a result, the Education Department declared Mathematics or Mathematics Literacy as a compulsory learning area from Grade R-9 and committed to give full support to a new intervention programme started in 1995 to recover mathematics (South Africa. DoE, 1995).

The old view of mathematics perceived as “difficult and irrelevant” to our lives. Learners in Chapter 2 evidenced that view through asking questions like “where and when are we going to use these x and y in our real life?” Learners could see no relationship between what they were learning and what they would need in the future. It seemed to them to be irrelevant. The main emphasis of my study is on using learners’ cultural background experience and knowledge when looking for mathematical concepts in beadwork artifacts.

I saw a need to link the classroom experiences of learners to their own life experiences. Those were the factors which motivated me to conduct or pursue this study.

In the literature review I explored the notion that traditionally mathematics had been taught as absolute, abstract, pure and universally true. The underpinning philosophies for these beliefs were absolutist and dualist; they viewed mathematics as culture-free as explained in the literature review (Chapter 2).

On the other hand, ethnomathematicians viewed mathematics as cultural product (Bishop, 1988 and D’Ambrosio, 1985). Ethnomathematics also addresses the

relationship between gender and mathematics, for example, women's contributions to mathematics (Harris, 2002). Also the use of learners' cultural background in solving mathematical problems is encouraged.

Ethnomathematics is however not without criticism.

5.2 CRITICISM OF ETHNOMATHEMATICS

As ethnomathematics combines culture and mathematics, mathematicians felt that it should be a branch of anthropology. Mathematicians argue that ethnomathematics is not developed abstractly and logically, with proofs as in the academic tradition. Also in ethnomathematics courses less time is spent on teaching useful mathematics (Wikipedia, 2007). Ethnomathematicians on the other hand argue that ethnomathematics should not be a branch of mathematics nor anthropology but be seen as the combination of both elements from mathematics and anthropology (*ibid*)

Some critics of ethnomathematics emphasise culture differences rather than similarities. These critics should also be able to see unifying aspect of across different cultures. For example, "the negative numbers have been discovered on three independent occasions, in China, in India and in Germany having the same rule for multiplication" (Wikipedia, 2007:5). Ethnomathematicians argue that the central role in ethnomathematics is to explain how mathematics arises in ordinary life, such as where counting is necessary in a variety of situations. For example, in the situation where people cannot count but use stones to represent the number of sheep and cattle.

In my view ethnomathematics is another method to understand how mathematics arises in ordinary life and it motivates learners to understand the contributions made by their own culture towards mathematics, for example, beadwork artifacts. From there they can appreciate the contribution of the cultures other than their own understanding.

5.3 SOME REFLECTIONS AND LIMITATIONS

As this study exposed participants to Xhosa beadwork artifacts, participants were able to identify different kinds of mathematical problems, such as transformations and mathematical calculations. The vertical line symmetry was common in the beadwork artifacts. As far as transformations go, transitional transformation dominated in the beadwork artifacts.

Through interviews, participants were able to express their overall perceptions of the research process. Six participants were chosen on the bases of their designs and completed artifacts (section 4.5 Chapter 4). Through the responses given by the participants, it became clear that they were able to identify mathematical concepts on the designs and completed beadwork artifacts. For example, they made mention of measurement involving centimetres and counting of beads. Patterns and different shapes were also identified.

Also participants' findings revealed that mathematics could be found in economics that is, selling and buying beadwork artifacts (Chapter 4). Besides the mathematical and economic findings, participants enjoyed the mathematical activity found in beadwork artifacts.

5.4 LIMITATIONS OF THE STUDY

Although the study went well, there were a few limitations which I would like to highlight:

- The period allocated for the research was insufficient, especially in that the activities needed practical work.
- The introduction of the Revised National Curriculum Statement had an impact, as participants had a number of projects to do. As a result some participants could not complete their beadwork artifacts.
- Cultural stereotypes posed challenges on the learning intervention programme. Boys withdrew because they perceived the threading of beads as belonging to girls.

- The Researcher herself experienced time constraints, as a full-time educator and being only able to conduct and write up the research on a part time basis.

5.5 RECOMMENDATIONS

This study could lead to further investigation on the relationship and links between different learning areas of mathematics. I would recommend that mathematics educators be involved in mathematics research programmes in order to empower and develop themselves in this field. Especially the area of ethnomathematics which encourages the use of cultural products in the learning of mathematics.

As this study tried to expose participants to cultural artifacts and they were able to connect those cultural artifacts to mathematics, I would recommend that educators try and use other cultural means to enhance the mathematical understanding of learners. I also recommend some changes in mathematics instruction during teacher training. Methods utilized during training need to encompass ethnomathematics. Also I recommend the use of ethnomathematics programmes at schools be integrated into other learning areas. All cultures demonstrate some mathematical practices (Bishop, 1988).

Most importantly I would recommend the use of resources available locally as some of them are easily accessible to the learners. For example the use of the local museum and projects might reinforce the view that mathematics is found everywhere, all around us.

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APPENDIX A

QUESTIONNAIRE ON LEARNERS' BACKGROUND

1. Do you stay in hostel?

.....
1.1. If yes, where do you come from?

.....
1.2. If no, where do you stay in Grahamstown?

.....
2. Have you been to the Albany Museum?

.....
3.1. If yes what was the aim?

.....
3.2. If no, why?

.....
4. Was it your first time to be exposed to beadwork?

.....
4.1. If no, where have you seen it?

.....
5. Why did you choose to do beadwork?

.....
6. In your different learning areas where can beadwork be used?
Give reasons for your answer.

.....
7. Are there any areas where beadwork can be used as learning support material?
Give examples

.....

APPENDIX B

INTERVIEW QUESTIONS

You have made beautiful designs of a necklace and anklet.

1. Can you tell me what have you done when you received your beads?
2. Were you able to thread your drafted design?
3. Was it your first time asked to thread the beads?
4. You were not able to thread your design, why?
5. From your design can you identify any mathematics present? Explain your answer.
6. The anklet design has a special pattern. What type of translation is it?
7. Can you suggest any other learning area where beadwork can be used as learning support material?

What would you say about the whole activity?

