RHODES UNIVERSITY

An investigation into the use of traditional Xhosa dance to teach mathematics: A case study in a Grade 7 class.

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By

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ABSTRACT

This study seeks to explore mathematical concepts embedded in traditional Xhosa dance and how these concepts can be incorporated into a learning programme for the teaching and learning of mathematics. The study seeks to gain insight into whether learners could benefit from the implementation of such a learning programme. Learners from a Grade 7 class in a rural school performed traditional Xhosa dances and their performances were captured through video recording. The video recordings were then observed and analysed to determine the mathematical concepts embedded in the dances. These concepts were then linked to those found in the Grade 7 mathematics curriculum. A learning programme integrating mathematical concepts from the dance activities with mathematical concepts from the Grade 7 curriculum was then designed. The learning programme contained mathematical problem solving activities that required learners to re-enact the dance performances in order to find the required solutions. The learning programme was then implemented with the learners over a period of three weeks. During the implementation, learners' behaviour towards the learning experience was observed, their engagement with the problem solving activities as well as their strategies for solving the problems, were carefully observed. Also, their interactions with each other were noted. After the implementation of the learning programme, focus group interviews were held with learners to determine their opinions, attitudes and feelings about their experience of learning mathematics through traditional Xhosa dance. Key findings indicated that traditional Xhosa dance can be used as a medium for learning many concepts in the mathematics curriculum; the use of the dance gave learners an opportunity to learn mathematics from a familiar context and to participate actively and collaboratively in their learning. Also, it emerged that the use of dance to teach mathematics had potential to help improve learners' attitudes towards mathematics. Conclusions were reached that the dance had potential for use as a means for the meaningful learning of mathematics. However, limitations and challenges with the study were identified, such as its limited replicability in other mathematics classrooms.

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DEDICATION

This dissertation is dedicated to the memory of my late father, Hamilton Fundile Socishe, a wise fellow and a loving father.

DECLARATION OF ORIGINALITY

I declare that this dissertation is my original work and has not previously been submitted for a degree in any other university.

Signed: .... Date: ....

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CHAPTER 1

INTRODUCTION

1.1. INTRODUCTION

In this chapter I explain the background and context of my study, briefly discussing my motivation for doing the research and the theoretical rationale that has shaped its focus. Secondly, I state the purpose of the study, explain how I plan to achieve this purpose and give a justification for why I consider this study significant. Finally, I outline the structure of the study and present a brief summary of each chapter.

1.2. BACKGROUND

In my experience of teaching mathematics I have witnessed the fear and anxiety that some learners experience when faced with the prospect of having mathematics as one of their subjects. Conversations with mathematics teachers suggest that this apprehension seems linked to the fact, amongst others, that learners do not get any enjoyment from doing mathematics and also do not see how it relates to their lives. The fear of mathematics is further documented in the literature, such as in the following assertion: "As a consequence of unhappy childhood experiences in the mathematics classroom, many people experience a sense of alienation, coupled with fear and despair, at the mere mention of the word 'mathematics'" (Millroy, 1992, p. 2). Hence I was motivated to do some research on how the negative classroom experiences of learners could possibly be improved.

Learner's belief that mathematics does not relate to their everyday life might be justified because "the content of school mathematics is so divorced from students' everyday experiences that it appears irrelevant" (Tate, as cited in Ladson-Billings, 1997, p. 697). Various authors have provided arguments suggesting that this situation needs to be changed. For example, Mosimege (2000) sees mathematics as "a useful subject for everyone ... relevant and practical and ... applicable to everyday life" (p. 283), while Freudenthal (as cited in Hough & Hough, 2007) reasons that "mathematics must be connected to reality, stay close to children and be relevant to society in order to be of human value" (p. 34). These suggestions prompted me to investigate ways of making use of learners' everyday experiences for the learning of mathematics in the classroom.

The current advocacy of the inclusion of indigenous knowledge systems in school curricula (South Africa. Department of Education [DoE], 2003)prompted the idea ofan exploration of an indigenous activity that learners engage with in their everyday lives. This seemed to me to be an appropriate field of investigation. With so many indigenous activities to choose from, I decided to focus on the potential of traditional dance for teaching and learning mathematics. The main reason for this choice is that the literature on previous research involving indigenous knowledge systems reveals that few studies have explored the integration of dance in learning mathematics. While there have been studies investigating the use of dance in teaching mathematics, these have focused on contemporary rather than traditional dance (Cancienne&Snowber, 2003; Paton, 2010). There are also studies involving indigenous knowledge systems that explore activities such as indigenous games, and beadwork and other indigenous artefacts (Mosimege, 2000; Dabula, 2000; Mogari, 2002; Myemane, 2007).

Various theories on the teaching and learning of mathematics strengthen the justification for the choice of my focus and the characteristics of my research. For example, the concept of indigenous knowledge systems in the context of mathematics is situated within the broader theory of ethnomathematics. Ethnomathematics is a theory that

> ...involves a very broad range of human activities which, throughout history, have been expropriated by the scholarly establishment, formalised and codified and incorporated into what we call academic mathematics. Yet it has remained alive in culturally identified groups and constituted routines in their practices.
>
> (D'Ambrosio, 1985, p. 47)

My intention with this study is therefore to help bring cultural practices into the classroom by using the context of traditional dance. My study also relates to the theory of enactivism, with its key proposal that we learn emotionally and conceptually by interacting with the spatial environment (Maturana & Valera, 1988). This theory is relevant to my research because dance involves movement in space and is therefore capable of generating insight into how this interaction between the person and the environment occurs.

The fact that dance, as a possible activity to be integrated with classroom mathematics, involves motor-sensory activity, informed the choice of school grade or age of learners involved in the research. I decided to do the research with a Grade 7 class, at a school in a rural area where traditional dance forms part of learners' everyday activities. The school is situated in the Eastern Cape, South Africa, where *isiXhosa* is the main language spoken. The research took place at a time when schools and teachers were grappling with the challenges created by the changes in the South African school curriculum. Hence I reasoned that a study that explored the inclusion of an indigenous activity in the mathematics curriculum, as stipulated in curriculum documents, could only benefit schools.

1.3. THE PURPOSE AND SIGNIFICANCE OF THE STUDY

The goals of this study are:

- To explore mathematical ideas and concepts embedded in traditional Xhosa dance.
- To design, implement and evaluate a learning programme that is based on traditional Xhosa dance performances.

The first goal is intended to determine whether any important mathematics can be extracted from traditional Xhosa dance. To achieve this goal, I planned to use video recordings to capture learners' dance performances. These recordings would later be observed in order to identify any mathematical concepts embedded in them. Findings from these recordings would help decide whether dance had the potential to be used for the teaching and learning of mathematics in the school curriculum, in the grade that I had chosen for the study.

Findings from the first stage, namely, video recordings of dances, would lead to the achievement of the second goal: that is, mathematical concepts discovered in the dances would be used to design a learning programme that incorporated these concepts. The learning programme would then be implemented in the classroom, with the intention of evaluating it in order to gain insight into whether it had an effect on how learners learn mathematics. Thereafter, focus group interviews would be held with learners to further evaluate the impact of the learning programme.

I am hopeful that the results of my study will inspire and help other teachers to integrate socio-cultural activities into their teaching. This is especially important because of the current changes in curriculum, which encourage the use of indigenous knowledge systems. I shall provide suggestions on how to adapt and use a similar programme in other classroom situations.

As mentioned earlier, research on the integration of traditional dance in the learning of mathematics is limited. I am hoping that my study will add value to current research in ethnomathematics. Some findings from my study could also trigger further research, as will be explained in the last chapter.

1.4. THE STRUCTURE OF THE DISSERTATION

This dissertation is arranged in chapters according to the key stages that I went through in conducting my research.

In Chapter 2, I set out a critical review of literature that relates to my study. I do this by analysing and synthesising previous research that has important implications for my study. Also included here is reference to the theory behind the issues and concepts raised in my study.

In Chapter 3, I describe and justify the methodological approach used in my research. I also explain the methods of data collection chosen and provide a rationale for the instruments used.

In Chapter 4, I present the findings of my research, relating them to the goals as they were initially stated. I also discuss the findings by explaining their significance and why they are important.

In Chapter 5, I discuss the importance of my study and make suggestions for further research.

1.5. CONCLUSION

In this chapter I have taken the reader through the conceptualisation of my research. I did this by providing a brief background that clarified the broader issues and problems, and followed this with an explanation of the goals of my study, culminating in a brief justification of its importance.

CHAPTER 2

LITERATURE REVIEW

2.1. INTRODUCTION

In this chapter I discuss the literature that informs my study. First I look into the history of traditional Xhosa dance in order to paint a picture of the background of the dance and when it is performed. Then I critically discuss the literature around the idea of learning mathematics within real life contexts. Next I engage with concepts, ideas and issues that relate to Xhosa dance and its introduction into the mathematics classroom, such as, indigenous knowledge systems and ethnomathematics, integration across the curriculum and learning mathematics through dance. Finally, I discuss the theory that informs the design of the learning programme used in my study.

2.2. A BRIEF HISTORY OF TRADITIONAL XHOSA DANCE

The term "traditional dance" has been defined as "dance in an ethnic group which is considered by most members of the group to be their cultural heritage and which has not been created or introduced by most of the current participants" (Hanna, 1965, p. 21). Dancing forms an integral part of Xhosa culture and is traditionally part and parcel of most Xhosa rituals. Within an indigenous dance tradition, each dance performance usually serves a specific purpose, which may express or reflect the communal values and social relationships of the people (Harper, 2011). In the Centane area, for example, where I undertook my research, traditional Xhosa dance is used mainly during customary functions such as the ritual to ensure the fertility of a girl before she marries or to restore her fertility if she has trouble bearing children after the marriage. The dances are also common during the "initiation season", where boys do the stick dance (which is actually a friendly fight characterised by rhythmic movements of the arms, legs, and so on), and women dance to music during the ceremony.

In explaining the purpose of Xhosa traditional dances, Hardman (2003) claimed that these dances have been known as "a construction of 'traditional Xhosa values' constituted in the performance of the dance" (Hardman, 2003). Traditional Xhosa dances, therefore, often do not appear in isolation but are part of broader cultural activities. Dances of love are performed on special occasions, such as weddings and anniversaries. Rites of passage dances are performed to mark the coming of age of young men and women. They give the dancers the confidence to perform in front of everyone while they are being formally acknowledged by the adults. This builds pride, as well as a strong sense of community. Dances of welcome are a show of respect and pleasure to visitors, as well as a display of how talented and attractive the host villagers are. These dances are characterised by dancers doing various impressive stunts to mark tempo and rhythm changes. Hardman (2011) researched the 'courtship dance', a dance choreographed in the idiom of traditional Xhosa practices. This particular dance was an activity which "actively constructed a cultural ethic, in terms of behavioural ethics and bodily praxis, explicitly promoting sexual abstinence while still valuing courtship as a valuable traditional custom" (Hardman, 2011).

Traditional Xhosa dances, as is the case in many other African cultures, are usually performed in groups, for example, of girls or boys or old women or men. This indicates strong beliefs about what being male or female means, and some strict taboos about interaction between the two. The style of dance between men and women is also usually different. For example, men dance "with an attack of rapid, forceful movements to express masculinity, whereas the women dance with a sustained grace to reflect their femininity" (Harper, 2011, p. 5). However, both sexes use similar movements when they move to the rhythmic pulses of their dance through their postures, gestures and steps. These movements were evident in dance performances that I witnessed in my own research study. The rhythm is usually provided by a song or some percussive instruments or a combination of song and these instruments. The most basic rhythmic pattern is the continuous repetition of a simple beat at a steady tempo for the duration of the dance, such as the one provided by the clapping of hands or the stamping of feet.

The Xhosa people usually have unique names and dresses for their traditional dances. For example, as stated in the National Curriculum Statement document for the dance studies learning area, "indigenous African folk dances include dances such as *ingcekeza* and *umteyo*" (South Africa, DoE, 2006, p. 38), both of which are Xhosa dances that are performed during particular functions. The *umteyo* (shaking dance) involves the rapid undulation or shaking of the thorax so that the whole length of the spine appears to be rippling. However, due to societal changes and the evolution of culture, there are now other forms (and names) of dances that are relatively new to the Xhosa tradition, yet form part of current Xhosa community practices. Harper (2011) maintains that these changes have been caused by, among other things, the introduction of formal primary education that has radically altered the pattern of life. She goes on to suggest that education could change children's attitudes towards their dance, which they no longer have time to learn in the inherited manner. An example of a popular new dance in the Eastern Cape area is the gumboots dance, usually performed by boys or young men. This particular dance is characterized by steady beats of the feet that result in rhythms that are consistent. The gumboots dance is one of the dances performed by the dancers in my study, which I will discuss further in later chapters. Another relatively new dance is the *kwasa kwasa*, which is very popular with young girls and boys.

2.3. MATHEMATICS LEARNING WITHIN A REAL LIFE CONTEXT

"As a consequence of unhappy childhood experiences in the mathematics classroom, many people experience a sense of alienation, coupled with fear and despair, at the mere mention of the word 'mathematics'" (Millroy, 1992, p. 2). In my own experience of teaching mathematics I have witnessed the fear and anxiety that some learners experience at the thought of doing mathematics as one of their subjects. Conversations with other teachers reveal that a possible cause of this apprehension is the feeling that mathematics has no connection to their lives and they get no enjoyment from doing it. Others see it as irrelevant, too abstract and therefore difficult – this despite claims that "mathematics is a useful subject for everyone ... relevant and practical and … applicable to everyday life" (Mosimege, 2000, p. 283) and the insistence that "mathematics must be connected to reality, stay close to children and be relevant to society in order to be of human value" (Freudenthal, as cited in Hough & Hough, 2007, p. 34). Research claims that as children go through their schooling, they "begin to lose their belief that learning mathematics is a sense-making experience because there is "a disconnection between their knowledge as exhibited in school mathematics tasks and the informal mathematics knowledge that they bring to school" (NCTM, as cited in Gutstein, Lipman, Hernandez & De los Reyes, 1997, p. 709).

Other authors support this idea of a disconnection between mathematics in school and the outside world. For example, it has been claimed that "the content of school mathematics is so divorced from students' everyday experiences that it appears irrelevant" (Tate, as cited in Ladson-Billings, 1997, p. 697), since "such [knowledge derived from everyday experience] may not conform to the tenets of what counts as 'genuine' mathematics according to the interpretation of teachers" (Millroy, 1992, p. 2). Hence I decided to do research on how to embed and integrate a familiar and popular indigenous practice (Xhosa traditional dance) into the mathematics curriculum. By doing this, I hope to inspire and help other educators to close the gap that exists between classroom activities and activities outside the classroom, by ensuring that the learning of mathematical concepts in classrooms is not done in isolation but takes into account the daily experiences of learners.

I was particularly inspired by Werner's (2001) study that sought to answer the question, "How does integrating dance and mathematics in an intense co-teaching model of integration affect student attitudes toward learning mathematics?" A motivation inventory post-test methodology was used, and the results showed that dance/mathematics students had a more positive attitude towards and excitement for mathematics than their non-dance/mathematics counterparts. Both groups of teachers involved with the students asserted that dance/mathematics students were more likely to have more successful and positive experiences with mathematics than non-dance/mathematics students. Thus the learning of mathematics in ways that are interesting to learners and applicable to their everyday life could enhance their success in the subject.

Barnes and Venter (2008), in their discussion of the application of the theory of Realistic Mathematics Education (RME) as a potential approach to facilitate teaching in context, defined mathematics as "a product of investigation by different cultures – a purposeful activity in the context of social, political and economic goals and constraints" (p. 5). Learners should thus learn mathematics by "mathematising subject matter from real contexts and their own mathematical activity rather than from the traditional view of presenting mathematics to them as a ready-made system with general applicability" (Barnes & Venter, 2008, p. 7). There is strong agreement on the alternative of teaching through RME, where "context problems are used as both a starting point (a route 'into' the mathematics) and the medium through which pupils develop understanding (a route 'through' the mathematics)" (Hough & Hough, 2007, p. 34). In my research, I use these routes to the extent that the dance context provides a starting point (a didactic tool) to discover mathematics, as well as a medium through which learners will be assisted to understand mathematics by working on activities developed in the context of dance. Another reason given for the importance of teaching mathematics in context is the fact that South African learners struggle far more than the rest of the world when required to perform mathematics within a context, as is evident in the

Trends in International Mathematics and Science Study (TIMMS) (Barnes & Venter, 2008, p. 7).

Millroy (1992), in support of the teaching of mathematics in relation to a familiar context, conducted a six-month ethnographic study as an apprentice carpenter. Her study showed that many conventional mathematical concepts are embedded in the practices of carpenters, such as congruence, symmetry, proportion and straight and parallel lines. She cites the work of various authors who provide evidence that people frequently construct and apply innovative and creative methods of their own to reach satisfactory solutions to real-life problems. In my study I am hoping that by giving learners the opportunity to engage in activities that are part of their real life, they will develop such innovativeness and creativity. A further valuable contribution of Millroy's (1992) work to my own study is that it offers possible ideas on methodological techniques for "identifying mathematics in thought and action" (p. ix). For example, she cites Schon who proposed that "schools should learn from the many traditions of education for practice, such as studios of art and design, conservatories of music and dance, athletics coaching and apprenticeships in the crafts, all of which emphasize coaching and learning by doing" (Schon, as cited in Millroy, 1992, p. 22). Millroy (1992) then suggests that "by observing and by reflecting upon our actions, we can describe the tacit knowledge that is implied by our actions" (Millroy, 1992, p. 23). Such "reflection-in-action" will apply in my study when learners perform the dance activities and then reflect on their physical actions in order to identify possible mathematical concepts.

In another study, Guberman (2004) examined relations between ethnicity, out-of-school activities and arithmetical achievements in Latin American and Korean American children in first, second and third grades. The findings indicated that children's performances on arithmetic tasks mirrored their engagement in out-of-school activities: those who were more often engaged in related activities out-of-school correctly solved more tasks than others. The study provides evidence that engagement in practices outside of school may have a profound impact on the knowledge that the children bring to the classroom. I support Guberman (2004) in his claim that using learners' knowledge from their out-of-school practices may provide a good base for school mathematics.

Much as the learning of mathematics within a real and familiar context is encouraged, there are challenges involved. For example, Ladson-Billings (1997) suggests that "to be successful at moving from students' lives and interests to meaningful mathematics, teachers themselves will have to be very knowledgeable in mathematics" (p.705). For this reason, she cautions against teachers using "surface connections, such as changing the names of story problem characters... problems should be deeply embedded in students' experiences, even if it means doing some things with students that look very 'unmathlike'" (p. 705). Perhaps it is because of such 'unmathlike' activities that some teachers have been worried about the idea that "in order to make teaching interesting and to engage pupils you have to get down to their level", whereas "the point of school is to introduce children to new things and to challenge them" (Paton, 2010, p.1). Without suggesting that I agree with such teachers, my own word of caution would be that, in trying to link school mathematics with learners' real life experiences, care should be taken that mathematics learning is not 'watered down'. For example, in my own study, the 'unmathlike' dance activities should be clearly linked with important mathematical concepts and ideas that form part of the learners' 'formal' mathematics curriculum.

The South African curriculum also supports my purpose for doing the research of teaching mathematics through dance when it is stated that:

> The teaching and learning of Mathematics aims to develop the following in the learner:
>
> ■ A critical awareness of how mathematical relationships are used in social, environmental, cultural and economic relations;
> ■ The necessary confidence and competence to deal with any mathematical situation without being hindered by a fear of Mathematics;
> ■ An appreciation for the beauty and elegance of Mathematics;
> ■ A spirit of curiosity; and
> ■ A love for Mathematics.
>
> (South Africa, DoE, 2002, p. 4)

2.4. INDIGENOUS KNOWLEDGE SYSTEMS AND ETHNOMATHEMATICS

One of the principles of the National Curriculum Statement (NCS) is "valuing indigenous knowledge systems", and teachers are encouraged to "recognise the wide diversity of knowledge systems through which people make sense of and attach meaning to the world in which they live" (South Africa. DoE, 2003, p. 4). Various definitions of indigenous knowledge systems have been suggested. For example, Grenier (1998) states that "indigenous knowledge refers to the unique, traditional, local knowledge existing within and developed around the specific conditions of women and men indigenous to a particular geographical area (p. 1). For the purpose of this study, I draw upon the definition given by Warren (as cited in Mosimege, 2006), namely, "a systematic body of knowledge acquired by local people through the accumulation of experiences, informal experiments and intimate understanding of their environment in a given culture" (p. 66). Inspired by the African Renaissance in particular, an interest in and focus on the world-views and knowledge systems of indigenous cultures in Africa, as a supplement to what some call reductionist science and knowledge systems, have led to an exploration of "the role of the social and natural sciences in supporting the development of indigenous knowledge systems" (Hoppers, as cited in Breidlid, 2009, p. 141). The South African Department of Science and Technology (DST) issued a policy document on Indigenous Knowledge Systems (IKS) in 2004, in an effort to "affirm and develop IKS in South Africa" by providing a "a basis upon which indigenous knowledge can be used to make more appropriate interventions" (DST, as cited in Breidlid, 2009, p. 145). My study can be seen as an attempt at "intervention", even though one of very limited scope.

Mosimege and Nkopodi (2009) give a number of examples of mathematical analyses of various indigenous activities, and illustrate how these can be analysed to reveal a variety of mathematical concepts. For example, the understanding of mathematical concepts such as geometric figures, symmetries and ratio and proportion could be developed from the *morabaraba* game. They make suggestions as to how such activities might be used in the mathematics classroom. I find these suggestions relevant to my study: for example, the "play in action" is video-recorded and the video is then replayed and paused at intervals so that the game can be analysed. Moves taken are discussed and the everyday language used is translated into mathematical language (Mosimege & Nkopodi, 2009, p. 389). This is what I purpose to do in this study, when learners are performing the dance or watching the dance videos.

The processes involved in carrying out the investigations in Mosimege and Nkopodi's (2009) research, as well as the findings of these investigations, in form my own research. For example, Mosimege and Nkopodi suggest that it is important to identify indigenous games according to their potential for use in the curriculum, that is, depending on the subject area concerned and the relevance of the games in terms of the curriculum (Mosimege & Nkopodi, 2009, p. 384). Among the questions that the authors suggest should be asked, I identify two of relevance to my study, namely:

- Can the games be played by both male and female learners?
- Do the games reveal a variety of embedded mathematical concepts (even at a superficial level of analysis)?

(Mosimege & Nkopodi, 2009, p. 384)

For reasons of inclusivity I believe that both males and females should participate in the dance activities, hence my interest in the first question. The second question is the key question that frames my study. Many studies have been conducted in which various indigenous activities have been analysed to reveal mathematical concepts, principles and processes associated with such activities (Gibbs & Sihlabela, 1996; Zaslavsky, 1996; Gerdes, 1997; Gutstein et al., 1997; Dabula, 2000; Mogari, 2002; Myemane, 2007). But none of these studies looked into the use of dance to teach mathematical concepts.

Some teachers may argue that they do not have enough time to engage learners in such indigenous activities. Mosimege and Nkopodi (2009) acknowledge that "the issue of lack of time will need to be addressed alongside the general matters of teaching strategies" (p. 379). However, they caution that one of the challenges they had with their study was that some learners were new to the game. In such cases their lack of knowledge caused the game to take longer than when the rules were known. This lack of knowledge of the game also implied that "the learner who did not know the game was to a large extent dependent on the knowledgeable learner for some of the decisions, which in turn favoured the knowledgeable learner as he/she could exploit this situation to his/her advantage" (Mosimege & Nkopodi. 2009, p. 386). I anticipated encountering similar challenges with my own study, where some learners might not be able to perform the dance. In such cases these learners would have to rely on observing those who could perform the dance. At least they would still be able to learn the mathematics associated with the moves they are observing. Mosimege and Nkopodi (2009) further claim that by using indigenous activities such as games, the problem of inadequate finances to purchase learning materials may partly be solved, because indigenous games can often be constructed simply without spending much money. I maintain that this is also the case with using traditional Xhosa dance, because learners do not need any complicated materials to perform the dance.

My research relates to "ethnomathematics", that is, "the mathematics which is practised among identifiable cultural groups, such as national-tribal societies, labour groups, children of a certain age bracket, professional classes, and so on" (D'Ambrosio, 1985, p. 45). Anthropological studies have found that mathematics has a cultural history (Bishop, 1988; D'Ambrosio, 1985). It is argued that mathematics learning "is not limited to acquisition of the formal algorithmic procedures passed down by mathematicians to individuals via school; it occurs as well during participation in cultural practices as children and adults attempt to accomplish pragmatic goals" (Saxe, as cited in Masingila, 1994, p. 432).

Ethnomathematicians such as D'Ambrosio and his colleagues have engaged in research to "identify within ethnomathematics a structured body of knowledge" by "collecting examples and data on the practices of culturally differentiated groups which are identifiable as mathematical practices and trying to link these practices into a pattern of reasoning, a mode of thought" (D'Ambrosio, 1985, p. 47). My study is not about establishing a body of knowledge so much as it is concerned with seeking to identify mathematical ideas embedded in cultural practices.

Culture informs all human thought and activity and cannot be suspended as human beings interact with particular subject matters or domains of learning (Ladson-Billings, 1997, p. 700). For example, "part of the deep structure of African American culture is an affinity for rhythm and pattern. African American artistic and physical expressions such as music, poetry, games, dance, fashion, all reflect African American influences of rhythm and pattern and these should be connected to mathematical foundations" (Ladson-Billings, 1997, p. 700). According to Ladson-Billings (1994), the notion of culturally relevant teaching implies "a pedagogy that empowers students intellectually, socially ... using cultural referents to impart knowledge, skills and attitudes. These cultural referents are not merely vehicles for bridging or explaining the dominant culture; they are aspects of the curriculum in their own right" (p.18).

Gerdes (as cited in Millroy, 1992, p. 48), addressing concerns that Mozambican culture is in danger of being lost, suggests a number of ways in which cultural elements can be used to investigate mathematical ideas and rediscover the "hidden" or "frozen" mathematics in the traditional work done by artisans. Furthermore, Stigler and Baranes (as cited in Millroy, 1992, p. 33)claim that cultural practices such as the navigational traditions of illiterate Micronesian islanders, were shown to require such tasks as estimating and calculating distances and angular measure, while the fish marketing strategies for women in Ghana made use of the concept of probabilities. A further argument in support of "culturally responsive teaching" is that "it builds bridges of meaningfulness between home and school experiences as well as between academic abstractions and lived sociocultural realities" (Gay, as cited in Mukhopadhyay, Powell & Frankenstein, 2009, p. 65).

Amoah (1996) conducted an ethnomathematics project at the Centre for Research and Development in Mathematics, Science and Technology at the University of the Witwatersrand. Some of the aims of the project were:

- To investigate evidence of mathematical activities in local communities which can be related to the school curriculum
- To investigate the performance of pupils using materials based on ethnomathematics.

(Amoah, 1996, p. 47)

Mathematical activities investigated include the game of string figure patterns, looking at different types of huts that are designed and built by the Xhosa, Zulu and Sotho people, exploring the game of '*ma-dice*' and identifying and researching ethnomathematical activities involving mural paintings and beadwork. The learners involved in the project were able to explore patterns that resulted from quadrilaterals and triangles in the string game. Concepts such as those of measurement (for example, area) and construction as well as geometric shapes emerged from investigations of the different types of hut design. The game of '*ma-dice*' had the potential to be used as a starting point for the teaching of probability. Among the reservations expressed by teachers was the concern that the activities required more time than did their conventional classroom equivalents, and that it could be difficult to introduce ethnomathematics in a multi-cultural classroom (Amoah, 1996, p. 54).

Zaslavsky (1999) argued that Africans have made significant contributions to the development of counting and numbers and therefore should be recognised in studies that deal with the subject. In her book *Africa counts*, she wrote about the construction of the numeration system as experienced and practised in various countries in the African continent. Zaslavsky's (1999) work thus supports the call to embrace "a fundamental ideal of the pedagogical philosophy of culturally relevant teaching ... teachers use the knowledge and experiences that children bring in the classroom as a starting point" (Gutstein, Lipman, Hernandz & de los Reyes, 1997, p. 722) as a foundation for further learning (Ladson-Billings, 1994). Other studies that have sought to integrate students' cultural knowledge with the learning of mathematics include those of Dabula (2000) and Myemane (2007), who conducted research in the Mthatha and Grahamstown areas of the Eastern Cape respectively. The two researchers identified and explored mathematical concepts associated with traditional Xhosa beadwork. Mathematical concepts that were found to be embedded in beadwork included number patterns, geometrical shapes, tessellation, and various types of symmetry.

The challenge for mathematics teachers and teacher education programs lies in translating socio-cultural theories into pedagogical practice (Kaartinen, as cited in Nolan, 2006, p. 2). Ladson-Billings (1995) acknowledges this when she says that "the teachers themselves feel no need to name their practice culturally relevant" (p. 478). However, she goes on to suggest that "culturally relevant teaching must meet three criteria: an ability to develop students academically, willingness to nurture and support cultural competence, and the development of a socio-political or critical consciousness" (Ladson-Billings, 1995, p. 483).

2.5. INTEGRATION ACROSS THE CURRICULUM: MATHEMATICS AND THE ART FORMS

The use of traditional dance in teaching mathematics also supports the NCS principle of "integration across subjects or fields of learning" (South Africa. DoE, 2003, p. 3). Other authors have written in support of integrating mathematics with other subjects or contexts at school. For example, Ollerton (2009), exploring the theme of inclusive education – which is defined as "what a school, a mathematical department, or an individual teacher seeks to do in order to provide the learners with their entitlement to the statutory national curriculum for mathematics" (p. 5) – emphasises that seeking to support students' learning of mathematics requires imaginative and creative approaches "which could include using the playground, dance, fashion and architecture as contexts for learning mathematics" (Ollerton, 2009, p. 5). Suzuki (2009) maintains that there is a solid alliance between mathematics and the arts, for example in the relationship between rhythms in music and mathematical permutations. Johnson (2009) argues that music theory can be used to expose students to interesting examples of abstract notions in higher algebra (p. 116), or, more generally, present them with "a plurality of such examples that help diversify and enrich their understanding of some core mathematical ideas" (Johnson, 2009, p. 122).

The important role of dance in the context of integration across the curriculum becomes evident when we look at the Department of Education's purpose in introducing dance studies as a learning area in the Further Education and Training band:

> Dance studies builds values and attitudes of respect and inclusivity and provides access for learners with physical and social barriers to learning ... promotes diverse South African cultural and artistic practices. Through exploring dance, learners reflect on ways of promoting cultural fairness and learn to respect cultural and other diversities ... Through the inclusion of indigenous dance, learners realise the important contribution that Indigenous Knowledge Systems (IKS) make to the understanding of dance and its practices.
>
> (South Africa. DoE, 2008, p. 7)

By 2005, music, art, drama and dance had become a combined course in the arts and culture curriculum (South Africa. DoE, 2005). The learning outcomes and assessment standards for grades 3 through 7 for music and dance are as follows:

> Learning Outcome 3: The learner will be able to demonstrate personal and interpersonal skills through individual and group participation in Arts and Culture activities.
> A.S. 5.3.1 Dance Assessment Standard: Demonstrate partner skills such as copying, leading following and mirroring movement.
> A.S. 6.3.1 Dance Assessment Standard: Works co-operatively with partners, improvising and composing dance sequences.
> (South Africa. DoE, 2005, p. 26)

The grades 10-12 curriculum goes further to specify that the learner "researches the historical background of dances done by their elders in terms of social or cultural contexts, purpose and unique characteristics" and "finds out about, tries out and explains a song-dance ritual (e.g. snake dance, rain dance, wedding dance, circle dance, reed dance, stick dance), referring to its purpose and structure – patterns, repetition and sequence" (South Africa. DoE). Therefore, by suggesting how learners might learn mathematics through dance, I will be helping them integrate the arts and culture learning area, which is part of their curriculum.

The introduction of the new curriculum in South Africa placed huge demands on teachers to organize their teaching so that it promotes the integration of one learning area with another. However, there have been concerns that teachers are not adequately trained to handle these new curriculum demands, given that they are qualified in specific disciplines (Dhlamini, 1997).

2.6. LEARNING MATHEMATICS THROUGH DANCE

Learning mathematics through dance, as one of the art forms, provides "a vehicle for students to become actively engaged in the construction of their own learning" (Gamwell, 2005, p. 359). Watson (1990) has described some ways in which links between mathematics and dance have been, and can be, exploited educationally. For example, a choreographer did this explicitly by asking dancers to imagine themselves inside a cube and touching various features of it, vertices, midpoints and so on, with various limbs, knees, elbows and other parts of their bodies. In creative dance, for example, which has been found to have an integral place in the curriculum, mathematical fractions might be taught by rhythmic chanting and movement (MacDonald, 1991, p. 436). Watson (1990) gives an account of abstract representations of structure, such as permutations, combinations and graph theory that are manifested in many traditional dances. She gives an example of English country dances that usually include actions of combination and their inverses.

Dance has been defined as "culturally patterned sequences of deliberative and rhythmical bodily gestural movements that possess both intrinsic and aesthetic value" (Seitz, 2002, p.37). Dance has also been defined as patterned and rhythmic bodily movements, usually performed to music, that serve as a form of communication or expression. Maturana and Varela (1988), as proponents of the theory of enactivism claim that we learn emotionally and conceptually by interacting with the spatial environment. Lack (2006), in her arts-based research, investigated how participants responded to non-verbal expression, movement and the body. She "used dance to provoke reaction and discussion" (Lack, 2006, p. 5), in much the way that I will be using dance to encourage mathematical investigations and discussions. This will be facilitated by the ability of the body to perform such actions as rotating, bending, stretching, jumping, and turning. By varying these physical actions and using different dynamics, human beings can devise an infinite number of body movements. However, in my study, certain parts of the body will be used more often than others, since "out of the range of movements that the body is capable of performing, every culture emphasizes certain features in its dance styles" (Youngerman, 2009, p. 1). Lack (2006) has used a technique called "the Thinking Body, the Feeling Mind (TBFM)" (p. 1).This interaction between the body and the mind was earlier articulated by Eisner (1992), who believes that "as children learn to manipulate, manage, and monitor the nuances of voice, movement and visual form, they discover the effects that their own fine-tuning achieves" (p. 85).

Youngerman (2009) suggests that

> The primary elements of dance include (1) the use of space—floor patterns, the shapes of the moving body, and designs in space made by the limbs; (2) the use of time—tempo, the length of a dance, rhythmic variations, and the attitude toward filling time, from taking one's time to making quick stops and starts; (3) the use of the body's weight—overcoming gravity to execute light, graceful movements, surrendering to gravity with heavy or limp movements, or exerting the body's weight against gravity with strength; and (4) the use of energy flow—tense, restrained, or bound movements or freely flowing motion.
>
> (p. 1)

Cancienne (2003) adds eloquent personal testimony: "I could make geometric shapes with my body and physically 'understand' those shapes … continue to incorporate angles, curves, spirals, and circles into my aesthetic designs … my body is the very matter that reaches, pushes, extends, pulls, stretches, contracts, and glides into the infiniteness of space" (p. 246). These are the elements that I analysed when working with the dancers in my study. Using the body to learn about mathematics is especially effective with those learners who have "kinaesthetic intelligence" (Gardner, 1993). Touval and Westreich (2003) describe "kinaesthetic teaching strategy" as a strategy that "offers an unconventional approach that allows students to explore mathematical ideas through movement" (p. 230). Other aspects of mathematics that have been identified as relating to dance are spatial exploration, rhythm, structures and symbolisation (Watson, 1990).

2.7. INTERVENTION PROGRAMME INCORPORATING DANCE: THE THEORY

I designed a learning programme through which learners worked on activities that incorporated traditional Xhosa dance. I see this plan as resonating with D'Ambrosio's (1985) notion of "*finding an underlying structure of inquiry* in these ad hoc practices. In other terms, we have to pose the following questions ... how are ad hoc practices and solution of problems developed into methods?" (p. 46). My approach to designing a learning programme is also similar to that used by Ollerton (2009) in collaboration with one of the schools where he was doing research: they developed a wide range of investigative approaches in lessons and built these approaches into schemes of work. In this way they were able to create opportunities for the students to play an active role in their learning and find things out for themselves (Ollerton, 2009, p. 6). Similar opportunities were created for learners in the learning programme I designed because they had to play an active role in performing different dances.

The learning programme that I developed thus supported a learner-centred approach to learning. Gibbs (as cited in O'Neill & McMahon, 2005) describes learner-centred courses as those that "emphasise: learner activity rather than passivity; students' experience on the course outside the institution and prior to the course; process and competence, rather than content" (p. 28). During the implementation of the learning programme in my study, learners became actively involved in their learning by performing certain dance moves that they knew from their experience outside the school. Rudolf Laban's framework for creative exploration and kinaesthetic movement experience in dance classrooms is regarded as a learner-centred approach because "it tends to encourage movement exploration and creativity, while recognising qualitative elements of movement description and use" (Green, 2001, p. 158).

Laban Movement Analysis "includes an understanding of how body parts interrelate for effective weight shift and level change ... an identification of the direction of movement through space using a sophisticated reference system (within geometric forms), and a view to how the body changes shape" (Eddy, as cited in Green, 2001, p. 158).Similarly, the learning programme that I developed created opportunities for learners to explore, describe and use elements of their own movements in order to learn mathematics. For example, they looked at the angles and directions through which their bodies turned, explored the interrelations between body parts such as arms and legs, named shapes formed by their bodies, and used mathematical terminology to articulate their observations.

The idea of using the body in the manner described above, to learn about mathematical concepts, is aligned to the theory of enactivism. Enactivism considers cognition to be rooted within the kind of experience that comes from having a body (Varela, Thompson & Rosch, 1991, p. 173). My interpretation of this is that, by virtue of having a body, learners have some experience of performing various activities with, and interacting with the environment through, this body, as well as the knowledge that comes from such experiences. Hence Valera et al. (1991) perceive knowledge as dependent on "being in a world that is inseparable from our bodies, our language, and our social history – in short, from our *embodiment*" (p. 149). In my study, such knowledge was deployed to learn mathematics in the classroom situation. In particular, my study relied on the use of the body to perform certain movements that facilitated the learning of mathematical concepts. I thus incorporated Lozano's (2005) idea that cognition is "dependent upon the kinds of experience that come from having a body with various sensor motor capacities" (p. 26).

The notion that learners' experience can be used to enhance their learning or facilitate cognition is the cornerstone of the theory behind experiential learning. Experiential learning is "a process of constructing knowledge that involves a creative tension among the four learning modes ... experiencing, reflecting, thinking, and acting ..." (Kolb & Kolb, 2005, p. 194). Because of their experience, learners are able to reflect, think and act on situations that they come across during the process of learning. For example, in my study, by reflecting on their experience of performing traditional dances, learners could observe and think about the moves that characterise these dances. Thereafter they could take some action to explore (say, by repeating the moves several times) the dance performances in order to discover various mathematical concepts. This exploration should then develop their cognition since "we perceive things in a certain way because of the manner in which we relate to them through our actions" (Lozano, 2005, p. 26). The effectiveness of experiential learning can be improved by "making space for good conversation as part of the educational process", which "provides the opportunity for reflection on and meaning making about experiences" (Kolb & Kolb, 2005, p. 208). The fact that during the implementation of the learning programme learners worked on the activities in small cooperative groups made provision for this facet of experiential learning. For example, learners could through such conversations remind each other of the songs or dance moves that had to be performed from time to time.

In designing the activities in the learning programme I also applied the theory of problem-based learning. Savery and Duffy (2001) mention two guiding forces in developing problems for problem-based learning: "First, the problems must raise the concepts and principles relevant to the content domain: Second, the problems must be 'real'" (p. 11). The activities that I designed for the learning programme were relevant to the mathematical content in the Grade 7 curriculum and also gave learners an opportunity to solve real life problems. For example, learners had to solve 'real' problems involving their reluctance to lead the dance groups for the various dance performances, by determining 'wise positions' in the context of number patterns. In this case the dancers' reluctance to become lead dancers became a "stimulus" or "goal for learning", or the "problematic" that leads to learning (Dewey, as cited in Savery & Duffy, 2001, p. 11). My role throughout the implementation of the learning programme became one of facilitator, with the aim of developing students' thinking or reasoning skills. I did this by "asking questions which probe students' knowledge deeply", constantly asking: "Why?", "What do you mean", "How do you know that's true?" (Savery & Duffy, 2001, p. 13).

2.8. CONCLUSION

In this chapter I have engaged with literature that relates to my study. The process has helped to generate new ideas that are germane to the goals of my study. For example, research on the exploration of mathematical ideas embedded in indigenous games alerted me to some of the issues to consider when planning such interventions. Also, studies that investigated the integration of everyday life activities into the learning of mathematics illustrated how this could be done practically, without overlooking the challenges involved. Studies on dance gave me ideas on what to look for when integrating dance into mathematics. Finally, theories such as those of enactivism and learner-centred education emphasised the importance of having a coherent rationale for any intervention into standard teaching practice.

CHAPTER 3

METHODOLOGY

3.1. INTRODUCTION

In this chapter I first describe the qualitative approach, the research orientation that I adopted in carrying out this research. Then I give details on the use of the case study method to conduct the research and why I chose it, with a brief mention of the limitations associated with this method. The research site and participants are then identified, and justification for their selection is provided. Next I describe in detail the research tools used to collect data, how the tools were used and why they were chosen. Lastly, I reflect on validity, data analysis and ethical considerations.

3.2. RESEARCH ORIENTATION

This research study used a qualitative approach in which "the inquirer or researcher often makes knowledge claims based primarily on the constructivist perspective – multiple meanings of individual experiences, meanings socially and historically constructed ... using strategies like case studies and collecting open-ended, emerging data with the primary intent of developing themes from the data" (Creswell, 2003). In qualitative research, the researcher interacts with the subjects of the study, whether this interaction assumes the form of living with, or observing the informants over a prolonged period of time, or actual collaboration (Creswell, 1994, p. 6). In my study I interacted with selected learners as they performed the dance, learnt from and talked about it over a period of five weeks. During this period I observed them, recommending moves which they had to focus on, asking questions about their performances and experiences, and so on.

3.3. METHOD

A case study method was used to conduct the research. Wilson (2009, p. 204) describes a case study as "a research strategy that investigates a phenomenon within its real-life context

... case study methods involve an in-depth, longitudinal examination of a single instance or event – the case". My case involved a group of Grade 7 learners from a particular school in a rural area. In my case study I investigated the phenomenon of dance, as performed by the learners, and its potential use in the teaching and learning of mathematics. I used a case study approach so that I could provide a unique example of real people in a real situation, enabling readers, especially teachers, to understand the ideas involved more clearly than would be possible through abstract theories or principles (Cohen, Manion & Morrison, 2007, p. 253). My case study should also contribute to addressing the challenge of mathematics teachers and teacher education programs having difficulty with translating socio-cultural theories into pedagogical practice (Kaartinen, as cited in Nolan, 2006, p.2). By viewing the mathematics classroom through socio-cultural lenses, this case study aimed to understand more about theory-practice transitions through a deliberate effort to ground theory in the practice of innovative instruction and the mathematics classroom (Kaartinen, as cited in Nolan, 2006, p. 2).

I had hoped that through the use of the case study I would be able to provide a rich and vivid description and chronological narrative of events that are relevant to the case I was dealing with. Hitchcock and Hughes (1995) regard vivid description and chronological narrative as among the hallmarks of a case study. In my case, for example, the analysis of video images of dances made possible the detailed and graphic description of ways in which dance moves could be related to mathematics. Also, the data collection methods I used in the study, namely, video observation and analysis, learning programme intervention and focus group interviews, enabled me to provide a chronological narrative of events.

The case study approach, with its use of multiple data-collection methods and analysis techniques, provides researchers with opportunities to triangulate data in order to strengthen the research findings (Wilson, 2009, p. 209). This is how Denzin (as cited in Mouton & Prozesky, 2001) defines triangulation:

> Triangulation, or the use of multiple methods, is a plan of action that will raise sociologists [and other social science researchers] above the personal biases that stem from single methodologies. By combining methods and investigators in the same study, observers can partially overcome the deficiencies that flow from one investigator or method.
>
> (p. 275)

In my study I used video recordings, learning programme intervention and focus group interviews as methods of collecting data, thus providing for triangulation. I will dwell more on triangulation later in this chapter, in the section on validity

Further advantages of the case study method are suggested by Cohen et al. (2007). One is that case studies are ‘a step to action’, meaning that “their insights may be directly interpreted and put to use: for staff or individual self-development; for within-institutional feedback; for formative evaluation; and in educational policy-making” (Cohen et al., 2007, p. 256). As I stated in Chapter 1, I hope that my study will inspire and help other teachers in integrating socio-cultural activities into their teaching, thus putting the results of the case study into action.

Despite the advantages provided by case study research, it has been criticized for its various limitations. For example, there have been claims that it is limited in terms of validity (Cohen et al., 2007; Wilson, 2009). Validity refers to “the degree to which the interpretations have mutual meanings between the participants and the researcher”, that is, “do researchers actually observe what they think they see?” (McMillan & Schumacher, 2006, p. 324). However, remedies have been proposed to counteract this limitation. Lincoln and Guba (as cited in Cohen et al., 2007), for instance, suggest “member checking”, in terms of which the researcher attempts “to assess intentionality, to correct factual errors, to offer respondents the opportunity to add further information or to put information on record ...” (Cohen et al., 2007, p. 136). I will return to the issue of validity in a later section of this chapter.

A further criticism of case study research relates to its limitation in terms of generalisability. Cohen et al. (2007) describe generalisability as follows:

> The view that theory generated may be useful in understanding other similar situations ... generalising within specific groups or communities, situations or circumstances validly and, beyond, to specific outsider communities, situations or circumstances (external validity).
>
> (p. 135)

The results of a case study are not generalisable beyond the immediate case (Mouton & Prozesky, 2001) “except where other readers/researchers see their application” (Cohen et al., 2007, p. 256). Giddens (as cited in Wilson, 2009) insists that case study methodology is ‘microscopic’ in terms of its scope (p. 205). To counteract this limitation, Wilson (2009) argues that “provided the researcher refrains from over-generalisation, case study research is not methodologically invalid simply because selected cases cannot be presumed to be representative of entire populations" (p. 205). Thus the results of my case study are valid for the school and learners with which I conducted the research, and for whichever readers (teachers) can use or apply the results in their own classes.

3.4. RESEARCH SITE AND PARTICIPANTS

3.4.1. Site selection

My research sought to explore traditional Xhosa dance and its use in the teaching of mathematics in a Grade 7 class. Therefore I chose to do the research with learners from a school that is situated in the rural area of Centane district, where traditional Xhosa dances form part of the community's daily life. The site thus allowed me to investigate dance as a phenomenon within its real-life context (Wilson, 2009). The particular school I selected also provided me with an added benefit since I was familiar with the staff and some of the learners in the school as I had taught there in the past. Familiarity with the site was helpful in that I had an understanding of the culture of the school, thus reducing my status as a stranger (Adendorff, 2010). I used this familiarity to my advantage as my acquaintance with the staff members, learners and the parent community made it easy for me to obtain access to the school, as well as to get informed consent to do the research because they trusted me.

Wilson (2009) highlighted the importance of the researcher developing trust with the individuals involved in educational research. The trust of the members of the school and its community in me, made it easy for me to work comfortably with my research study. For example, they allowed me to work freely and flexibly with time schedules. I was allowed to have additional time for activities or change time schedules when it was convenient for me, as long as it did not disturb the running of the school. They even phoned me when there was a unexpected opportunity of a more convenient time slot – for example, earlier in the day, instead of the afternoon - when the Grade 7 teachers had to attend a workshop. The arts and culture teacher even offered to divert from the lessons she was currently busy with in order to do some traditional dance songs with the Grade 7 learners during the arts and culture periods. She told me that they usually have to practise before engaging in traditional dance so that they know exactly what songs they are going to sing. This helped in preparing them for my sessions.

3.4.2. Sampling

I used purposeful sampling in choosing the participants in my research study. Purposeful sampling involves “selecting information-rich cases for study in-depth” (Patton, as cited in McMillan & Schumacher, 2006, p. 319). The participants involved in my research study consisted of one class of 25 Grade 7 learners - boys and girls - aged between 12 and 15 years. These learners were “information-rich key informants” (McMillan & Schumacher, 2006, p. 319) that were likely to “have in-depth knowledge about particular issues, maybe by virtue of their ... expertise or experience” (Cohen et al., 2007, p. 115). For example, children of this age group usually perform the traditional dances in the small rural village of Centane district. Therefore it was likely that they were familiar with such dances, whether from performing them or from watching the dances being performed.

In deciding on the number of participants to involve in the study, I was firstly influenced by the purpose of the study, which was about investigating the use of dance in learning mathematics in a Grade 7 class. Therefore I worked with all the learners in the Grade 7 class, so that no learners would feel they had been excluded from the learning experience. This was especially important for two reasons: the research study dealt with important concepts in their mathematics curriculum; dance studies have a potential to build values and attitudes of respect and inclusivity, and provide access for learners with physical and social barriers to learning (South Africa, DoE, 2008, p. 7). Secondly, by working with all the learners in the Grade 7 class I made sure that the number of both boys and girls involved in the dance performances was sufficient for them to comfortably form the separate dance groups according to gender (Harper, 2011). Thirdly, there was only one Grade 7 class at the school and the number of learners in that class fell within the suggested guidelines of 1 to 40 participants for purposeful sample size (McMillan & Schumacher, 2006, p. 321).

3.5. RESEARCH TOOLS/ TECHNIQUES

I need to mention the fact that the research tools in my study were used in a sequential manner, that is, the effective use of a particular tool depended on the use of a tool or tools preceding it. For example, it would have been impossible to design a learning programme without first capturing video images of dance performance and observing them. Hence I would like to discuss the use of the research tools in stages as follows:

3.5.1. Phase one: Video recording

In order to achieve the first goal of my study, namely, to explore mathematical ideas and concepts that are embedded in traditional Xhosa dance, I used video recordings to capture learners' dance performances. I also used video recordings during the intervention programme that followed. Video recording makes it possible to "capture rich behaviour and complex interactions and it allows investigators to re-examine data again and again" (Clement, 2000, p. 577). Since I was particularly interested in the movements of the dancers during their dance performances as well as their behaviour when they engage in the dance activities, it was convenient for me to use videos. Student behaviour and attitudes can be captured with greater accuracy when using video recording than by making observation notes (Koshy, 2005, p. 103) and not only can video recording document behaviour in minute detail, it also has the potential to capture unexpected behaviour that might have otherwise gone unnoticed. Using video recordings allows the researcher to observe an activity afterwards by watching the video, without the disruption of the classroom or time constraints (Koshy, 2005, p. 103). The images I captured allowed me to observe the different moves made by learners during the dance performances, in order to identify mathematical concepts that I could use in designing a learning programme. A copy of the video recording is attached to the thesis.

I had initially planned to visit the school during one afternoon and do the video recording of the dance performances. However, I ended up visiting the school three times before I could finish capturing the videos. On the first day the boy forgot to bring the guitar he needed. He promised to bring it the following day because it would take too much time for him to go and fetch it. Since the guitar was one of the key musical instruments to be used during the boys' dance performances, we could not continue with video recording without its presence. I wanted to go ahead and do video recording of the girls' dances. However, they mentioned that they did not bring any calamine lotion to smear on their bodies - as it was customary to smear the white calamine lotion, especially on their faces to do some decorations (refer to the image in – because they "thought that I would bring it with me". This meant that I could not do any video- recording on that day.

On the second day of my visit to the school the guitar was available and I brought some calamine lotion for the girls. However, both of the boys' dance groups did not bring the appropriate attire. I decided to continue with the girls' dance group and one of the boys groups, who had to do the dance in their school uniform. The second boys' dance group forgot to bring gumboots, which were essential for their dance. Therefore I had to arrange a third day for the video recording of the gumboots dance group.

At first I recorded the dances spontaneously as they were performed. Hence there were cases where learners made mistakes in the directions in which they moved. Later on I asked them to repeat certain moves so that I could capture particular aspects of the movements that seemed less consistent due to errors by one or more dancers. I will dwell more on these inconsistencies and their effects in the findings and discussion chapter. Also, from time to time I would ask them to continue a little longer with certain songs (and dance) which seemed too short for me to be able to capture all the movements involved.

Although video recording is a valuable methodological technique for gathering data, it is not without limitations. "Video cameras cannot capture everything. In aiming a video camera, researchers implicitly or explicitly edit and make sampling choices by focusing or not on particular events" (Martin, as cited in Powell, Francisco & Maher, 2003, p. 408). For example, in my own video recording I sometimes tried to focus the camera on the boy who played the guitar and the one who played the horn. I felt that their role could be easily underestimated compared to that of the whole boys' group and might thus seem insignificant. This could result in an unintended bias in my data analysis.

3.5.2. Phase two: Observation of video images

Videos enable researchers to watch the same sample of events over and over, each time looking at a different dimension of the recorded verbal and physical behaviour (Powell et al., 2003, p. 409). At first I watched the videos alone to identify relevant mathematical concepts for a Grade 7 class. Sometimes I repeated some of the tapes so as to get a clear idea of how a particular aspect of the dance performances could fit in the learning programme. Later on I watched the videos - on a television which I brought to the class - together with the learners when I began with the implementation of the learning programme. The video images made it possible for us to "examine many facets of the data, including topics ranging from gestures to behavioural or speech patterns" (Stigler, as cited in Powell et al,, 2003, p. 409). For example, we carefully observed and listened to the clapping of hands to see if they formed a rhythmic pattern. We looked at the movement of arms and legs for descriptions of specific shapes in space, on the floor, and so on. Gillham (2000) argues that "the overpowering validity of observation is that it is the most direct way of obtaining data ... it is not what people have written on the topic; it is what they can actually do" (p. 46).

To address issues of validity, it was necessary, after careful observation, to ask learners to repeat some performances in order to get clarity on some moves. This involved asking them to explain how particular movements of some dances were supposed to be made when they made mistakes. It was evident at this stage of data collection that one of the disadvantages of using video recording is that one has to constantly fast-forward or rewind to watch, code, and analyze the video content, which was simply too time-consuming.

3.5.3. Phase three: Designing and implementing a mathematics learning programme

After the video recording and observation of the dance activities I designed a mathematics learning programme for the Grade 7 class (refer to Appendix C). The intervention programme consisted of mathematical problems and activities based on the observation of the videos. These were closely linked to the dance they had performed or to their behaviour during the dance performances. Furthermore, the topics involved in the mathematical activities were linked, as far as possible, to the Grade 7 mathematics curriculum, so that learners worked at a

level that is appropriate for their curriculum requirements. I thus aligned myself to the Mosimege and Nkopodi's (2009) idea of identifying indigenous games "according to the potential of their use in the curriculum, that is, depending on the subject area of focus and the relevance of such games in terms of the curriculum" (Mosimege & Nkopodi, 2009, p. 384).
I spent a period of about two hours in the afternoon once a week for three weeks with the learners at their school, implementing the programme.

3.5.4. Stage four: Conducting focus group interviews

Focus groups seek to expose what Schutz and Luckman (as cited in Osborne & Collins, 2001) have termed the 'intersubjectivity'—the collective description of everyday reality and its interpretation (p. 444). The main advantage of focus groups in comparison with participant observation is the opportunity to observe a large amount of interaction on a topic in a limited period of time based on the researcher's ability to assemble and direct focus groups (Mouton & Prozesky, 2001, p. 292). I conducted three focus group interviews after completing the implementation of the learning programme. My experience of working with the learners during the first three phases of the research gave me some idea of their individual capabilities, especially in terms of their ability or willingness to express their views. Therefore I chose the focus group members intentionally (Osborne & Collins, 2001) so that I could get a balanced representation of the 'talkative' and the 'not-so-talkative' learners in each group. The idea was to include 'talkative' members who could influence others to respond to questions under discussion without influencing the "group dynamic" in a negative way (Osborne & Collins, 2001, p. 144). Also, I did not want to resort to putting too much pressure on learners to respond, in case they decided to say something just to please me. I therefore relied heavily on the idea that a focus group interview is characterised by the group context that "offers a degree of support and security and the option not to respond, which is not available in one-to-one interviews" (Powell et al., 2003, p. 421).

The aim of the focus group interviews was to explore the learners' ideas on or thinking about their experience of learning mathematics through dance. For example, I was interested to know whether they thought the dance helped them understand mathematics better or not. I encouraged them to reveal both their discontent and satisfaction with the whole experience of learning mathematics through dance and working on the intervention programme. Critics of the focus group method of collecting data have argued that "there is a tendency for the discussion to degenerate into a negative critique", with learners expressing "long - harboured dissatisfactions" (Powney & Watts, as cited in Osborne & Collins, 2001, p. 145). To address this challenge, I tried to develop the focus group interview questions in such a way that I specifically asked them to also share their positive experiences (refer to Appendix D).

Finally I identified emergent themes that came out of the group focus interviews. These will be discussed in the next chapter.

3.6. DATA ANALYSIS

McMillan and Schumacher (2006) describe qualitative analysis as "a systematic process of selecting, categorising, comparing, synthesising and interpreting to provide explanations of the single phenomenon of interest" (p. 462). In my study, data was analysed according to the research goals. For example, video images were selected and categorised according to their potential of providing mathematical concepts that could be relevant to the Grade 7 class. During and after the intervention programme, learners' oral as well as written responses to the activities in the learning programme and their behaviour during the implementation of the programme, were analysed to determine whether the programme provided learners with an opportunity to learn mathematics in a practical context that is meaningful to them.

The comments of learners, especially those who were more articulate during the focus group interviews I conducted, threw light on some "alternative interpretations" (Wilson, 2009) of some of the learners' actions. *Learners' own voices in the findings section of the next chapter are represented in a different font, namely, the one used in this sentence.* Common topics that came out of these comments formed the themes around which data from the focus group interviews were analysed. Morgan and Krueger (as cited in Osborne & Collins, 2001) concur with this approach to data analysis when they say:

> The best evidence that a topic is of significance comes from a combination of three factors: how many people mention a topic; how many groups mentioned a topic; and the energy and enthusiasm the topic generated amongst the participants (p. 446).

3.7. VALIDITY

As I have mentioned in the discussion on case study research method earlier on in this chapter, triangulation provided me with the possibility of overcoming some of the deficiencies that could flow from one of the data collection methods I used. For example, it may be difficult to know or interpret the feelings of a student who is not participating actively in the actual dance performances, by merely observing their behaviour in the video images. However, by asking appropriate questions in the focus group interviews, I could get a better idea of why he or she was not participating, or how the non-participator felt during the activities. Thus "member checking" (Lincoln & Guba, as cited in Cohen et al., 2007) was facilitated in my study through the inclusion of focus group interviews as a research tool, where learners were asked to explain their actions during, and experiences with the dance activities. Their responses were then "phrased in the participant's language and verbatim accounts, not in abstract social science terms" (McMillan & Schumacher, 2006, p. 325). Moreover, the use of multimethod strategies, namely, video recordings, learning programme intervention and focus group interviews, permitted "triangulation of data across inquiry techniques" (McMillan & Schumacher, 2006) and through this triangulation it is hoped that the credibility of the findings was increased.

3.8. ETHICAL CONSIDERATIONS

Access to the school and learners was negotiated with the school and the parents of the learners concerned. I visited the school well in advance to ask for permission to do research at the school. I had prepared a letter asking for access to the school as well a letter of consent for the parents. Letters of consent, written in Xhosa and some in English, were sent to parents, with the help of the school, informing them about the research and also asking for permission to allow their children to participate in the research. Both letters clearly explained the purpose of the research and how it would be used. I did this to align myself with the view that "whatever level of informed consent is required, it should be in a formal and written form, specifying who has access to the data and the use of the data" (Powell, Francisco & Maher, 2003, p. 410). The letters of consent to the parents assured them that anonymity and confidentiality would be assumed as far as possible and that they had the right not to agree to their children participating in the research. I also informed the learners about the aim of the research and how the results of the research will be used. I informed them about their right to withdraw from the research whenever they wanted to.

3.9. CONCLUSION

In this chapter I discussed the methodological approached followed in the study. The case study method used was discussed, citing its strengths and weaknesses. There was also a section on the description of the research site and the research participants, including and sampling procedure. Data collection instruments were discussed in the context of the purposes they served.

CHAPTER 4

FINDINGS AND DISCUSSION

4.1. INTRODUCTION

In this chapter I present the findings from the different stages of data collection, namely, video recording, observation of video images, learning programme intervention and finally the focus group interviews. I found it difficult to isolate data from the first three stages as the process was interlinked, for example, while I video recorded, I made certain observations of the people I was video recording. Also, while observing the videos (in the second stage) I thought about implications for the learning programme I aimed to develop.

After presenting the findings, I discuss them.

4.2. PHASE ONE: VIDEO RECORDING AND VIDEO IMAGES

Since traditional dance is a cultural activity that is enjoyed by many people in the village or school community, there were many spectators during the recording of the dance performances. Some were learners from the other classes that were not involved in the research who decided to stay behind and watch the singing and dancing. Other spectators included mothers who were at the school as members of the school's feeding scheme. The presence of these spectators added to the levels of noise and excitement. There were other disturbances such as singing along, cheering and ululation by the mothers. This ululation and cheering became louder when the younger boys took the stage. The spectators could not help but encourage the learners, much to the detriment of the audibility of the songs as well as the concentration of the boys. This seemed to affect the level of performance of some learners who were rather shy to perform in front of a large crowd.

The girls' group entered the classroom, which acted as the stage for the dance, by singing and dancing a particular song and dance. The dance song for entering the classroom stage was *Umfazi kaMagumede.*

Fig. 4.1. A picture showing how the dancers entered the stage in the classroom

There were four different groups of dance performances: first there was the older boys' dance group, followed by the younger boys' dance group, then the girls dance group; the older boys dance group again (they had to repeat their performance because they "were not as serious as they should be", according to one of the teacher-spectators, whose comment I decided to include here although she was not a participant in my research); and then finally the boys' gumboots dance group. These divisions according to gender and age support the idea that many dances are performed by only males or females.

The types of songs that accompanied the dances portrayed typical cultural rural life in terms of the meanings of the songs. For example, the girls' dance song, *Uphondo lwam* (*lwahlala emthini)*, meaning "my horn was put on the tree" is associated with traditional ceremonies where a bull is slaughtered and then its horn attached to a tree in the household yard as a sign of remembrance of, or respect to the ancestors. Also, the boys' dance song, *Amaxhegw'alapha* (*alele*), meaning "Old men from this place are sleeping" suggests that the old man are no longer effective in keeping things in order in the neighbourhood. However the meaning of the girls' dance song *Suk'etheni uzogilwa ziimoto* is "stay away from the tar road because the cars will hit you". It is an example of one of the relatively new songs that emerged due to societal changes and the evolution of culture, yet forming part of the current Xhosa practices in the Centane area, as I noted in Chapter 2.

Almost all the dance performances consisted of straight line formations. In the girls' dance performances, there was always a straight line formation consisting of nine members in total:

seven ‘back-up’ singers and two solo dancers who emerged from the straight line formation to perform special dance moves in front of the whole group.

Fig. 4.2. A Straight line formation (picture on the left) from which two ‘lead dancers’ emerge (picture on the right)

There was one exception where one girl came forward to kneel in front of the group and did some gestures that represented somebody in pain (because of the headache, as implied by the song *Intloko*).

Fig. 4.3.One dancer kneeling in front of the group during the dance song “Intloko”

In the boys’ dance groups there were no solo dancers, only a straight line formation of six members for each of the younger and the older boys’ group. From time to time there were movements of the whole group to the left and to the right, backwards and forwards and up and down. The boys’ groups (except for the gumboots dance group) were accompanied by a guitarist (who was also the lead singer), a boy who blew a horn and one who beat on an old bucket, substituting a drum, which they “could not bring to school” because they “did not *get it from the village*". The guitarist sat on a chair behind the straight line formation, together with some members of the class who were not participating at the time. The horn blower and the drum beater alternated between kneeling down on the floor and squatting, also behind the straight line formation. This setup is illustrated in the pictures below.

Fig. 4.4. Pictures showing the positions of the guitarist, horn blower (learner behind second dancer in the picture on the left) and the drum beater (learner bending over the bucket in the picture on the right) behind the dancers

The boys' gumboots dance also formed a straight line formation, except in one instance when they changed from the straight line formation to an almost 'square' formation.

Fig. 4.5. Picture of the gumboots dance forming the straight line formation

The dance movements of the learners confirmed what Harper (2011) observed, that men dance "with an attack of rapid, forceful movements to express masculinity, whereas the women dance with a sustained grace to reflect their femininity" (p. 5). A comparison of the girls' dance song *Selina* (dvd code 17:32 - 18:43) and the boys' dance song *Akabhali* (dvd code 21:28 – 23:56) highlights this distinction17:32 - 18:43. In all the girls' dance performances the 'back-up' singers clapped their hands in rhythmic patterns, with slow tempos in some songs and fast tempos in others (for example, compare the dance songs *Uphondo lwam*, dvd code12:80 -13:58)and *Jolinkomo* ndinengxaki, dvd code 14:03 – 15:10). The movements of the two solo dancers consisted of a light stamping of feet (in the dance song *Jolinkomo ndiyabulaleka*, dvd code10:33 -12:08), lifting of arms and/or legs (in the dance songs *Uphondo lwam*, dvd code 12:80 -13:58; *Khongo liyatsamaya*, dvdcode 09:12 – 10:15; *Abafana bakithi*,dvd code 10:16 – 10:32; *Jolinkomo ndinengxaki*, dvdcode14:03 – 15:10; *Iintombi zaseGcuwa*, dvd code 16:00 – 16:57 and *Sukethen'uzogilwa ziimoto*, dvd code 20:00 - 21:04), taking "sustained graceful" movements (Harper, 2011, p. 5) in different directions (for example, in the dance songs *Selina*, dvd code 17:32 - 18:43)as well as kneeling down on the floor (*Intloko*, dvdcode16:58 – 17:30).

The following table represents the dance songs in the order in which they appear in the dvd. Included in the table are the codes that locate the exact position of each dance song in the dvd, the English meaning of each song and an indication of the group that performed the dance for each song.

Dance song	**Coding**	**Traditional name**	**English meaning**	**Details of performers**
1	01:45 – 03:42	*Emakhaya*	At our homes	Senior boys
2	03:43 – 05:03	*Amaxhegw'alapha*	Elders of this place	Senior boys
3	05:03 – 06:29	*Ndiyinkwenkw'endala*	I'm a fully grown up boy	Senior boys
4	06:30 – 08:40	*Ndiyinkwenkw'endala*	I'm a fully grown up boy	Junior boys
5	08:44 – 09:05	*Umfazi kaMagumede*	Magumede's wife	Girls
6	09:12 – 10:15	*Khongo liyatsamaya*	Khongo is leaving	Girls
7	10:16 – 10:32	*Abafana bakithi*	Our young men	Girls
8	10:33 -12:08	*Jolinkomo ndiyabulaleka*	Jolinkomo, I'm experiencing hardships	Girls
9	12:80 -13:58	*Uphondo lwam*	My horn	Girls

10	14:03 – 15:10	*Jolinkomo ndinengxaki*	Jolinkomo, I'm troubled	Girls
11	15:10 – 16:00	*Momncinci*	My aunt	Girls
12	16:00 – 16:57	*Iintombi zaseGcuwa*	Butterworth maidens	Girls
13	16:58 – 17:30	*Intloko*	Headache	Girls
14	17:32 - 18:43	*Selina*	*Selina*	Girls
15	18:45 – 19:58	*Izinja*	Dogs	Girls
16	20:00 - 21:04	*Sukethen' uzogilw aziimoto*	Stay away from the tar road because the cars will hit you	Girls
17	21:28 – 23:56	*Akabhali*	He does not write us letters	Senior boys
18	24:00 – 26:08	*Uzowaxox'amatyala*	You will account for your wrong doing	Senior boys
19	26:11 – 27:32	*Abafana*	Young men	Senior boys
20	27:33 – 29:24	*Amagwinya*	Fat cakes	Senior boys

Table 4.1: List of dance songs as they appear in the dvd.

Youngerman's (2009) primary elements of dance were evident in the dance performances in the sense that

1. Significant **space** was used when, for example, shapes were formed by the movement of feet or position of the dancers on the floor and angles formed in space by the limbs.
2. The dance involved an element of **time** in that there were different tempos for different clapping of hands or stamping of feet. Also, the length of the dance or song as well as the rhythmic variations differed from song to song.
3. The use of **body weight** was definitely conspicuous, with some dance performances involving heavy movements, such as in most boys' dances, while others involved light, graceful movements, such as in most girls' dances.

4.3. PHASE TWO: OBSERVATION AND ANALYSIS OF VIDEOS TO IDENTIFY MATHEMATICAL CONCEPTS EMBEDDED IN THE DANCES

4.3.1. Overview of the dances

I observed the videos to identify the mathematics that was embedded in the different dance performances. There were many different dance songs, especially by the girls group, that provided an opportunity for learning about mathematics. Most moves in both the girls' and the boys' dances were similar for the various dance songs and therefore related to the same mathematical concepts. For that reason I did not use all the dance songs for the intervention programme.

Inconsistencies in dancers' moves sometimes made it difficult to define movements. For example, in the dance song *Suk'etheni uzogilwa ziimoto*, it was not entirely clear whether the 'lead dancers' took the four steps once or twice in each of the directions they faced. At first it seemed they did the steps twice, with one of the girls even indicating to the other when they should change directions. However, as the song continued, one or sometimes both of the dancers took the steps only once in each direction. The same could be said about the *Selina* dance song. While the steps in this song were not very easy to follow, they were made more complex by the fact that the dancers were not consistent. In such cases I had to ask learners who were more knowledgeable about the original, correct movements to explain these to me and to the rest of the class when I engaged them in the intervention programme. Inconsistencies with the gumboots dance seemed deep-rooted in the sense that some of the dancers themselves were not entirely sure how certain moves are actually made. For example, some boys slapped once on the boots while others clapped hands together, without touching the boots (refer to the dvd code 26:11 – 27:32). During the intervention programme, when I asked them to explain the correct moves, they could not reach agreement. I did not bother about that since I had decided that we would concentrate on the sound we heard, whether it came from "hands hitting boots" or from 'hand hitting another hand".

4.3.2. Mathematical concepts in the girls' dances

All the girls' songs consisted of clapping of hands, some with a faster beat and others with a slower beat. This clapping of hands and the rhythm produced confirm Ladson-Billings' (1997) assertion that "part of the deep structure of African American culture is an affinity for rhythm and pattern" (p. 700). The dance songs provided for rich opportunities to learn about mathematics. Below I detail these concepts as they apply to different dance songs.

4.3.2.1. *Umfazi ka Magumede* (dvd code 08:44 – 09:05)

The girls sang this song as they entered the stage in the classroom. They twisted their feet and waist from side to side as they moved to take their position on the stage. Once they reached the stage and made their straight line formation, they stopped singing. Therefore there were no dance moves to consider for mathematical concepts, as it is the case with the other dance songs.

4.3.2.2. *Khongo liyatsamaya* (dvd code 09:12 – 10:15)

The following mathematical concepts were embedded in this dance:

- Symmetry and transformation

The dance for this song consisted of four different sets of moves. For the first, second and third sets of moves, the two lead dancers faced each other and made the same movements at the same time. First they moved their arms and legs forwards and backwards, then they alternately tapped their right and left feet lightly on the floor, and finally they jumped up and down, kicking their right feet forward after each jump. Because they were facing different directions their images would be similar only if one of them rotated through an angle of 180º. Hence the concepts of rotational symmetry and rotation as a form of transformation were relevant for this set of moves.

For the fourth set of moves the two dancers turned towards the same direction, first facing the front and then facing the back. They both moved their upper body backwards at the same time, keeping their feet stationary and kept turning to change the direction from front to back.

Because this set of moves involved dancers doing identical movements while facing the same direction, the image of one dancer could be referred to as the translation of the image of the other dancer.

4.3.2.3. *Abafana bakithi* (dvd code 10:16 – 10:32)

In this dance song the lead dancers faced the same direction and make identical movements simultaneously. First they moved their right feet twice from left to right over their left feet. Then they moved arms and legs up and down four times, clapped once and then touched the floor with their right hands. After completing this cycle of different moves they changed direction by turning through an angle of 90º and repeated the moves. They continued doing this until they had moved through an angle of 360º.

Therefore the mathematical concepts that are embedded in this dance song are:

- Patterns, formed when the dancers change moves after a particular number of counts.
- Angles, through which the dancers turn after making a complete set of different moves.
- Transformation – translation.

4.3.2.4. *Jolinkomo ndiyabulaleka* (dvd code 10:33 -12:08)

The lead dancers in this dance song tapped their feet lightly on the floor according to a particular rhythmic pattern. While tapping on the floor with their feet, the dancers moved towards each other in a horizontal plane and ultimately interchanged positions.

4.3.2.5. *Uphondo lwam* (dvd code 12:80 -13:58)

The lead dancers in this dance song faced each other, one dancer starting to dance from the extreme left and the other starting from the extreme right. They lifted their right feet and right arms; took big steps forward and smaller steps backwards until they met each other almost halfway through. Then they passed each other and ultimately interchanged positions. Once they reached the other side, they made a new set of moves which involved lifting arms and legs up and down without changing their position. After a specific number of times lifting hands and arms up, they crouched for a while.

The following mathematical concepts are embedded in this dance:

- Number patterns, formed by counting the number of forward steps and backwards steps as well as the number of times arms are lifted before crouching.
- Transformation - rotation, formed by the images of the dancers when facing each other and doing the same movements (see figure below).

Fig. 4.6. Picture showing rotation

- Position on coordinate system – horizontal movement or change in position as they move forward towards each other.

4.3.2.6. Jolinkomo ndinengxaki (dvd code 14:03 – 15:10)

This dance song consisted of three different sets of moves. The first two sets of moves are executed while the lead dancers face each other. First they simultaneously tap their right feet lightly on the floor. Then they kick the right legs forward and the left legs backwards. They do the last move by facing the same direction and sliding backwards and then change direction after three 'slides'

The following mathematical concepts are involved:

- Transformation – translation and rotation

- Number patterns

4.3.2.7. *Momncinci* (dvd code 15:10 – 16:00)

In this dance song the two lead dancers stood on extreme ends of the stage, one on the left and the other on the right. They stamped their feet simultaneously according to the rhythm of the song and took turns pointing at each other.

The following mathematical concepts are involved:

- Angles – right angles formed by pointing arms at each other.
- Patterns – formed by the stamping of the feet.

4.3.2.8. *Iintombi zaseGcuwa* (dvd code16:00 – 16:57)

The lead dancers lifted their arms and kicked their legs up alternately and then crouched after the third kick.

The following mathematical concepts were involved:

- Transformation – rotation of one image so as to resemble the other.
- Patterns formed by the movement of the legs and arms.

4.3.2.9. *Intloko* (dvd code 16:58 – 17:30)

This dance song, as I mentioned earlier, was an exception to the usual observation where two lead dancers emerged from the straight line formation. Here only one person came forward and she knelt in front of the group and uttered some words which were difficult to make out. She made gestures with her hands, which covered her face as if in pain, and her shoulders were shaking as if she was under a spell. I could not find any mathematics that was associated with this song or dance.

4.3.2.10. *Selina* (dvd code 17:32 - 18:43)

This dance involved the lead dancers taking steps sideways, forwards and backwards. While doing this they moved towards each other until they passed each other and interchanged positions.

Mathematical concepts involved are:

- Number patterns
- Parallel lines
- Polygons – triangles, rhombi and parallelogram
- Congruency
- Transformation – reflection, rotation
- Position on coordinate system – horizontal and vertical change

4.3.2.11. *Izinja* (18:45 – 19:58)

In this dance song the lead dancers used the posture in which the dancer inclines forward from the hips. But in this case, instead of moving the attention and gesture towards the ground, the dancers gestured towards each other.

This dance song was different from the others in two ways. Firstly, the back-up singers moved from left to right, compared to standing in one position as they had done in the other songs. Secondly, the lead dancers stood closer to and facing each other, moving only their upper body rhythmically, inclining it towards each other while their feet were stationary.

I did not find much mathematics in this song except for the rhythmic movement of the back-up singers which could form some number pattern.

4.3.2.12. *Suk'etheni uzogilwa ziimoto* (20:00 - 21:04)

In this dance song the lead dancers faced the same direction and took forward steps. They kept changing the direction they were facing after a specific number of steps.

The following mathematical concepts are involved:

- Patterns
- Transformation – translation

Fig. 4.7. Picture showing translation

4.3.3. Mathematics in the senior and junior boys' dances

The movements in the senior and junior boys' dance songs were so similar that it would be pointless to analyse them individually. Therefore I will combine all five dance songs, namely, *Emakhaya, Amaxhegw'alapha*, *Ndiyinkwenkw'endala*, *Akabhali* and *Uzowaxox'amatyala* performed by the boys, both the seniors and the juniors.

The dances accompanying these songs consisted mainly of vigorous movements of legs forwards, backwards, to the right, to the left, up and down. It was interesting to notice that the number three (3) was often used. For example, movements to the different directions were mostly changed after three counts or steps, although there were also changes after two steps; hands were clapped after three distinct moves, and so on (refer to the code 21:28 – 23:56).

The following mathematical concepts were identified from the boys' dance songs:

- Transformations

There was mainly the translation of the body when the boys changed position (right, left, forwards and backwards)

Fig. 4.8. Picture showing translation

- Angles

Angles were formed by the movements of the boys when they changed the directions they were facing. For example, they turned left or right through an angle of 90º. Also, in the boys' gumboots dance, the boys turned through an angle of 90º after completing a cycle of different dance moves.

- Number Patterns

Various patterns of numbers were formed in the boys' dance performances through their forward kicks, sideways and backwards movements, up and down movements and the clapping of their hands.

- Shapes

At some stage the boys drew a shape that looked like a rhombus with the movement of their feet on the floor (refer to the dance song *Amaxhegw'alapha*, code 03:43 – 05:03).

4.3.4. Mathematics in boys' gumboots dance

The following mathematical concepts applied in the boys' gumboots dance.

- Patterns

The clapping of hands and the stamping of feet by the boys formed number patterns (refer to Activity 1.3 in the learning programme in Appendix C).

- Angles

When the boys turned to face different directions they moved through an angle of 360º (refer to the dvd code 26:11 – 27:32)

Fig. 4.9. Pictures showing gumboots dancers turning through an angle of 360º

- Shapes

A rectangle or square in the boys' gumboots dance were formed.

Fig. 4.10. A picture showing the formation of a square in the boys' gumboots dance

4.4. PHASE THREE: IMPLEMENTATION OF MATHEMATICS LEARNING PROGRAMME

For the implementation of the learning programme, learners were asked to repeat some of the moves in the dances in order to emphasise or highlight a particular mathematical concept. I brought a television set to class so that they could watch the dance performances that were applicable for the various activities on the learning programme. The video recording that was done in the first phase thus provided an opportunity for video playback on the television, so that learners could identify or master certain moves or concepts during the intervention programme (Clement, 2000, p. 577).

Mosimege and Nkopodi (2009, p. 384), in their study involving the use of indigenous games to teach mathematics, emphasised the importance of identifying games according to their potential usefulness in the curriculum. The design of the learning programme that I developed was informed by the curriculum requirements for the grade in which I was conducting the study, as well as the kind of mathematical concepts that emerged from the dance performances (refer to Appendix C). For example, most songs involved the movement of arms and legs in particular directions and with dancers occupying particular positions. These were more relevant for the concepts of lines, angles, geometric shapes and transformations. Hence these concepts formed a substantial part of the learning programme. Also, the rhythm in the songs, produced by the clapping of hands and stamping of feet led to the inclusion of the concept of number patterns in the learning programme.

It was challenging recreating some of the songs and dance moves because some learners were sometimes not willing to participate, whereas I wanted as many learners as possible to be part of the actual physical activity. This was especially the case with learners who were not involved in the original dance performances that I had video recorded. The situation was more problematic with the boys, who were reluctant to mimic “girls’ dance movements” when they had to learn about certain mathematical concepts in the S*elina* dance song, for example.

During the implementation of the learning programme I asked learners to form groups and work on the activities in the learning programme. There were five groups. I captured the interaction that took place during this phase of the research with a video camera so that I could analyse it later on. In the learning programme I incorporated three of the boys’ dance songs, namely, *Emakhaya*, *Amaxhegw'alapha*, and *Uzowaxox'amatyala* as well as the song *Abafana* in the gumboots dance. I did not use all the girls' songs in the learning programme because the mathematics involved in them was similar for many of the songs. I included only five of the girls' dance songs, namely, *Jolinkomo ndiyabulaleka*, *Uphondo lwam*, *Jolinkomo ndinengxaki*, *Selina* and *Suk'etheni uzogilwa ziimoto* (see learning programme in Appendix C).

Table 4.2. below summarizes the mathematical concepts embedded in the dance songs I mentioned above. I also include the alignment of these concepts to the Grade 7 curriculum:

Name of dance	**Code**	**Mathematical concepts**	**Alignment to curriculum (NCS)**
Uphondo lwam	12:80 -13:58	Transformations (rotation)	LO 3: AS 5 Use transformations to investigate (as a member of a group) properties of geometric figures.
Jolinkomo ndinengxaki	14:03 – 15:10	Calculations involving fractions Number patterns Number patterns Transformations (rotation and translation)	LO 1: AS 7 Calculations appropriate to solving problems that involve addition, subtraction and multiplication of fractions. LO 2: AS 1 Investigate and extend numeric patterns represented in tables. LO 2: AS 2 Describe observed relationships or rules in own words. LO 3: AS 5 Use transformations to investigate (as a member of a group) properties of geometric figures.
Suk'etheni uzogilwa ziimoto	20:00 - 21:04	Number patterns Transformations (translation)	LO 2: AS 1 Investigate and extend numeric patterns found in cultural contexts. LO 3: AS 5 Use transformations to investigate (as a member of a group) properties of geometric figures.
Jolinkomo ndiyabulaleka	10:33 -12:08	Number patterns	LO 2: AS 1 Investigate and extend numeric patterns of the learner's own creation.
Amagwinya	27:33 – 29:24	Number patterns	LO 2: AS 2 Describe, explain and justify observed relationships in own words.

		Geometric figures (rectangle)	<u>LO 3: AS 2</u> Describe geometric figures in terms of • Parallel and perpendicular sides
Selina	17:32 - 18:43	Number patterns Geometric figures (triangles an quadrilaterals) Geometric figures (triangles an quadrilaterals) Transformations (reflection and translation) Ordered pairs	<u>LO 2: AS 1</u> Investigate and extend numeric patterns represented in tables. <u>LO 3: AS 1</u> Recognise and name geometric figures in cultural forms. <u>LO 3: AS 2</u> Describe geometric figures in terms of • Sides and angles of polygons • Parallel sides <u>LO 3: AS 5</u> Use transformations and symmetry to investigate (as a member of a group) properties of geometric figures. <u>LO 3: AS 8</u> Locate positions on co-ordinate systems (ordered grids) using horizontal and vertical change.
Uzowaxox'amatyala	24:00 – 26:08	Geometric figures (rhombus) Transformations (translation)	<u>LO 3: AS 1</u> Recognise and name geometric figures in cultural forms. <u>LO 3: AS 5</u> Use transformations to investigate (as a member of a group) properties of geometric figures.
Emakhaya	01:45 – 03:42	Transformations (translation)	<u>LO 3: AS 5</u> Use transformations to investigate (as a member of a group) properties of geometric figures.
Amaxhegw'alapha	03:43 – 05:03	Transformations (translation)	<u>LO 3: AS 5</u> Use transformations to investigate (as a member of a group) properties of geometric figures.

Table 4.2: Mathematical content for each dance included in the learning programme

These are the findings for each of the activities in the learning programme:

4.4.1. Activity 1: Number patterns

Seeing that some learners could not re-enact the original moves in the dances, except for the clapping of hands, I asked the class to imitate the moves and sounds (for example, of stamping of feet or beating on gumboots) by clapping hands or tapping lightly on the desks. This way I was hoping to involve the whole class in 'experiencing' the moves. However, I noticed when I watched the video that a few of the learners either could not, or were not willing to mimic the moves even by using their hands while sitting at their desks.

4.4.1.1. Activity 1.1

The activity on completing the pattern of the dance song *Suk'etheni uzogilwa ziimoto* was done well by many groups, who identified the letters as front, left, and back. However a lot of argument ensued in connection with "whose left or right" were we referring to the dancers on the video or the learners who were watching the video? I allowed the groups to discuss the question and they came up with the idea that according to the pattern, the "left" and "right" referred to those of the dancers, with respect to the original direction they were facing. We had to ask some volunteers to come to the front so that these directions could be identified and clarified. The steps for the dance were repeated several times by the volunteers, at first accompanied by the song and then later on without the singing.

4.4.1.2. Activity 1.2

Different groups came up with different patterns for the activity on the *Jolinkomo ndiyabulaleka* dance song. A common pattern of stamping of feet consisted of numbers as follows:

1,2 1,2, 1,2, 1,2 1,2, 1,2, 1,2, 1,2

1,2,3,4, 1,2,3,4, 1,2,3, 4, 1,2,3,4,

When asked to explain this, the learners said that they "*listened*" to the sound made by the feet and "*heard two different types of steps*" according to the above pattern.

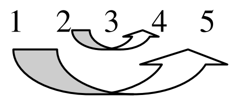
This dance was also re-enacted to enable clear explanations by the different groups. This time I took the opportunity to encourage active participation by asking each group to have its own volunteers who were willing to do the steps to help us see how they came up with their group's pattern. In cases where a group could not find someone who knew how to do the dance, I asked the group members to tap on the desks and explain how they arrived at their pattern.

4.4.1.3. Activity 1.3.

This activity, which involved the gumboots dance, excited the class tremendously. The class was abuzz with activity. Learners were trying to make sense of the meaning of the big B's and the small b's, which were supposed to be pronounced as 'BHA' (with a 'loud' sound) and 'bha' (with a 'softer' sound) respectively. I played the dvd of the gumboots dance several times for them to listen to the sounds and come to some conclusions. Most groups managed to associate the pattern with the dance, although it was difficult to make complete sense of the last step (step 4) because the gumboots dancers did not finish it well in the dvd, as some either stopped before the actual end of the dance or fumbled their way to the end. A boy who claimed to "*know more about the dance than the others*" explained how the "*correct*" tapping on the boots should be done.

4.4.1.4. Activity 1.4

The activity on 'wise positions' stretched learners' thinking skills in that they ultimately had to come up with a generalization for the pattern formed. After explaining the background to the activity, I put the question in the current context of the girls' dance, by referring learners to the video of the girls' dances. Seeing that the number of dancers in the video was an odd number and therefore convenient for the question, I asked them to identify the person who was standing in a 'wise position' in a video clip where the girls were all standing in a straight line formation. This was easy for them to do. Thereafter I did the simplified part of the problem solving activity, where they had to find the 'wise positions' for three and five dancers respectively, together as the whole class. There was reluctance when I asked for volunteers to come forward to represent a group of dancers with three members, until I assured them that they were not going to actually do any dance. From this representation they were able to identify the person occupying the 'wise position'. For the example on the five-member group of dancers I did not use actual learners (or objects). Instead, I wrote the numbers one to five in a straight line, representing dancers, on the chalkboard and drew arrows to indicate the paired dancers, as follows:



Again they were able to identify the 'wise position'. In my interaction with them I tried to encourage them to talk about and explain their thinking by asking questions like, "Why do you think that Nontsikelelo is in the 'wise position' in this three-member group?" Some of their answers to such questions were: "Because she is in the middle" or "because she does not have a partner" or "because *umnqakathi*" (she is the odd one out). These explanations were later revisited by learners in answering the questions that followed. For example, when answering the question on why only odd numbers were used for the activity, they mentioned that if there was an even number of dancers, then "nobody would be without a partner." During these instances I had the opportunity to ask them to use the correct mathematical language, such as 'even numbers' and 'odd numbers'

In working out numbers to complete the table, most groups wrote down numbers next to each other and drew lines connected the different pairs for 7, 9 and 11 dancers. However they began to realise that there was a pattern in the numbers on the second row of the table, and started filling in the numbers without drawing lines. Although learners recognised the pattern, it was difficult for them to describe it, as required in the question. In trying to describe the pattern they used sentences like "the numbers follow each other" and "the difference between the numbers is one". None of the groups tried to relate the top and the bottom rows.

I spent quite some time on the question that required them to determine the 'wise position', given different numbers of dancers in a group, namely, 37, 43, 133 and 251 people. At first some groups continued writing numbers in a line and connecting lines to indicate pairs and then see which number is left "without a partner". However, I asked them whether that way of working the 'wise position' would be convenient or practical if one worked with big numbers. After they were convinced that the method would not be suitable when working with big numbers I asked them to find other ways of finding the 'wise positions'. Below are some examples of how they worked out the 'wise positions' using different strategies:

Group 1: 'wise position' for 37 people

One girl explained:

"We know from the table ... for 15 people then the wise position is 8 ... so for 17 people, it is 9... and then we continue ..." (and then she began to show me what they had written):

15, 8

17, 9

19, 10

21, 11

The list continued up to 37, 19

I challenged them by asking: "What if you did not already know the wise position for 15 people?" After further discussion they realised that their method was similar to the one of pairing numbers using lines. I also re-emphasised the possibility that their method might not be convenient for very big numbers. I asked them to think about other ways of finding the solution.

Group 2: 'wise position' for 43 people

"You take 20 this side and 20 on the other side... you are left with 3. Then you take 1 from that 3 and add to this side (pointing at the number 20 on the left hand side) and another 1 to this side (pointing to the number 20 on the right hand side). You have 21 this side and another 21 on the other side..." (a pause). Another member of the group then finished the problem: "Then you know the person in the middle is 22"

I asked this group whether this method would work with any (odd) number of dancers given and they were quick to show me how they could also "divide" (meaning break it down) 133 in the same way they did with 43:

$$\begin{array}{r@{\qquad\qquad}r} 50 & 50 \\ 15 & 15 \\ 1 & 1 \\ \hline 66 & 66 \end{array}$$

Therefore the ‘wise position’ is 66 + 1 = 67

It was clear that this group (and two other groups that used the same method of “dividing” or “halving” the given number, as they called it) used the concept of dividing the given number into two equal parts because of the context that required them to find the position of the person in the “middle”.

The fifth group struggled to find the solutions to the question. I realised this for the first time by accident when I heard my camerawoman giving hints to this group as I passed by. This group was still using the method of pairing numbers using lines. When they realised that the method would be tedious for the big numbers, they gave up and that is when the camerawoman tried to help them. I asked her to just concentrate on video-recording and let me do the teaching. I spent some time with the group until they reached a level of understanding that was almost on a par with that of the other groups.

The next step in the activity was to find a general rule for determining the ‘wise position’, given any (odd) number of dancers. After several attempts by different groups to find the rule, the explanations given were derived from the method of “breaking down the given number into equal parts” as described by one learner, using an example of finding the ‘wise position’ for 133 people:

“You find the half of 133, which is 66 and then you add one for the person in the middle”. Other learners also mentioned the word “half”, which they did not really mean. For example, for 251 people, they said: “Find the half of 251, which is 125 and then add one to get the position of the person in the middle.” After further deliberations and my intervention, they realised that they were actually finding half of the number which is one less than the given number, and then adding one to the answer. That is, Wise position = ½ of (the given number – 1) + 1

Or in short:

$W = \frac{1}{2}(n - 1) + 1$

Later on the other learners realised that the answer for the 'wise position' could also be obtained by finding half of the number which is one more than the given number. For example, to get the wise position for 9 people, find half of 10, that is,

$\frac{1}{2}(9 + 1)$

The generalization could be written as

Wise position = ½(the given number + 1)

Or $W = \frac{1}{2}(n + 1)$

Seeing that the learners always mentioned "*finding half of the given number*" I asked them: "What if you wanted to start by finding half of the given number and then work the wise position from there?" I asked them to try this method by using a small number of dancers, such as 5 dancers. Now that they were confronted with the challenge of working with fractions, which they did not seem comfortable with, I helped the different groups and they ultimately realised that the wise position can also be calculated as follows:

Wise position = ½(the given number) + ½

Or $W = \frac{1}{2}(n) + \frac{1}{2}$

In the end I worked together with them to show that the three expressions for the generalisation were equivalent, that is,

$\frac{1}{2}(n - 1) + 1 = \frac{1}{2}(n + 1) = \frac{1}{2}(n) + \frac{1}{2}$

It is important for me to state here that the learners did not seem to be intimidated by the use of the variable 'n' during this stage of the implementation of the learning programme, although I was to learn later on in the focus group interviews that most of them were anxious about working on mathematical problems that involved variables or "*calculations involving x*" as they put it.

4.4.1.5. Activity 1.5

In order to be able to work meaningfully on this activity, learners had to make the moves practically. I drew lines that were similar to those in the learning program worksheets on the classroom floor, using coloured soft chalk. It took me some time to explain the instructions for this activity because the learners were not familiar with the concepts of "location of points on co-ordinates systems" and the terminology this involved. This lack of familiarity with certain concepts also emerged during the focus group interviews when, for example, a learner said that he had learned for the first time about the x-axis and the y-axis during our lessons together. Also, it seemed as if the diagram was confusing to some learners so much so that I had to simplify it by omitting some lines when I drew it on the classroom floor. To address the challenge of non-familiarity with certain concepts that were a prerequisite for the implementation of the planned programme I had to introduce these concepts outside of the dance context.

This was another activity in which learners were forced to participate actively because each group had to find its own volunteers to make the moves on the grid. They needed two volunteers in each group, so that they could move towards each other while the other members of the group counted the number of steps in order to find the required horizontal distances.

Some groups had to take many steps before they could see the pattern in the bottom row. One group tried to fill in the table without actually doing the moves. As a result they filled the table incorrectly as follows:

Number of moves by each dancer	0	1	2	3	4	5	6
Horizontal distance (units) between dancers	12	10	10	8	6	4	2

When I asked them to explain how they got the numbers they filled in the table, they said that "the numbers in the bottom row are even numbers". When I asked them why 10 is repeated, they did not answer. So I suggested that they do the actual moves and determine the horizontal distances practically until they were sure that they had discovered a pattern.

Most learners found it difficult to explain why the numbers in the bottom row of the given table repeat or why they skip certain numbers. However, after carefully observing the distances between the dancers as they moved towards each other, taking equal steps, and with my help, the learners began to understand why the numbers in the table are as they are.

4.4.2. Activity 2: Lines, angles and geometric shapes

Learners did not find it difficult to identify most of the concepts involved in this activity because they were familiar with them. For example, most of them were familiar with the properties of a rectangle, isosceles triangle and rhombus (or a diamond, as they called it). However, I could hear from their exclamations while working on the activity that they seemed shocked to learn that they could find, for example, parallel lines, in the movements of the *Selina* dance song (Activity 2.1) and a rhombus in the boys' dance songs (Activity 2.2). Many of them mentioned that they "have never heard of the word 'parallelogram' before", but it was not difficult to explain it since they already knew parallel lines. Also, a few of them said they did not know the word 'rhombus' although they have seen the shape before, which they called a diamond.

I was surprised to notice that learners were enthusiastic during this activity, with many of them busy moving up and down in order to "check the number of moves it would take for the two dancers to cross paths", given that they were sometimes reluctant to participate in enacting some of the dance moves in earlier activities. However, there was still the challenge of the boys not being eager to repeat their own performances for Activity 2.2., especially the older boys. This was exacerbated by the fact that many of the learners, especially the girls, could not do the complicated moves, even though some were willing to try. Although the younger boys could do the same moves, theirs were not as well defined as the older boys' (compare the dance song *Ndiyinkwenkw'endala* for the young boys, dvd code 06:30 – 08:40 and the same dance song for the older boys, dvd code 05:03 – 06:29). This challenge was, however, partly overcome by the fact that I was able to play the videos repeatedly, so that the learners could identify the moves or concepts involved without them being re-enacted by the original dancers.

Learners' enthusiasm towards this activity was also evident during the focus group interviews, when most of them said that the *Selina* activity was the one they liked the most.

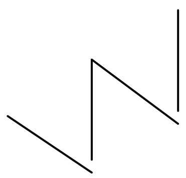
During this activity learners seemed to understand that whenever they had difficulty in understanding or answering the question, they should try to work it out practically by making the relevant moves.

4.4.3. Activity 3: Symmetry and transformation

It was good that the learners were still enthusiastic after the activity they enjoyed so much (involving the dance song *Selina*) because it was imperative that they perform the dances for this activity in order to answer most of the questions. Even though I played and replayed the video to allow them to make the necessary observations, it was not enough, especially because I did not have the 'slow motion' facility in the television. However, by asking them to perform the activities practically themselves, I was able to explain the questions, which initially seemed difficult for them to understand because of the vocabulary. For example, they could not immediately make sense of the meaning of "two dancers both occupying the same position (space)... their positions coincide". I had to explain the meaning of these sentences by using a demonstration for the whole class, where two volunteers performed the required moves and I interrupted from time to time in order to emphasise a point.

After I had explained the first question, the learners could understand the next question more easily because the questions were similar. The fact that some of them had done transformations before was helpful because they were able to explain these concepts to their group members (as mentioned by learners in the focus group interviews) so that by the time I attended to the groups they had a similar understanding of the problem.

During this activity I also had the opportunity to correct learners' misconceptions. For example, learners had the mistaken belief that symmetry is not found in "open shapes" such as the following shape formed by the moves in the *Selina* dance song:



4.5. PHASE FOUR: FOCUS GROUP INTERVIEWS

In this section I describe the learners' responses to the questions I asked them during focus group interviews. The questions required them to express their feelings about the experience of and attitude towards learning mathematics through traditional Xhosa dance. Specific questions were also asked around my current or interim findings and emerging themes from the earlier tools I used. For example, I had noticed during the implementation of the learning programme that some learners were sometimes reluctant to participate in the re-enactment of the dance performances. To get more insight into their thinking and feelings, I asked them during focus group interviews to explain the reasons for their reluctance to participate. In this way the focus group interviews served the purpose of "member checks", a common validity criterion used in qualitative research (Lincoln & Guba, as cited in Cohen et al., 2007).

Analysis of the focus group interviews consisted mainly of compiling recurring themes for the questions posed to the different focus groups. That is, a theme was identified because it was mentioned often by different learners within a group or by different focus groups (Morgan & Krueger, as cited in Osborne and Collins, 2001, p. 446).

The following themes emerged from the focus group discussions:

4.5.1. An abundance of mathematical concepts are embedded in traditional Xhosa dance

The belief that "*a lot of mathematics*" was learned through the dance came through quite strongly in all the focus groups. Although most learners in these focus groups mentioned the same concepts or activities, mainly the ones they liked most, I was able to probe for more information. They mentioned the following mathematical concepts as embedded in the dance activities they engaged in:

- Counting

Learners indicated that they counted the number of claps as they imitated the various dance steps such as the ones found in the gumboots dance. They also counted the number of different steps taken during the various dance activities.

- Number patterns

The formulation of number patterns was mentioned in the context of various examples of the activities done. For example, all the focus groups seemed to remember the patterns formed in the 'wise position' and *Selina* activities.

The learners seemed to think that "tables" was a mathematical topic or concept on its own, as they mentioned that they "learned about tables and how to complete them". I had to ask them to remember the context in which they completed the tables so that they could see that the tables were used as a tool to represent number patterns.

- Geometric shapes

Triangles, rectangles and squares were mentioned as some of the shapes formed during the dance activities. Learners reminded each other about the activities in which they had identified these shapes. However, some learners seemed to have forgotten about the names "rhombus" and "parallelogram", adding that they were not familiar with these concepts.

- Measurement

Surprisingly, the concept of "measurement" was never mentioned by any of the focus groups, even though it was mentioned during the implementation of the learning programme. Instead, learners mentioned that they "learned about the y-axis and the x-axis" or that they "counted (meaning that they determined) the distance between two dancers moving towards each other". After much probing they realised that by "counting" the number of moves by the two dancers in the *Selina* activity, for example, they were measuring the horizontal distance between the two. Then they were able to relate "y – axis", "x – axis" and "distance between the two dancers" to measurement.

- Transformations

Learners recalled how they had recognised different transformations from the various dance activities. They mentioned translations, rotations and reflections within the context of different activities. Quite a number of learners from all the focus groups mentioned that they were not familiar with the transformation terminology.

It was interesting to note that learners seemed to be pleasantly surprised that so many mathematical concepts could be learned through traditional Xhosa dance. They mentioned that they "*had not thought that so much mathematics can be learned from dance*". To them, dance was a "*means of entertainment during cultural functions in the village*", or "*part of the arts and culture period at school*".

4.5.2. Dance created opportunities to learn and access mathematics better, through a familiar cultural practice

The merits of learning mathematics through traditional Xhosa dance were recognised by almost all the learners. This was evident in their responses to the question of whether they thought that they learnt mathematics better through the dance. They said, for example, that "*you count something that you know, for example, you can see the steps you take ... and you know that you are able to do this (taking the steps) and it is better ...*" Some learners felt that it would be better if their teacher could sometimes also teach them mathematics through dance because "*I will know it because I have done it before*".

The benefits of learning mathematics through a familiar context can also be linked to learners' attitudes towards mathematics. For example, when asked about how they felt about learning mathematics, one learner mentioned that it was "*difficult working with solving for x*". The other learners immediately echoed the sentiment, contrasting it with the experience of learning mathematics through dance, where "*you do calculations about something you know*". A more interesting point of view came from one learner who claimed that learning mathematics through dance could motivate him to come to school regularly: "... *not that I do not like school, but sometimes you can be regarded as stupid by the maths teacher... so, knowing how to do the steps – for example, making the correct turns in the gumboots dance – during the maths class helps you get some respect*".

4.5.3. Learners' active participation in the dance and its effect on understanding the mathematics

Closely linked to the idea of learning mathematics through the familiar dance context is the idea of learning mathematics by being actively involved in the dance performances. When asked if the active participation helped them understand mathematics better, learners said it did. They supported this by giving examples where they had to practically count the number of moves required before the two dancers could meet in the *Selina* dance song. They also raised the fact that it would have been difficult to make sense of some patterns by only listening to the sound, without actually performing the dances.

I was also interested to know whether participating in the actual dance performances improved learners' understanding of mathematics more than it would if one was only a spectator. In response to this, learners who did not do the actual dance performances because they were "*not able to do some of the dance moves*" seemed to believe that their learning was not less effective. They claimed that they worked together with those who performed the dances and watched and learned mathematics from their moves. In fact, one of the girls who performed (as one of the two lead dancers) in most of the girls' dances had the opinion that "*it does not affect me negatively when I am the one doing the dance moves all the time, but it would be better if others could also learn to do the dance steps so that I could watch and learn from others' moves*"

4.5.4. Working together as groups: collective meaning making

Most learners in the focus group interviews seemed to react positively to the idea of working together as groups during the implementation of the learning programme. They mentioned that working in groups helped them do things they would otherwise not have been able to do. One girl explained: "*You would not be able to count moves from one side to the other … without another person … because you would move and count at the same time… you would have to estimate*". Most learners felt that they benefitted from working together as groups because they were able to "*help one another*" or "*give advice to one another, for example, on how to break down numbers during the 'wise position' activity*".

4.5.5. Doing mathematics in a playful way

The issue of learning mathematics through a play-like activity such as dance came up in two of the three focus groups. Learners felt that the atmosphere in which the dance performances occurred allowed them to be "*free to discuss things*" because it felt like they were "*playing and happy*". Following up on these comments, I asked them if they learned any meaningful mathematics if it felt like they were playing. One girl immediately responded that it was "*unusual*" to look happy while learning mathematics because it was a "*serious subject*". However, the other learners in the group assured me that they learned meaningful mathematics even though it seemed like they were playing, adding that there is nothing wrong with doing mathematics and being happy about it.

4.6. DISCUSSION: SYNTHESIS OF THE DATA

In this section I summarise the findings from the previous section and thereafter I discuss the findings by explaining their meaning and importance.

4.6.1. Summary of the key findings

The use of traditional Xhosa dance in teaching mathematics has various potential benefits. Key findings indicated that traditional Xhosa dance can be used as a medium for learning many concepts in the Grade 7 mathematics curriculum; the dance gave learners an opportunity to learn mathematics from a familiar context and to participate actively and collaboratively in their learning. Also, it emerged that the use of dance to teach mathematics had the potential to help improve learners' attitudes towards mathematics.

4.6.2. The meaning and importance of the findings

4.6.2.1. Learning about mathematical concepts from an indigenous activity of traditional Xhosa dance

Traditional Xhosa dance, an indigenous activity in the area where I did my research, has great potential for use as a medium to learn about mathematics. The results of my study showed that mathematical concepts such as those involving number patterns, geometric shapes, symmetry and transformations, as prescribed in the school mathematics curriculum, are embedded in the dance and these can be explored meaningfully by allowing learners to re-enact the dances. Other studies involving the use of indigenous activities to learn mathematics also support my findings. For example, Mosimege and Nkopodi (2009) showed that an understanding of mathematical concepts such as geometric figures, symmetries and ratio and proportion could be developed from the *morabaraba* game; the studies of Dabula (2000) and Myemane (2007) concluded that mathematical concepts such as number patterns, geometrical shapes, tessellations and symmetry were embedded in traditional Xhosa beadwork; Amoah (1996), in his ethnomathematical project, discovered that mathematical concepts involving measurement, construction and geometric shapes emerged from investigations of different types of hut designs and that the game of '*ma-dice*' had the capability to be used as a starting point for the teaching of probability. These studies strengthen my argument that traditional Xhosa dance can be used to make appropriate interventions in the teaching and learning of mathematics.

The fact that the dance was an activity from learners' real life context seemed to encourage them to come up with solutions that made sense to them. For example, the methods they used to arrive at solutions were not particularly 'conventional' or 'formal' mathematical strategies but their own inventive strategies which seemed to work for the particular problems they were faced with. I can infer from these findings that the use of traditional Xhosa dance seemed to motivate learners to think creatively. This is affirmed by Millroy (1992) who, in her ethnographic study as an apprentice carpenter, had evidence to conclude that "people frequently construct and apply innovative and creative methods of their own to reach satisfactory solutions to real-life problems" (p. 22).

My advocacy of the use of traditional Xhosa dances to teach mathematics does not imply that a particular mathematical concept can be explored or learned in its entirety through the dance. Findings from my study indicated that learners sometimes lacked understanding of a particular concept or prerequisite concept, in which case I had to use other strategies to ensure understanding of such concept before I could use the dance. For this reason I suggest that it might be more appropriate or meaningful to use dance only to introduce mathematical concepts or to consolidate concepts already learnt. This idea reflects that of Guberman (2004), who in his study of the relations between ethnicity, out-of-school activities and arithmetic achievements, suggested that learners' knowledge from their out-of-school practices may provide a good base for school mathematics. I further caution that care needs to be taken when choosing dance activities for inclusion in the mathematics learning programme. For example, in my study, I discovered that not all dance songs lend themselves to the extraction of complex and rich mathematical concepts and so learners would not benefit academically from their inclusion in the learning programme. Ladson-Billings (1995) concurs that one of the criteria that "culturally relevant teaching" must meet is that it should have "an ability to develop students academically" (p. 483).

4.6.2.2. Active participation of learners in their learning

The implementation of a mathematics learning programme that incorporated traditional Xhosa dance activities provided opportunities for learners to participate actively in their learning. For example, learners explored various mathematical concepts by clapping hands, stamping feet, moving arms and legs in various directions and measuring distances, among other things. While doing all this they were thinking, reasoning, reflecting and making important discoveries and conclusions in connection with problems that they had to solve. The role of the video recording was key in facilitating this active learning because learners could master important dance moves by watching them several times. Thus video recording became a powerful tool in facilitating meaningful learning since the dvd could be paused and played back in order to capture specific moves which learners would then imitate or observe so that they could learn about certain mathematical concepts.

By asking learners to repeat some dance moves I gave many of them an opportunity to participate actively, even those who did not participate in the initial video recording. However, the inability or unwillingness by some learners to participate in re-enacting the dances was problematic as it could defeat the aim of using the dance activity in the first place. However, members of the various dance groups felt that they could also learn by observing someone else perform the dance rather than always being the ones actually doing it. Linked to this unwillingness to perform is the concept of learning styles, where some learners may not necessarily learn better when they actively perform. The question of learning styles forms the basis of the critique or limitation of the learner-centred approach as presented by O' Neill and McMahon (2005). For this reason, I acknowledge that active participation during the dance activities suited some learners better than it did others. This is especially true in cases where, for example, a learner was so shy that it made him or her feel very uncomfortable to do a dance performance or a particular dance move in front of the whole class and be a centre of attention for that particular moment. Then the experience of learning mathematics through active participation in dance activities may not be an educative one for such a learner. This sentiment is shared by Kolb and Kolb (2005) when they argue that

> The belief that all genuine education comes about through experience does not mean that all experiences are genuinely educative ... For some experiences are miseducative. Any experience is miseducative that has the effect of arresting or distorting the growth of further experience...
>
> (p. 205)

4.6.2.3. Changing attitudes towards mathematics

The fact that traditional Xhosa dance was familiar to learners in my study seemed to make the learning of mathematics less threatening and frightening to them. For example, the concept of variables, which normally intimidated learners, when introduced through the activities involving their dance activities, did not seem to cause anxiety. Instead, learners used the context to come up with generalisations in a meaningful way, without realising that they were using the dreaded variables. It would thus seem that the experience of learning mathematics through dance has the potential to help develop "the necessary confidence and competence to deal with any mathematical situation without being hindered by a fear of Mathematics" (South Africa, DoE, 2002, p. 4).

Even though it was difficult for some learners to express themselves, it looked like they preferred a learning environment where they did not feel intimidated by the unfamiliarity of some of the mathematical concepts they had to learn. Learning mathematics through traditional Xhosa dance seemed to provide them with that kind of an environment. Learners appeared to have found their own different passions satisfied through the different dance moves, rhythm or the music that accompanied the dance, as well as the relaxed atmosphere.

The excitement and enthusiasm that characterised the classroom during the implementation of the mathematics learning programme that incorporated traditional Xhosa dance suggested that learners were developing a spirit of curiosity and love for mathematics. The dance activities seemed to boost some learners' self-esteem as they confidently and proudly explained how to make particular dance moves correctly, or as they mastered certain moves, turns and correct measurements or calculations. In some way, for the learners who usually felt "invisible" during mathematics lessons the dance seemed to have developed "the fist" with which to "fight the scheming ignorance of prejudice", as described by the African-American dancer Pearl Primus (Hanna, 1995, p. 328).

4.6.2.4. Learning mathematics as cooperative groups

The dance activities forced learners to work together. For example, in most of the activities some learners had to re-enact the dance moves while the other group members counted the number of moves, or observed the turns made. The collaboration on physical activity was not the only benefit that learners obtained from working together in groups. They further discussed mathematical concepts, questioned one another's opinions for clarity, put their heads together in order to look at alternative strategies or offered suggestions on how to approach certain problems in order to get the required solutions. Therefore learning mathematics through the medium of dance helped develop learners' skills in working effectively as cooperative groups. Savery and Duffy (2001) attest to the benefits of cooperative groups by stating:

> Collaborative groups are important because we can test our own understanding and examine the understanding of others as a mechanism for enriching, interweaving, and expanding our understanding of particular issues or phenomena. As von Glasersfeld (1989) has noted, other people are the greatest source of alternative views to challenge our current views and hence to serve as the source of puzzlement that stimulates new learning
>
> (p. 2).

"The ability of the tutor to use facilitatory teaching skills during the small group learning process is the major determinant of the quality and the success of any educational method aimed at ... developing students' thinking or reasoning skills..." (Savery & Duffy, 2001,p. 13). I support Savery and Duffy's view because much of the success of the collaborative groups during the implementation of the learning programme in my study depended on my role as a facilitator. At appropriate times I had to help groups of learners by probing for further explanations to responses given, asking thought provoking questions to help them in their reasoning and giving hints when necessary. Also, I used the facilitation process as an opportunity to correct learners' misconceptions and helped them use correct (and sometimes new) mathematical terminology instead of the everyday language that they used.

4.7. CONCLUSION

In this chapter I presented the findings of the study in terms of each stage of data collection and followed this with a discussion. The findings showed that mathematical concepts can be extracted from traditional Xhosa dance and that these can be related to the mathematics curriculum as stipulated in curriculum documents. Video recording proved to be a useful tool in capturing dance images for use in designing a mathematical learning programme, as well as for constant playback during the implementation of the learning programme. Observations of and interactions with learners during the implementation of the learning programme, and interviews with them thereafter, showed that traditional Xhosa dance is capable of promoting the meaningful learning of mathematics.

CHAPTER 5

CONCLUSION AND RECOMMENDATIONS

5.1. INTRODUCTION

In this chapter I first summarise the importance of this study by describing the manner in which its research goals have been achieved, then outline its possible contribution to and usefulness in mathematics education. Secondly, I make suggestions for the implementation in other mathematics classrooms of an intervention programme like the one that forms the basis of this study. Thirdly, the limitations of the study are discussed, and finally I make recommendations for further research.

5.2. THE IMPORTANCE OF THE STUDY

This study sought to investigate the potential use of traditional Xhosa dance in the teaching and learning of mathematics. Specifically, an exploration of mathematical concepts that are embedded in traditional Xhosa dance was carried out with the aim of using these concepts to design a learning programme incorporating dance. The results of the study indicated that many mathematical concepts were embedded in traditional Xhosa dance and that these concepts could be firmly located within the school mathematics curriculum. It was further established, through the implementation of a mathematics learning programme, that dance created opportunities for learners to learn mathematics through a familiar cultural practice, and that this was likely to increase the effectiveness of their learning. Learners' active participation in the dance performances seemed to have a positive effect on their understanding of the mathematical concepts with which they were engaged. Opportunities for collaborative meaning making were created, and these further strengthened the potential of traditional Xhosa dance for learning mathematics. A concise yet comprehensive way of summarising the benefits of using traditional Xhosa dance for teaching and learning mathematics is offered by the following assertion: Dance has "various effects from empowering people by developing creativity, self-esteem and physical and mental strength, to the ability to communicate and interact beyond language" (Holzhausen, 2005, p.58).

Although the research consists of only a small case study of the teaching of mathematics through dance in one school over a limited period of time, its findings are of potential use and benefit to a wide audience. To start with, it could be an eye opener for other teachers in the field of mathematics and encourage them to experiment with strategies that "recognise the wide diversity of knowledge systems through which people make sense of and attach meaning to the world in which they live" (South Africa. [DoE], 2003 p. 4). Inevitably, there are challenges as well as opportunities attending the implementation of such strategies, and these will be discussed in detail in the next section.

One of the challenges associated with the implementation of mathematics lessons that incorporate indigenous activities is the complaint that materials relating to such activities are scarce (Amoah, 1996). The findings of studies such as this could help teachers to realise that they do not need sophisticated material in order to start implementing, at least on a small scale, ethnomathematical lessons. At the same time, my study could be a useful resource for writers and researchers exploring initiatives to create suitable ethnomathematical texts and other learning support materials. The availability of such learning support materials could help to enable differentiated learning and reduce the need to use exercises from the textbook (Ollerton, 2009, p. 6). In my experience, textbooks, more often than not, lack activities relevant to learners' particular culture and context.

The contribution of this study to the existing literature is that it has both confirmed the findings of similar research and produced some new findings. The study demonstrates the usefulness of integrating traditional Xhosa dance into the teaching and learning of mathematics, while earlier comparable research has investigated other indigenous activities such as games, beadwork and other cultural artefacts and practices (Mosimege, 2000; Dabula, 2000; Mogari, 2002; Myemane, 2007). This pioneering study – at least in the context of the area where it was conducted and its focus on Xhosa dance – could stimulate further interest in the investigation of similar phenomena. Such research is likely to address some of the challenges encountered in my own study. This possibility is discussed in the section on recommendations for further research, below.

5.3. SUGGESTIONS FOR IMPLEMENTATION OF THE PROGRAMME IN OTHER CLASSROOMS

Without meaning to overlook one of the major limitations of a case study, namely, its lack of generalisability, I want to suggest possible ways in which the findings of my study can be implemented in other mathematics classrooms.

Activities similar to the ones I used in the implementation of the learning programme in this study can be used in different phases of the school mathematics curriculum. Care should be taken to ensure that the “unmathlike” (Ladson-Billings, 1997, p. 705) dance activities are clearly linked with the mathematical concepts, as stipulated in the phase curricula concerned. I would particularly recommend the foundation phase, for three reasons. Firstly, I had the opportunity to personally present some of the activities I had developed, with necessary amendments in order to fit the foundation phase mathematics curriculum, to a group of foundation phase teachers at a conference recently. Although these were teachers and not learners, the feedback I received from them seemed to suggest that the activities could be used effectively in this phase, with more facilitation from the teacher. Secondly, from my experience of teaching at a junior secondary school for many years and seeing the behaviour of young learners, I believe that they could benefit from a ‘play- like’ activity such as learning mathematics through dance. Thirdly, the new Curriculum Assessment and Policy Statement (CAPS) for foundation phase mathematics (South Africa [DoE], 2010) prescribes various topics that could be organised around an activity such as the Xhosa dance.

The introduction of a similar learning programme in other classroom situations comes with its own challenges. For example, the learning programme that I implemented with the learners in my study seemed to yield positive results because the activities in it originated from a dance that the learners themselves knew and could perform. The question then is: Can the programme from my study be replicated for use in other mathematics classrooms? In answer to this question I would say that total replication is not desirable, even in cases where learners are familiar with Xhosa dance (unless their dance performances are identical or they come from the same area as the one in which I did the research). Instead, the teacher should identify traditional dances from the learners’ own background and use them to design a learning programme as I have done in my study. I say this because the strength of my study seems to lie in the exploration of learners’ dance performances in the context of their own particular cultural background. Secondly, it might be difficult for learners who come from an entirely different cultural background to imitate the Xhosa dance moves.

But from a different perspective, the programme could be used with learners from different backgrounds, just as any other reference material (such as a textbook) would be used to give them an opportunity to practise a particular skill. In such cases a video recording of the dance performances could be played for the learners, without their being necessarily expected to perform the dance. Again, this could work provided that there were no serious objections to the use of such dances in that particular context. According to Gottschild (2008), in certain communities, "the Africanist dancing body is vulgar, comic, uncontrolled, undisciplined, and, most of all, promiscuous" (p. 4). Perhaps the moves of the dance song "*Izinja*" (dvd code 18:45 – 19:58) would fit the above description. In such communities it would not be advisable for teachers to use the video recordings of the dances.

Other challenges to the implementation of a learning programme such as the one in my study could stem from teachers' reluctance to introduce activities which they think will take up too much of the limited time they have to teach. In such cases, Nkopodi and Mosimege (2009) suggest that "the issue of lack of time will need to be addressed alongside the general matters of teaching strategies" (p. 379). This means that teachers would have to weigh the possible benefits of using the dance to teach mathematical concepts against the loss of time. For example, just as is the case with other teaching strategies that are regarded as time consuming, such as learner-centred approaches (O'Neill & McMahon, 2005), teachers may decide to use dance to teach particular concepts from which they think their learners will derive the most benefit.

5.4. LIMITATIONS OF THE STUDY

Although the study has been generally successful, there are certain limitations that need to be noted.

Even though my familiarity with the school and community in which I conducted my research worked to my advantage, as I mentioned in the discussion on site selection in Chapter 3, it also posed some challenges for me as a researcher. For example, some teachers disrupted my research classes or lessons by just coming in, or sending some learner to ask the learners I was working with for some information, without consulting me. This disturbed the learners because they felt awkward in the presence of teachers or learners from other classes. It could have affected the results of my study, especially when the disturbance occurred during a dance. I had to talk nicely to the teachers later on – without spoiling the good relationships we had - and ask them not to interfere.

Another limitation of my study pertains to the use of video recording as a data collection tool. Although it had been convenient for me to ask someone else to help me with the video recording during stage three of the data collection (implementation of the learning programme), I could not do the same thing during the focus group interviews. I was sceptical about involving someone else in case it inhibited the learners and prevented them from talking freely. However, doing the focus group interviews alone without somebody to help with the camera was a challenge. For example, I could not capture the body language of all the learners when they spoke or when some other learners spoke, because the angle of the camera limited the view. To address this limitation I tried to identify some of those learners who were quiet or who made funny noises (such as *yho*! – an exclamation) to explain why they behaved thus. In this way I tried to minimize the limitation caused by the insufficient area coverage of the video camera.

The lack of generalisability as a result of the case study method used implies that there is limited scope for the replication of the study in other mathematics classroom situations. But I wish to emphasise that this does not mean that the study loses its merit as an exemplary experiment in the teaching and learning of mathematics. For instance, its findings are still valid for settings, conditions or situations similar to those under which it was conducted. Furthermore, looking on the other side of the same coin, this shortcoming could become a strong point when possible ideas for further research are triggered by it.

5.5. RECOMMENDATIONS FOR FURTHER RESEARCH

Some of my recommendations for further research derive from the limitations of my study. For example, it would be worthwhile to get some useful insights into the challenges that teachers might face in implementing learning programmes or lessons incorporating traditional Xhosa dance, so as to improve similar programmes in future.

In order to find ways to address the other limitation I mentioned in the preceding section, namely, that of the opinions of learners, a study that focuses on learners' attitudes towards learning mathematics through traditional Xhosa dance could be conducted. A related study could also look into whether learning mathematics through traditional Xhosa dance improves learners' attitudes towards mathematics, a study perhaps parallel to that of Werner (2001). I make this recommendation because in my study there was some indication of attitude change, but the intervention period was too brief for me to make any substantial claims in this regard. Perhaps a study that explores this idea further could use action research methodology, for the reason mentioned above.

5.6. PERSONAL REFLECTION

The experience of doing the study has taught me a great deal about research in general, my professional practice, and the students with whom I work on a daily basis.

To begin with, I had the opportunity to engage seriously and carefully with data and participants, as a researcher in an academic field. I had to think seriously about issues that I had taken for granted before, such as ethical considerations in research, analysing findings in an unbiased way, or not reading too much into a situation without the necessary evidence. I had constantly to ask myself if I was doing the right thing and why I was doing it. For example, deciding whether to force learners to re-enact the dances or not was not easy. A part of me wanted to believe that the learners enjoyed performing the dances and so they would not mind being told to do them over and over again. On the other hand, the fact that they were not volunteering to do the performances made me think about ethics in a practical way, within a research context.

My experience of doing the research was also an eye-opener for me in the sense that I learned about urgent and important issues in the teaching profession in general and in the field of mathematics education, in particular, through the review of literature. For example, I became aware, through documented evidence, of some of the challenges faced by teachers and education officials in South Africa, in connection with mathematics, such as underperformance in the subject in comparison with other countries, teacher qualifications in the subject or the attitude of learners towards mathematics. This reflection made me think critically about the contribution that I could make to address the challenges.

By engaging in the study, I became aware of the predicament that our learners find themselves in, as far as the learning of mathematics is concerned. For example, I discovered that despite their so-called negative attitudes towards the subject, learners do realise the importance of mathematics and would like to be given more time and scope to access it. Upon realising this, I began to ask myself questions such as: Have I been failing my students through the years and blaming their attitudes or the government for it? What have I done to make a contribution towards making the situation better? I know now that going forward, it is my responsibility (and that of other mathematics teachers) to instil in learners an appreciation of the subject, and this begins with taking small steps such as the study I conducted.

5.7. CONCLUSION

The study investigated the use of traditional Xhosa dance as an alternative approach for learners to learn mathematics from a familiar cultural context. Findings from the various stages of the research indicated that dance could make a useful, even powerful contribution towards the meaningful learning of mathematics.

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APPENDICES

APPENDIX A: LETTER OF ACCESS TO SCHOOL

6461 Extension 24

BUTTERWORTH

4960

22 February 2011

The Principal

Msento Junior Secondary School

CENTANE

Dear Sir

Letter of permission to do research at your school

I would like to ask you and the School Governing Body to allow me to do a research project at your school. I am employed as a lecturer at Walter Sisulu University in Butterworth and this research project is part of my studies towards a Masters in Education (MEd) qualification at Rhodes University.

The aim of the research project is to explore ways in which learners' cultural activities from their everyday life can be integrated into learning at school. I am particularly interested in ways in which traditional Xhosa dances can be used in the teaching and learning of mathematics in a Grade 7 class.

Through this project, I hope to integrate a familiar and popular indigenous practice (Xhosa traditional dance) into the mathematics curriculum. In doing this, I hope to inspire and help other educators to close the gap that seems to be always there between classroom activities and activities outside the classroom, by ensuring that the learning of mathematical concepts in classrooms is not done in isolation but takes into account daily experiences of learners.

Please note the following important points about the research project:

- The research project, which will be spread over a period of 5 to 6 days of about two and a half hours each, will not be conducted during official school contact time. Instead I will use afternoons, so that the educators' programmes are not interrupted, except in exceptional cases. In such cases I will ask for your special approval.

- During the project I will be working mostly with the Grade 7 learners who will be performing dances, watching videos of dance performances and working on mathematics activities that are based on the dances. Therefore I will require permission from their parents to allow them to work with me on the project. I have also attached here another letter requesting parents to allow their children to participate in the project.

- The learners will be free to withdraw from the project at any time if they so wish.

- The confidentiality of the information that will be provided during the research project is guaranteed, as well as the anonymity of the school or individual participants. However, from time to time I will need to consult my supervisor at Rhodes University during the research project and share some of the discussions that take place between the learners and me. In such discussions, the confidentiality of the learners and the school will be closely guarded by both me and my supervisor.

- Your school will not be identifiable in any way from the results of the research project. Therefore nobody from the general public will know any information or events about the school because of the research project.

Thank you in advance for your help and your favourable consideration of my request.

Yours sincerely

NP Mbusi (Mrs)

APPENDIX B: LETTER OF PERMISSION TO PARENTS

Dear Parent

I would like to ask for your permission to allow your child, who is doing Grade 7 at Msento Junior Secondary School, to participate in a research project that I will be conducting at his/her school. This project is part of my studies for Masters in Education at Rhodes University. However, it will also help children to learn mathematics in an interesting and meaningful way.

The project involves the exploration of ways in which learners can use the cultural activities that they are familiar with, for learning at school. I am particularly interested in the use of traditional Xhosa dance in the teaching and learning of mathematics.

Please read the following points and at the end indicate your willingness to allow your child to participate in the project:

- If you are willing to allow your child to participate in the project, he/she will be asked to perform or watch the performance of some traditional Xhosa dance together with other learners in his/her class. These performances will be video recorded so that later on we can use them for learning about mathematics.

- After video recording, the learners will be taught for about a week, during afternoons, on how to use traditional Xhosa dance to learn mathematics.

- At the end of the project the learners will be asked (interviewed) to give their opinion about their experiences, feelings, thoughts about the whole project. These interviews will be recorded and transcribed.

- The identities of the learners will not be divulged, therefore nobody will know their names or faces, their ideas and feelings that they share with me during the project.

- If, at any point, you are not comfortable with your child working with me on this project, you have the right to withdraw him/her at any time.

Thank you for your cooperation.

Yours sincerely

NP Mbusi

Declaration by parent
Having read the information provided above I confirm that I understand the nature of this research project and the commitments made to me by the researcher, I allow my child to participate in the research project.

Name : ---

Signature : -----------------------------------

Date : ------------------------------

XHOSA VERSION OF THE LETTER OF PERMISSION TO PARENTS

Mzali obekekileyo

Ndingathanda ukucela kuwe ukuba uvumele umntwana wakho owenza ibanga lesi-7 esikolweni saseMsento, athabathe inxaxheba kwi projekti endizobe ndiyenza apha esikolweni sakhe. Le projekti iyinxalenye yezifundo zam zobuNgcaphephe kwezeMfundo endizenza ne Yunivesithi yaseRhodes. Okunye, iprojekti le iya kuthi incedise abantwana ekufundeni izifundo zezibalo (mathematics) ngendlela enomdla nenentsingiselo ephuhlileyo kubo.

Le projekti imalunga nokufumana iindlela ekunokuthi abafundi bathabathe imidlalo yenkcubeko abayiqhelileyo emakhaya nasekuhlaleni, bayisebenzisele ukufunda esikolweni. Ikakhulu ndinomdla kwindlela esinokuthi sisebenzise ngayo imidaniso nemixhentso yakwaXhosa ekufundeni izifundo zezibalo (mathematics).

Nceda ufunde le miba ilandelayo ukuze ekupheleni ubonakalise ukuba uyavuma na ukuba umntwana wakho athabathe inxaxheba kule projekti:

- Ukuba uyamvumela umntwana wakho athabathe inxaxheba kule projekti, uza kuthi enze okanye abukele imixhentso nemidaniso yakwaXhosa kunye nabanye abafundi bebanga le-7. Le midaniso nemixhentso izakuthi ifotwe, ishicilelwe nakwicwecwe lomboniso bhanya-bhanya (video), ukuze ekugqibeleni isetyenziselwe ukufunda izifundo zezibalo (mathematics).

- Emva kokushicilelwa kwicwecwe lemiboniso bhanya-bhanya, abafundi baza kufundiswa izifundo zezibalo (mathematics), kusetyenziswa imidaniso nemixhentso eshicilelweyo. Konke oku kuza kwenzeka emva kwemini ithuba elingangeveki.

- Ekupheleni kwe projekti kuya kwenziwa udliwano-ndlebe (interview) nabafundi, bebuzwa imibuzo, ukuze kuqondwe izimvo zabo nendlela abaziva ngayo malunga neprojekti le. Le mibuzo izakushicilelwa kwicwecwe lomboniso bhanya- bhanya, iphinde ibhalwe naphantsi.

- Amagama abafundi, imifanekiso enobuso babo, izimvo zabo abayakuthi bazivakalise ngethuba endisebenza nabo ngalo kule projekti, azisayi kuthi zaziswe okanye zibonakaliswe kwabanye abantu.

- Nangaliphi na ithuba onokuthi uzive ungonwabanga kukuba umntwana wakho athabathe inxaxheba kule projekti, unelungelo lokumrhoxisa.

Ndiyabulela ngentsebenziswano yakho.

Ozithobileyo

NP Mbusi

Isifungo somzali

Ekubeni ndithe ndazifunda iinkcukacha ezingentla, ndikuqonda kananjalo konke okuqulathwe yile projekti, nezithembiso ezenziwe ngutitshalakazi oza kuqhuba le projekti, ndiyamvumela umntwana wam ukuba athabathe inxaxheba kule projekti.

Igama nefani : ---

Intsayino-gama (signature) : ---

Umhla : ---------------------------------

APPENDIX C: LEARNING PROGRAMME ON DANCE AND MATHEMATICS

In this Learning Programme, the following Learning Outcomes and Assessment Standards for the Grade 7 class will be covered:

Learning Outcome 1

AS 7: Estimates and **calculates** by selecting and using operations appropriate to solving problems that involve:
• Addition, subtraction and multiplication of common fractions

Learning Outcome 2

AS 1: Investigates and extends **numeric** and geometric **patterns** looking for a relationship or rules, including patterns:

- Not limited to sequences involving constant difference or ratio;
- Found in natural and cultural contexts;
- Of the learner's own creation;
- Represented in tables.

AS 2: Describes, explains and justifies observed relationships or rules in own words.

AS 3: Represents and uses relationships between variables in order to determine input and/or output values in a variety of ways using:
•Verbal descriptions;
•Tables.

Learning Outcome 3

AS 1: Recognises, visualises and names **geometric figures** and solids in natural and cultural forms and geometric settings, including those previously dealt with as well as focusing on:

•Similarities and differences between all quadrilaterals including kites and trapeziums.

AS2: In contexts that include those that may be used to build awareness of social, cultural and environmental issues, describes and classifies geometric figures and solids in terms of properties, including:

• Sides and angles of polygons (with focus on, but not limited to, triangles and quadrilaterals);

• Parallel and perpendicular sides.

AS 5: Uses transformations (rotations, reflections and translations) and symmetry to investigate (alone and/or as a member of a group or team) properties of geometric figures.

AS 8: Locates positions on co-ordinate systems (ordered grids) and maps using:

• Horizontal and vertical change;

ACTIVITY 1: NUMBER PATTERNS

Most of the traditional Xhosa dance songs dealt with are accompanied by a series of clapping of hands and stamping of feet that form certain patterns of sounds. For example, the girls' song "*Uphondo lwam*" consists of a slow, steady beat of clapping of hands, while the song "*Jolinkomo ndinengxaki*"has a fast beat of clapping of hands. Also, most of the boys' songs consist of vigorous stamping of feet that produce various sounds which form different patterns.

The questions in this activity require you to identify, explore and expand a variety of patterns generated from the dance performances recorded in the videos. It is hoped that exploring patterns helps learners develop an appreciation for the beauty of mathematics.

1.1. The following pattern is one way of representing the stamping feet of the dancers in the dance song "*Suk'etheni uzogilwa ziimoto*":

F: 1 2 3 4; 1 2 3 4; L: 1 2 - - ; - - - -; B: - - - -; - - - -; ...

(a) Observe the dance and say what the letters F, L, B, and so on could possibly mean.

(b) Complete the pattern.

1.2. Refer to the dance song "*Jolinkomo ndiyabulaleka*" and answer the following questions:

(a) How many different types of steps are there in this dance? (Concentrate on the two 'lead dancers' in front).

(b) In your group, formulate your own way of representing the pattern you observe. Another group will then be asked to complete your pattern.

1.3. One group has formulated the following patterns for the steps in the boys' gumboots dance song "*Amagwinya"*:

Step 1: BB b bb; BB b bb; BB b bb; ...

Step 2: BB BBBBBBBB b bb; BB BBBBBBBB b bb; ...

Step 3: B BB b b; B BB b b; ...

Step 4: BBB b b; BBB b b; ...

(a) Observe the gumboots dance, discuss this pattern in your group and decide whether it makes sense to you.

(b) Modify the four patterns by using numbers instead of letters.

1.4. In most of the girls' dance performances, two 'lead dancers' have to come up in front of the whole group to perform special dance moves. Some dancers do not feel comfortable leading the group and as a result some learners have to become 'lead dancers' more often, sometimes against their will (refer to the beginning of the dance song "*Jolinkomo ndinengxaki"*.

Suppose that dancers have to take turns in leading the group and the rule for selecting the two leaders for each performance is:

Select the first dancer on the line and then the last dancer on the line will become her partner in leading the group for the first performance. For the next performance, the second dancer on the line pairs with the second last dancer on the line, and the pattern continues in the same way.

Problem for you to solve

In which position must a dancer stand if she does not want to be selected as one of the pair to lead the group?

You could start by simplifying the problem and consider a few dancers for a start, and then increase the number, as follows:

For 3 dancers: 1 2 3

For 5 dancers: 1 2 3 4 5

As with three dancers, the people on the 1st and 5th positions must lead the group for the first song. For the second song, the people on the 2nd and 4th positions must lead the group, and so on.

Now answer the following questions:

(a) Why do we consider only odd number of dancers?

(b) Fill in the table:

No. of dancers	3	5	7	9	11	13	15
Wise position							

(c) Is there a pattern that you can see? Describe it.

(d) What would be the wise position if there are:

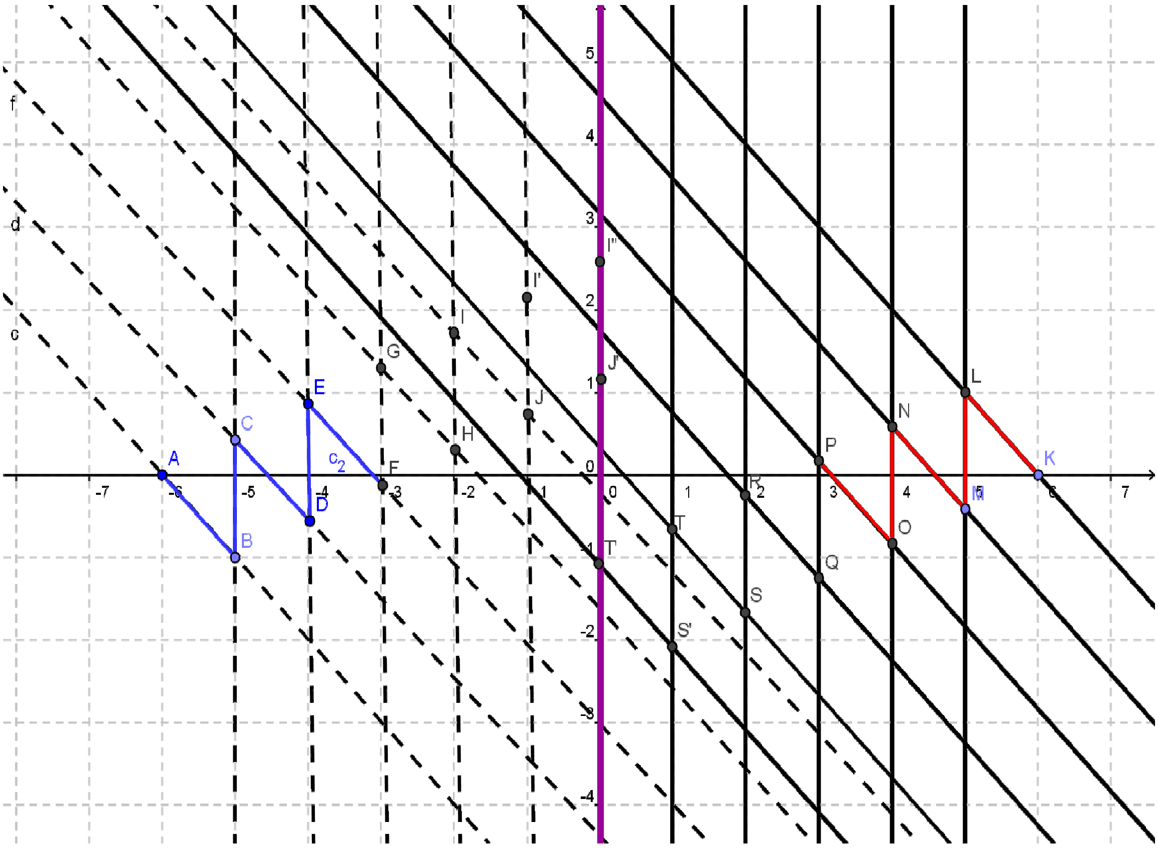
- 37 people
- 43 people
- 133 people
- 251 people?

(e) Describe how you could find the wise position if you are given any number of people.

(f) A girl who is number 24 on the line is standing in a wise position. How many people are performing the dance?

(g) Describe how you could find the number of people if you are given the wise position.

1.5. In the girls' dance song "*Selina*", the two dancers approach each other from opposite directions. Suppose that they move forwards and sideways (we ignore the backwards movements) in equal distances through the same angle (45º) each time they take a step. Their moves are represented in the diagram below (on a system of axes), such that line segments AB = BC = CD = ... = KL = LM = MN, and so on. The first dancer begins at point A and moves along the dotted lines from the left, while the second dancer begins at point K and moves along the bold lines from the right. The purple vertical line (y-axis) is equidistant from both of them.



(a) Complete the following table:

Number of moves by each dancer	0	1	2	3	4	5	
Horizontal distance (units) between dancers	12	10	10	8			

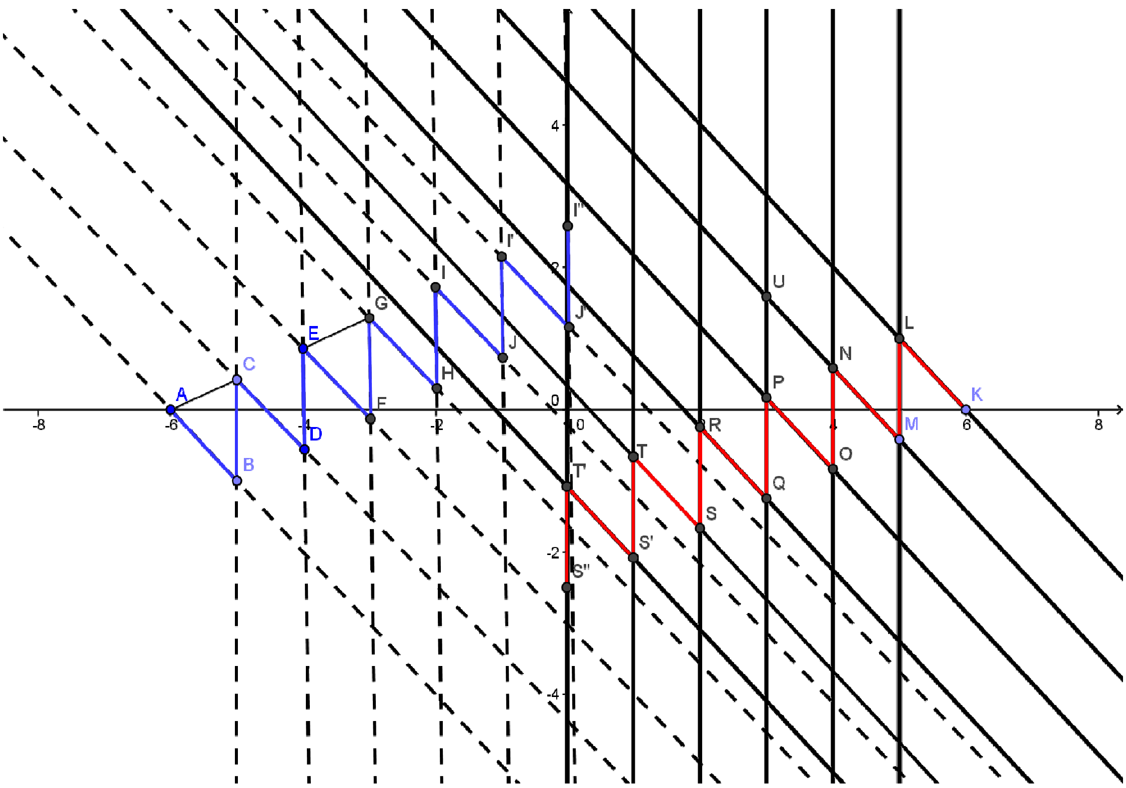
(b) Explain why the numbers in the bottom row repeat as well as why they skip certain values.

(c) Without completing the table, predict the number of moves the dancers make before passing each other (even though they pass each other at a distance). Check if your prediction is correct, by using the diagram or by extending the table.

(d) Use the answer you got from (b) above to determine how many moves it takes before they reach the opposite sides?

ACTIVITY 2: LINES, ANGLES AND GEOMETRIC SHAPES

2.1. In the dance song "*Selina*", the moves have been indicated as in the previous activity.



(a) If lines PO and RQ are extended as shown on the diagram, do you think they will ever meet? What do we call lines that keep the same distance between them and never meet?
(b) What kind of a polygon would be formed if you joined OPRQ with straight lines? Use the properties of this polygon to explain your answer.
(c) Use the diagram and your answer to (a) and (b) above to show that the two dancers will not cross paths. (You can actually perform the moves practically to check if this is true).
(d) If a line segment is drawn to join A to C, what kind of triangle will ABC be? Explain your answer.
(e) Find/calculate the sizes of angles A and C.
(f) Investigate what kind of polygon NOPU is.

2.2. In the boys' dance, 'U*zowaxox'amatyala*', one of steps involves the boys moving their feet in such a way that a certain shape is formed. What kind of shape is formed and what are the properties of the shape?

2.3. Compare the shape you mentioned in 2.2 above with the one formed by the boys in the gumboots dance song *Amagwinya*. What is the same about them? What is different?

ACTIVITY 3: SYMMETRY AND TRANSFORMATION

3.1. Refer to the song "*Suk'etheni uzogilwa ziimoto*" and answer the following questions:

(a) Are the following statements true or false? Explain.

(i) The two lead dancers are doing exactly the same thing such that their movements are identical.

(ii) The two dancers both occupy the same position (space), that is, their positions coincide.

(b) Choose the correct word (s):

In order for the dancers' positions and movements to coincide, one dancer has to **shift/turn around**.

(c) The type of transformation in (b) above is called ----------.

(d) What other type of transformation is involved in this dance?

3.2. Refer to the dance song "*Uphondo lwam*". Observe the movement of arms and legs of the two dancers in order to investigate the relationship between the position and movements of one dancer to the position and movement of the other.

Choose the correct word (s):

> Looking from your position, when the dancer on your left lifts up the arm or leg that is closer to you, the dancer on your right lifts the arm or leg that is **closer to/further from** you.

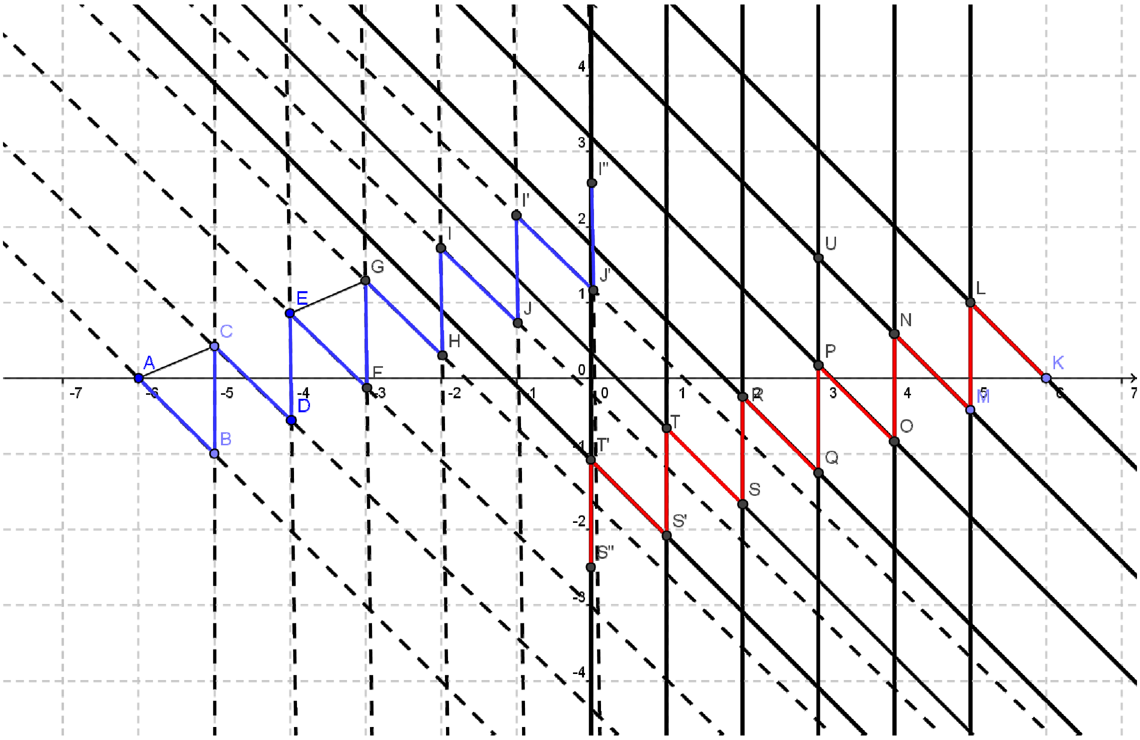
(a) What could be done by one of the dancers in order for you to see them do the same thing when you look at them from the front?
(b) What type of transformation is involved here?
(c) Is the following statement true or false?

The direction of the turn is not important for the resulting images or movements of the two dancers to be the same. (Do this practically to help you answer the question).

3.3. Now compare the movement of the arms and legs in the song "*Jolinkomo ndinengxaki"* and explain if the dancers have to make any turns in order for their images and movements to be identical, as well as for their positions to coincide. What kind of transformation of the image of one dancer to that of the other is involved here?

3.4. In the boys' songs and dance, for example, in "*Emakhaya*" or "*Amaxhegw'alapha*" what type of transformation is mostly involved? Choose one or two different types of movements to explain your answer.

3.5. Refer to the diagram below, which represents the moves in the "*Selina*" dance song.



(a) Would you say that triangles ABC and EFG are symmetrical? Draw the line of symmetry for each triangle.

(b) Consider the shape made by the movement of the dancer from N-O-P-Q-R. Is the shape symmetrical? If so, draw the line of symmetry. If not, what do you need to do to make it symmetrical?

(c) (i) Use the letters of the alphabet to identify the positions of the two dancers after the first move.

(ii) Use the in (i) above to explain/describe two ways in which you could move a point (representing the position of one dancer) in such a way that it coincides with its corresponding point (representing the position of another dancer). Mention the transformations involved.

(d) Use the answer from (c) (ii) above to illustrate, on the diagram, the answer to the following question:

What would you do to triangle KLM to make it coincide with triangle ABC?

(e) Compare the coordinates of the point B and those of the point L. What do you notice?

(f) Give the approximate coordinates for these "corresponding moves" :

(i) The 3rd move (that is, points D and N)

(ii) The 10^{th} move

(iii) The 11^{th} move

(g) Is your observation in (d) and (e) above true (or the same) for all other "corresponding points" representing corresponding moves of the two dancers?

APPENDIX D: FOCUS GROUP INTERVIEW

INTRODUCTION

- Good afternoon!
- Thank you for taking the time to meet with me once more. I hope that you do not mind if I tape record this session as I have done with the previous ones.
- In the past two weeks I have spent time with you doing some mathematical activities through dance. This time I want you to reflect on your experiences and impressions of the whole process. I will ask you specific questions that I need you to answer. Please speak freely and be honest with me because the information I get from you will help me improve the activities that I have been doing with you. Such activities may also help other teachers who may be interested to use them.

QUESTION FRAMEWORK

- Introduction question to dance....when do you dance...why?
- Do you think there is mathematics in dancing? Explain....give an example.....elaborate
- Have you learnt some maths....what?
- Do you think it's a good idea to learn ma
- When you started doing the dances, did you ever think that they could be related to mathematics? How do you feel now that we have related the dances with mathematics? Do you feel that you have learned any meaningful mathematics?
- Were you familiar with the dances that were used to learn mathematics? Did this familiarity with the dances help you learn mathematics meaningfully? Explain how?
- Have you ever been taught mathematics in a similar way to the one you have engaged in, that is, through dance, play, music, games, and so on? How did you find the experience then?
- Describe how you usually feel about learning mathematics. Why do you think learning mathematics brings about such feelings in you?
- Is there any particular section of mathematics that you like better than the others? Why is that so?
- Were you able to participate in the dance performances? If yes, did you enjoy the experience? More importantly, do you think that you have learnt mathematics meaningfully because you participated in the dance?

- If you did not participate in the dances, do you feel that your understanding of the activities was affected? Explain.
- Has the experience of learning mathematics through dance changed your attitude towards mathematics? How?
- Did any of the activities motivate you, encourage you or make you curious to want to solve mathematical problems? Give examples of such problems.
- Has the experience of learning mathematics through dance encouraged you to work with other learners? How has this cooperative learning benefitted you in terms of understanding mathematics?
- Would you like that your teacher taught mathematics in a similar manner as we have been doing in the past week or so? Why?
- What changes would you suggest should be made next time when these kinds of activities are used to learn mathematics, in order to improve your experience of learning mathematics?
- Is there anything else you would like to share with me in connection with your experience of learning mathematics through dance?