AN INVESTIGATION INTO THE TEACHER'S VIEWS TOWARDS THE INCORPORATION OF ETHNOMATHEMATICS IN THE TEACHING OF ORDINARY LEVEL GEOMETRICAL TRANSFORMATIONS

A THESIS SUBMITTED TO BINDURA UNIVERSITY OF SCIENCE EDUCATION FOR THE DEGREE OF MASTERS OF SCIENCE EDUCATION (MATHEMATICS) IN THE FACULTY OF SCIENCE EDUCATION

BY

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DECLARATION

No portion of the work referred to in this thesis has been submitted in support of an application for another degree or qualification of this or any other university.
DEDICATION

This dissertation is dedicated to my wife Gloria who tolerated missing my company during the course of the study. I also dedicate this dissertation to all the mathematics educators and researchers in Zimbabwe.
ABSTRACT

BINDURA UNIVERSITY OF SCIENCE EDUCATION

Abstract submitted by Charles Zirebwa for the degree of Masters of Science Education (Mathematics) and entitled An Investigation into the teachers’ views towards the incorporation of ethnomathematics into the teaching of Ordinary Level transformation geometry.

This dissertation investigates the teachers’ attitudes towards the incorporation of ethnomathematics in the teaching of ‘O’ level transformation geometry concepts of shear and stretch. The main objective of this research was to establish the teachers’ attitudes on the ethnomathematical approach as an alternative method set to improve the teaching of the concepts of shear and stretch. The study also sought to investigate the aspects that stood as the major hindrances towards the integration of ethno mathematics in the teaching of the concepts of shear and stretch. The study involved the developing of an ‘ethnomathematical program’ meant to teach the concepts of shear and stretch, and a Case Study evaluative approach was used to establish the teachers’ views on the use of ethnomathematics program in schools around Bindura. Thirteen teachers from Bindura Urban schools were selected for the study. The results of the study revealed that teachers regarded the use of ethnomathematics as a necessary approach for the teaching of transformation geometry concepts. It was also discovered that absence of textbooks written from an ethnomathematics perspective, a rigid examination system, teacher training, time, conflict between student’ personal constructs on shear and stretch and formal mathematics knowledge on the same concepts, are some of the aspects that pose a challenge to the incorporation of ethnomathematics in the teaching of the transformation geometry concepts.
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CHAPTER ONE

Introduction

1.1 Background to the problem

Geometry provides a culturally and historically rich context within which to do mathematics. Presenting geometry in a way that stimulates curiosity, empowering students and encouraging exploration, thereby enhancing student's learning and attitudes remains a challenge to teachers (Pimm, 1987). As a result, a large percentage of students continue to have difficulty in the learning of transformation geometry.

The Zimbabwe Schools Examinations Council (ZIMSEC) examiners reports (2000,2001,2002,2003,2004) states that the questions on transformation geometry, though popular among students over the years, have proved to be a difficult topic, especially the concepts of shear and stretch. With transformation geometry students are required to interpret transformations geometrically and analytically through the use of matrix operators. Most students fail to relate the geometrical and analytic ways of describing a shear and a stretch. In this case, their main problems are that, they fail to identify invariant lines. They also fail to describe a transformation that map one figure to the other, and to calculate shear factor, locate the co-ordinate of the image, and manipulate matrices in a transformation involving a shear. Likewise in a stretch they fail to identify the fixed points, stretch factor, the direction of stretch in both one way and two-way stretches, locate the coordinates of the image and manipulate the matrices. Haggart (2002) concurs with Jaji (1990) who asserts that the students' problems with transformation geometry are merely pedagogical, and failure can be attributed to the teaching approaches employed and also to:
- The tendency by teachers of teaching geometry by informing the students of the properties of the transformations, requiring them to learn the properties and then complete the exercises which show that they have learned the facts, but little attempt is made to encourage students to make logical connections and explain their reasoning (Haggart, 2002).

- Teachers tend to generalize the learners ability, that is, the teacher plans the lesson, teaches the lesson aiming at the average generalized ability of the learner including assumed knowledge, considering it as every student’s ability, whilst the average represents nobody.

- Dehumanization, depersonalization and decontextualization characterize mathematics teaching. Many times the school pupils are left confused, as to why they learn geometrical transformations. The goals of teaching these concepts are not made explicit to the students, and pupils do not realize the benefits of learning of shear and stretch and other topics. D’Ambroisio (1985) argues that much of the mathematics curriculum in schools worldwide is so disconnected from the child’s reality therefore it is very difficult for the child to be a full participant in it. In most classrooms, pupils are expected to learn prescribed transformation geometry concepts like shear and stretch, procedures of finding the shear and stretch factors, the invariant line, without gaining a deeper and conceptually significant understanding of what they are studying and without forming linkages between what they learn and the world around them.

- Another reason is that teaching tends to concentrate on verification of textbook materials, and devalue or omit exploration from immediate environment of students and as well as description (Haggart, 2002).

- Mathematics lessons are often presented in such a way that the learners are introduced
to the mathematical language relevant to a particular section of work and then shown a few examples using the correct algorithms to solve the problems pertaining to the topic before being given an exercise to complete (Barnes & Plomp, 2004). So finding a transformation matrix from a given shape that have undergone a shear or stretch and is represented geometrically involves students making a difficult transition from a geometrical representation towards an analytical representation. An effective teaching approach encourages students to recognize connections between different ways of representing geometric ideas and other areas of mathematics like matrices.

Research on ethnomathematics has brought awareness among educators of materials that can be used in the teaching of geometry (Amoah, 1996). For instance the use of African architecture and art in the teaching of geometry as portrayed by Gerdes (1995), who described various graphic designs that convey geometry aspects, embedded in various Mozambican practices. Amoah (1996) argued that for teachers to overcome the psychological and cultural block to the learning and development of mathematics, the African heritage, traditions and practices have to be incorporated in the teaching of transformation geometry which has proved to be a difficult 'O' level mathematics topic. Other scholars like Zaslavsky (2003), D'Ambroisio (1985), Gerdes (1990) have also concurred with the idea of incorporating mathematics with study of cultural traditions. They argue that use of mathematics that stem from ones' cultural has some constructivist connotations, in that learners construct their own knowledge or at least interpret it based on their own perceptions and experiences. In this case pupils having encountered various shapes, which have been transformed in art, and seen them on baskets; graphic designs (on fabrics where triangles have been rotated, rectangles that have been sheared and
many others) at home can easily recognize and interpret them in class. In this case mathematics begins to make sense to their lives, in other words it becomes realistic to their lives.

Unfortunately, although research support the incorporation of ethnomathematics in mathematics teaching, what happens in class is different, there seems to be a gap between within-school mathematics and outside-school mathematics (D'Ambrosio, 1985). Integration of ethnomathematics into the mathematics curriculum has not been smooth due to a lot of challenges, which include the disjunction between the teacher education and school classroom practices, and on the other hand the education policy. In other words there is no clear-cut educational policy with regard to the teaching of indigenous mathematics in Zimbabwe (Kushure et al, in press).

How to get the information from the indigenous people is another challenge given the conservative nature of the African culture. For commercial purposes some indigenous mathematics has not been made explicit for general consumption by the public, for instance the sorting, ordering and weaving in basket making. The mathematics used is not usually made public for the fear of competition. Another issue is that pupils have their own perception of the world, which is different from what is being taught in the classroom, so how to reconcile these two worlds is one of the biggest challenges being faced by teachers. Teachers also have their own perceptions, which determine the way they impart the mathematical knowledge. These are reflected in their teaching methods.

1.2 Problem Statement
Concern is on poor performance by 'O'level students in the area of geometric transformations especially on the concepts of shear and stretch which have become a perennial problem. Because of the way the concepts are taught, most students sit for their terminal examinations ill prepared to handle these concepts so that their performance remains depressed. It is regrettable to note that the concept of geometrical transformations is one of the commonly applied concepts in the areas of architecture (design) and art (paintings) but students fail to appreciate the mathematics behind them.

D'Ambrosio (1985), Gerdes (1988), Eglash (1990) and many others have written extensively on the need to use ethnomathematics in order to improve the student performance in mathematics. In addition many seminars have been held World wide, and it has been discovered that ethnomathematics have some constructivist connotations, in which students can easily manipulate cultural material at their disposal and in turn this helps them to understand taught concepts. Despite the growing popularity of constructivist methods, they have not had a substantial impact on classroom practices (Frid, 2000). Teachers have continued to use the teacher -centered methods like drill. And it seems that this method has not been effective enough in improving the student's learning of the concepts of shear and stretch as evidenced by poor results. So the main focus of this study is to investigate the teachers' views towards the teaching of transformation geometry concepts like shear and stretch from ethnomathematics perspective.

1.3 Assumptions
It is assumed that there are no significant cultural differences among the student in schools around Bindura town since this will favor multicultural education instead of ethnomathematics, which forms the basis of this study. It is also assumed that the student's performance as judged by the teachers will be representative of the students' performance in the terminal ZIMSEC examinations.

1.4 Main research questions

- What are the common approaches to the teaching of geometric transformations like shear and stretch?
- What are the teachers' attitudes towards the integration of ethnomathematics towards the teaching of 'O' level transformation concepts of shear and stretch?

Research sub-questions

- What examples can be drawn from pupils’ experiences that can be incorporated in the teaching of transformation geometry?
- What obstacles hinder the smooth integration of ethnomathematics in the teaching of transformation geometry?
- How can these obstacles be overcome?

1.5 Significance of the study

This study will go a long way in helping teachers to adopt teaching approaches that will enable them to teach 'O' level geometric transformations concepts of shear and stretch effectively. It will also help educators and policy makers to align the curriculum to the needs of the society and refocus the pedagogy in order to improve teaching of mathematics at 'O' level. The study also seeks to lay the basis from which other researches on ethnomathematics can be undertaken for the improvement of mathematics
education in Zimbabwe.

1.6 Delimitation

The study is going to be undertaken in secondary schools in Bindura Urban. Since the study is on the teachers’ views towards the incorporation ethnomathematics into the teaching of transformation geometry, the target population would be ‘O’ Level mathematics teachers.

1.7 Limitation of the study

The main limitation of this study is that some of the teachers included in the study were recent college graduates with little or no experience in teaching transformation geometry topic such that their responses to the questionnaire were unreliable. Another limitation of the study was that the ‘Ethnomathematics program’ designed was not tested in the field. So that it can be evaluated with students who are supposed to benefit from this research initiative.

1.8 Conceptual Analysis

1.8.1 Culture

Bishop (1990) perceives culture as a set of beliefs and understandings that serve as a basis for communication and unifying people within a community. Reuter (in Ezewu, 1985) defines culture as the sum of total human creations such as, tools weapons, pottery shelter and other materials, and all this have developed throughout the ages up to the present time including attitudes, ideas, beliefs and judgments, language and institutions, arts and sciences as well as philosophy and social organization. Aspects that are common in the above descriptions of culture are behaviors, practices, physical objects ideas and
knowledge. Various identifiable groups of people or communities have distinctive ways of identifying these elements. So for this research culture shall be defined as a way of thinking, behaving, and it also includes a groups' knowledge and customs, its traditions, memories and written records, dressing and language.

1.8.2. Ordinary Level

This is often abbreviated as 'O' level. This is a two-year course, taught at Zimbabwean Secondary schools. The mathematics syllabus is in two versions 4008 is in two versions 4008 and 4028. Syllabus 4008 is the non-calculator version and the 4028 is the calculator version.

1.8.3 Pedagogy

Pedagogy can simply be defined as the art or science of teaching pupils (Oldroyd, 1996). Pedagogy includes instructional behaviors that foster culturally responsive teaching. Pedagogy includes:

- Knowledge of the subject matter.
- A willingness to use cultural knowledge to make connections to new knowledge.

1.8.4 Ethnomathematics

Ubiratan D'Ambrosio, a Brazilian mathematician, coined the term "ethnomathematics" in the 1980s and he defines ethnomathematics as a way different cultural groups 'mathematise' (count, measure, relate, classify, and infer)" (D'Ambrosio, 1985). In other words, ethnomathematics is the study of mathematical practices of specific cultural groups in the course of dealing with their environmental problems and activities.

The prefix 'ethno' is a broad term that refers to the socio-cultural context therefore includes language spoken, the codes, of behavior, myths, values and symbols (D'Ambrosio, 1990). The derivation 'mathema' means to explain, to know, to
understand and do activities such as ciphering, classifying, ordering, inferring and modeling. The suffix 'tics' is derived from 'techné', and has same root as art and technique (D' Ambrosio, 1990). In this case, ethno refers to groups that are identified by cultural traditions, codes, symbols, myths and specific ways to reason and to infer. In other words ethnomathematics can be defined as the study of mathematics in a certain cultural context.

Ethnomathematics forms the intersection between cultural anthropology and institutional mathematics and utilizes mathematical modeling to solve real problems (Gerdes, 1996). In order to make mathematics more accessible to pupils from diverse cultural backgrounds, some researchers advocated for multicultural mathematics.

1.8.5 Transformations

A transformation is simply a process where each point on an object or shape is moved in a formulaic way. The original figure is called the pre-image and the resultant figure is called the image. Some transformations result in the distortion of the original figure like enlargement shear and stretch whilst some preserve both the shape and measurement (congruency). There are basically three congruencies and these are translations, reflections and rotations. A congruency preserves both shape and measurement.

Shear is a kind of transformation, which involve, one line being fixed and other points move parallel to the fixed line. An ethnomathematical definition of shear is that it means 'tsveyama'. 'Tsveyama' means to be tilted, lopsided, or lean sideways.

A stretch also involves an invariant (fixed) line while other points move a distance in the
direction of a pulling force. Stretch is referred to as 'tatamuka' in its ethnomathematical
definition, meaning to expand what is elastic.

1.8.6 Geometry
The word geometry stems from the Greek root words meaning "the earth" and
"measure". It is generally accepted that geometry had its origins in ancient Egypt some
time before 450BC. Recorded history has it that, geometrical figures like circles have
been used as symbols of beauty and perfection (Pimm, 1987). Geometrical shapes have
also been used to decorate other human artifacts since the earliest times and continue to
do so in pottery and clothing patterns.
Many objects humans make suggest straightness for example folds, cuts, edges and
stretched strings. Flatness mirrored on walls, floors and ceiling, tables and so on. One
view of mathematics has been that the world is mathematical, and a lot of mathematics is
waiting to be perceived. Galileo proclaimed that 'mathematics' is all around us and the
book of the world is written in the language of geometry (Pimm, 1987). Geometry is
strongly linked to human sense of sight and visual perception of form. It is closely
connected with the creation of shapes, the conjuring of images. But geometry also
involves their dynamic manipulations that involve some transformations.

1.8.7 Constructivism
It is a concept based on the premise that pupils construct their own perspectives of the
World through individual experiences and 'schema'. Constructivism has been embraced
by many teacher educators around the world and many have advocated constructivist
views of learning and teaching as avenues by which to design and implement
mathematics curricula that engender learning with understanding (Frid, 2000). In this
study, ethnomathematics shall be considered to be an aspect of constructivism since it
involves the construction of ones' knowledge through engagement of ones' culture. Therefore, ethnomathematics bridges culture and mathematics together, forming a connection between the surroundings of the child and the world of mathematics.

1.9.0 Summary

The chapter looked at the background to the study, stating the problem and the significance of the study. As indicated in this chapter that the students’ problems with the concepts of shear and stretch have something to do with the teaching methodologies that seem to be teacher-centered. So in this study, the researcher shall develop an ‘ethnomathematical program’ which is a student-centered approach and investigate the teachers’ views towards the incorporation of ethnomathematics in the teaching of transformation geometry concepts (shear and stretch) in schools.
CHAPTER TWO

Literature Review

2.1 Introduction

This chapter explores the various ways in which ethnomathematics can be incorporated in the teaching of transformation geometry, and its underpinning constructivist ideas. It also examines the history of geometry and ethnomathematics. The problems of teaching ethnomathematics have also been highlighted.

2.2 Difficulties of learning geometry

Geometry has been included in the 'O' level mathematics syllabus as a way of providing pupils grounding for geometrical ideas, but performance in this area in Zimbabwe has been generally poor.

From the evidence provided by the ZIMSEC examiner(s) reports (2000, 2001, 2002, 2003, 2004) it seems the students are not benefiting much from the teaching methods being used to teach the concepts of shear and stretch. Haggart (2002) noted that the main problem is that there seems to be little appreciation by the educators of the students' cultural backgrounds, which are not congruent to the content being taught. Zaslavsky (2003) noted that students do poorly in mathematics because they find the content interesting and irrelevant to their lives. Zaslavsky (2003) also noted that its no surprise that students find mathematics irrelevant that they develop some fears and anxiety about the subject and drop it as soon as possible.

The current teaching approach seem not to be providing an appealing context that facilitates the learning of the concepts of shear and stretch, and assessment made is more
intended on displaying what the students cannot do than what they know (Haggart, 2002). As a result the majority of students do not reach the third level of geometry learning as depicted Van Hiel’s model (see Appendix A). In this model Van Hiel describes the stages in which students undergo in gaining geometrical knowledge by observing the geometrical figures. In this model progress from one level to the other is dependent on the teaching methods than on age. Given the traditional teaching methods research suggests that most lower secondary school students perform at levels 1 or 2 with almost 40% of them completing secondary school education at levels below 2 (Haggart, 2002). The explanation being that most teachers are asked to teach the curriculum that it is at higher level than the students, using teacher centered approaches.

Some researchers have attributed failure to the content matter which they regard as being Euro-centric, and does not bear any relationship with the context in which it is being taught (D’Ambroisio, 1995, Bishop, 1990). Keeney (2002) views the traditional approach of teaching/learning geometry, with the sole use of textbook, chalk board, and paper and pencil as a possible factor affecting both attitudes and achievement. Nunes (in Vithal, 1993) noted that even though it maybe easier to solve the problems using the methods that are taught at school, school procedures are poorly learnt and quickly forgotten. Hence the power of school taught procedures is lost. Instead, self-invented strategies are more powerful (for example the use of ethnomathematical materials like the basket weaving patterns in learning the geometrical shapes), because they are well understood despite their more being cumbersome to use. The ethnomathematical materials provide a ‘real world setting’ where the mathematical representations can be explored.
The Nziramasanga Commission of Inquiry into the Zimbabwean Education (1999) reports that the high failure rate was a sign that mathematics education was in crisis, as a result many people advocated for the review of the mathematics curriculum so that ethnomathematics can be incorporated into the mainstream curriculum. Their argument being that if the ethnomathematics is incorporated into the curriculum, it will improve the pupils’ performance and interest.

2.3 History of ethnomathematics

For some time mathematics has been regarded as a culture free and value free discipline. Many African children experience mathematics as imported from outside Africa (Bishop 1990, Amoah 1996). People educated in a western way tend to think that mathematics is a unique product from the European culture (Amoah 1996). But the written records suggest that over the years, mathematics ideas have flourished all over the world. All societies have developed their own forms of mathematics appropriate to their lives and cultures. This type of mathematics, which is embedded in the cultural heritage, is what today is referred as ethnomathematics.

Traditionally mathematics has been viewed as a culture-free and universal discipline, and ethnomathematics emerged later than other ethno sciences (Gerdes, 1996). The principal forerunners of ethnomathematics are Wilder, White Fettweis and Raum. Wilder quoted in Gerdes (1996) noted that in various mans' cultures there are certain elements that are called mathematical. These have been found to be varying from one place to another such that what can be called mathematics in one culture cannot be called mathematics in another. Through time, standardization of symbols and the diffusion through migrations
and increased modes of communication the different mathematics elements of various cultures merged into what is today is referred as mathematics.

Research has revealed that ethnomathematical ideas exist in all cultures, but which ideas are emphasized, how they are expressed and their content varies from culture to culture. Ascher (1991) points out that the way mathematics is expressed in the traditional cultures is not the way it is expressed in the western culture. Therefore those who study mathematics from traditional cultures refer to the need to draw on resources and methodologies from other disciplines such as anthropology, economics, ethnology, archeology, art and architecture, literature and oral tradition. Ethnomathematics is based on and requires the kind of interaction across disciplines (Ascher, 1991).

Of the mathematics that is found across the world the mathematics of counting has received more attention. The concept of counting is universal (Bishop, 1988).

Research on ethnomathematics has also revealed that a wide range of ideas is found in traditional cultures (Vithal, 1993). These have been explored and elaborated in terms of, for example the number systems, words, gestures, symbolism, games, riddles and puzzles, geometry, symmetries art and architecture, graphs or sand drawings. It has also been shown that cultures may share some ideas and not others and further even where the idea is the same or similar, it may be expressed differently and have different contexts (Ascher, 1991).

2.4 Relationship between ethnomathematics and modern academic mathematics

Ernest in Gates (2001) offers the traditional view of mathematicians who regard mathematics as their specialist knowledge that is applied to the real world and other
problems and in diluted form used in informal cultural contexts (ethnomathematics). The mathematicians believe that they 'own' the pure essence of mathematics whilst the diluted form is used by others. Ernest (in Gates, 2001) also gives a contrary view in which an ethnomathematical or cultural view of mathematics which is regarded as an intrinsic part of most peoples' of most peoples cultural activities that academic mathematicians have appropriated, decontextualized, elaborated, and concentrated that mathematics until it seemed to stand on its own and disregarding its ethnomathematical origins.

Nunes (1992) points out that mathematics outside school tends to be more like modeling, in which both the logic of the situation and the mathematics are considered simultaneously by the problem solver. In contrast school mathematics typically focuses on school mathematics per se resorting to applications as occasions for practicing specific procedures.

On the other hand, Saxe (1990) has investigated the way in which mathematical understandings developed in one context are used in another context, He provides evidence that there is a gradual interweaving of school mathematics with the mathematics generated by candy seller's practices in Brazil. To support this view Saxe (1990) states children make use of cognitive forms linked to one practice (either school or candy selling) to accomplish problems in the other.

The importance of this debate is that it concerns the ownership and origins of mathematics, and the legitimacy of cultural practices outside the European tradition. Including the historical dimension in the teaching of mathematics can serve to counter the received Eurocentric view that promotes elements of multicultural mathematics
(Ernest in Gates, 2001). The unique characteristic of human beings is that they have and make cultures, and every culture has traits that can be called mathematical. Mathematics is cultural knowledge that derives from people engaging in the universal activities of counting, locating, measuring, designing, playing and explaining (Bishop, 1988).

2.5 Relationship between ethnomathematics and Indigenous knowledge Systems

What seems to be the major dispute with regard to indigenous knowledge systems in science and mathematics is how and what should be understood as indigenous science and mathematics knowledge (Garrote, 1999). In this study Indigenous knowledge systems shall be defined as the knowledge that people have developed over time. It includes a system of organization, a set of empirical observations about the local environment, and a system of self-management that governs the resource use. This knowledge is the basis for local level decision making in agriculture, education, natural resource management and a host of other activities in rural communities. (Netherlands Organization for international co-operation in Higher education/Indigenous knowledge NUFFIC/k-unit, 1999). Ethnomathematics on the other hand can be defined as the study of mathematical techniques used by identifiable cultural groups, in understanding, explaining and managing problems arising in their own environments (Gilmer, 1995).

A distinction between ethnomathematics and Indigenous Knowledge Systems (IKS) can be made in that the former is a strategy developed by mankind during its history to explain, to understand, to deal, sensible, perceptible reality, and with imagination within a natural and cultural context. While the latter is a body of knowledge accumulated overtime as a result of man's interaction with the physical environment, whereby in some
cases humans have some control and other cases have little control on the environment. Similarities can also be drawn between ethnomathematics and indigenous knowledge systems in that they are both:

- Culture and context specific and hence cannot be transferred to other sites. Language barriers make both the IKS and ethnomathematics difficult to be understood particularly by the outsiders.

- Non-formal knowledge, lacking systematic records, and means of transmission to other societies. It is therefore difficult to transmit ideas and concepts to those who do not share the same language.

- Inherently dynamic constantly changing through indigenous experimentation and innovation, fresh insight and external stimuli communities are therefore able to adapt to changing circumstances through identifying new problems and seeking solutions to them.

They differ in that ethnomathematics is the product of human creation, while IKS develop through interaction of people with the environment.

2.6 Ethnomathematics movement

D'Ambrosisio in the 1980s and 1990s designed an ethnomathematics program in which he advocated for its inclusion in the mathematics curriculum. He argued that this program would facilitate the acquisition of knowledge and understanding of mathematics concepts. The ethnomathematics movement is an engagement by researchers who are highly committed to the success of the discipline. Gerdes (1996) outlines the following as the basic tenets underlying the ethnomathematics movement in the educational context:

- Ethnomathematics in the Third World focus on mathematical traditions in peoples'
daily activities and find ways of incorporating these traditions and activities into the curriculum.

- Ethnomathematics also focus on cultural elements and activities that may serve as the starting point for doing and elaborating mathematics in the classroom. This means that 'O' level mathematics teachers need to focus on children cultural elements that embrace shearing and stretch.

### 2.7 The culture of the learner

For many students school mathematics seems completely separate from what they do at home. They cannot see the point why they are studying transformation geometry at school. They cannot see the connection between transformation geometry they do at school and the mathematics they do in other places like the market places, at home, and the fields (Stehlikova, 1991). This being the case it is imperative that teachers refocus their pedagogical practices, in order to bring the culture of the local community, which they are serving, into the mathematics classroom. In a transformation geometry lesson students should be presented with materials drawn from their home cultural backgrounds, like cultural drawing of geometrical shapes, and also be presented with opportunities to come up with ‘mathematical models’ that depict the concepts of shear and stretch.

According to Stehlikova (1991) bringing the culture of the learner is important because;

- It breaks down barriers between home and school.
- It values the mathematics that is going on in the community.
- It makes links between the mathematics that is used in the community and the school syllabus.
• It shows that the community is a good resource for mathematics.

• It makes mathematics relevant to students.

Amaoh (1996) argues that ethnomathematics allows for abstracting from a familiar situation, and the application of the previously learnt procedures. The integration of the ethnomathematics into the mainstream curriculum may serve to:

• To reduce the disempowerment of students whose backgrounds are not congruent with the western cultures (Laridon in Amoah, 1996).

• As an alternative way of teaching students concepts, which they find difficult to understand when, taught using the traditional methods like drill.

2.8 Exploration of the pupils’ cultural background: the key to successful instruction

Transformation geometry is an area of mathematics, which is open to many approaches. It has a long history, intimately connected to the development of mathematics. It is an integral part of our cultural experiences, being a vital component of numerous aspects of life from architecture to design (in all its manifestations) (Haggart, 2002). Haggart (2002) describes geometry as a topic that appeals to our visual, aesthetic and intuitive senses. As a result it is a topic that is of interest to the students. Haggart (2002) also argues that teaching geometry well involves appreciating the history and cultural context of geometry and many varied uses to which geometry is put.

When planning approaches to teaching and learning geometry it is important to ensure that the provision of material in the early years of the secondary school that encourage students to develop an enthusiasm for the subject by providing opportunities to investigate spatial ideas and solve real life problems (Haggart, 2002). It is also important
that teachers employ the teaching approaches that take cognizance of the student's background culture. In other words they should base their pedagogy on what the student already know (familiar contexts), of which it's usually the student's cultural background. The teacher should also take into cognizance of ethnomathematics embedded in various cultural practices that depict transformation geometry.

According to D'Ambroisio (1995) the mathematics curriculum should be rooted in culture and cultural artifacts and activities of the pupils' own home communities. Aesthetic appreciation of art, architecture and many artifacts involves geometric principles, symmetry, perspective, scale orientation, and so on (Haggart, 2002) Although some geometric aspects embedded in culture may illuminate the ideas of shear and stretch, but these have not been used to benefit pupils in a mathematics classroom. Gerdes (1996) describes various graphic designs that demonstrate geometric aspects in the cultural activities of the Mozambican people, and he advocated for the inclusion of these ideas in teacher education courses. Eglash (1999) also vividly illustrates how African cultural practices of hair braiding and plaiting are based on iterative geometrical transformations of scaling, rotation, reflection and translation. He also found further evidence of fractal geometry in African architecture and art, which can be used as ethnomathematics materials that can aid the teaching of mathematics in today's classroom.

Ethnomathematics fosters an understanding of basic concepts of shear and stretch since the materials that are used to teach these concepts are drawn from familiar contexts.

The argument being that pupils enter into the mathematics classroom with 'half-baked'
mathematical ideas related to shear and stretch, having encountered these from their day-
to-day cultural activities that involve using ‘folklore mathematics’. The mathematics
ideas related to shear and stretch could be used in curricula so that students can make
connections between formalized mathematics and their everyday life. Ethnomathematics
enables students to develop a language of geometry, which help them to describe and
communicate their ideas. Further, this would enable students to make sense of formal
mathematics. Use of cultural materials like baskets, art, and architecture stimulate
curiosity and confidence among students and it would be easier for students to visualize
complex transformations like a shear and two-way stretch.

Ethnomathematics requires that teachers learn more about students’ culture before they
can properly teach the curriculum, there is need to hunt for the teaching materials that are
relevant to the teaching of the mathematics concepts (Vithal, 1993). Since
ethnomathematics is a learner-centered approach, planning for a shear and stretch lesson
would require the teacher to use the materials that learner centered (Orey & Rosa, 2004).
Teachers need to bring in their lesson cultural materials like baskets weaving patterns,
cultural designs on garments and drawings that are relevant to the teaching of the
concepts, the elastic materials like rubber bands used in making catapults and other
materials drawn from the students’ backgrounds with their help.

Teaching geometrical transformations from an ethnomathematics context has some
constructivist connotations, in that teaching will be based on what the student is already
familiar with. Students can easily manipulate the materials, and apply their own
mathematical ideas. The fundamental premise of constructivism lie with the assumption
that, mathematical learning develops as an active and interactive endeavor of the learner with the environment.

The need to use the pupils' experiences in the teaching of mathematics is also linked to constructivist belief that learning is a result of ones' construction of knowledge through active cognitive and social engagement in ones' experiential world (Von Glasersfeld in Frid, 2000). Meaningful learning occurs when individuals are engaged in social activities, that is pupils being exposed to cultural activities which they are familiar with, for instance in the case of the problem in hand, the teacher should take students, to construction places, and ensure that students observe shearing that happens when roof trusses of huts and other buildings, fencing poles that are poorly supported, use of examples that involve cultural designs, art, hair plaiting, basketry, games and so many other examples. Students get into a classroom with the concept of elasticity in their minds, so the teacher should probe what the students already know and reinforce these ideas using examples drawn from the pupil's cultural backgrounds.

The teacher is then required to employ some constructivist methods in which he provides students with an opportunity to manipulate the objects 'mathematize', explore the properties of geometric shapes from the given patterns. According to Delaney (in Gates, 2001) the underlying tenet of constructivism is that the learner must construct meaning for himself or herself rather being a passive recipient. However the teacher can act as a guide, suggesting the paths that maybe profitable. In the context of the above stated teaching materials the teachers' role would be to scaffold or facilitate pupils' use of the teaching aids, in order to identify what could have been the invariant line in the shapes.
that display a shear, identifying the direction of stretch and so on through language and actions in order to help them make sense of the mathematics, and the 'hidden mathematics' aspects portrayed by the teaching aids.

Since no formal mathematics was used in designing the artifacts, but the 'hidden mathematics', this implicit mathematics discovered from analyzing the geometric forms of the cultural objects. This will foster in students an appreciation of transformation in a synthetic (geometric characterization) (Stehlikova, 1991). When investigating isometries students start from their geometric characterization and proceed to their analytic (matrix) description (Stehlikova, 1991). By a geometric characterization we mean determining some properties of a transformation, such as the properties it preserves for example area in a shear, what are the fixed points in a stretch, the fixed lines (invariant lines) and so on. The insights which students get from this investigative approach are more valuable than acquiring mathematics knowledge as ready made products (Stehlikova, 1991).

In order to understand the mathematics concepts better the students need to see connections between their thoughts, and the mathematics concepts they are studying and their everyday cultural activities (Burek, 1994). Students need to own and value their ideas, their questions and their thoughts. They need to transform their present view that mathematics is a finished product that results from reproducing exactly someone else’s thinking into a view of mathematics as a dynamic and creative process (Burek, 1994).

Other authors like D’Ambroisio (1995), Biembengut (2001), Langdon (1989) suggested alternative ways in which ethnomathematics, can be effectively integrated in the teaching
of transformation geometry. Some of their arguments have been outlined below.

Ethnomathematics bridges culture and mathematics together, forming a connection between the surrounding of the child and the world of mathematics. D'Ambroisio (1995) argues that much of the mathematics curriculum in modern schools is so disconnected from the child's reality so that it is impossible for the child to be a full participant in it. The mathematics in many classrooms has nothing to do with the world that a child is experiencing. Teachers should allow students to develop a personal understanding of why shearing and stretch are relevant to their lives, thereby forming connections; the student is then able to explain and comprehend his or her work on their own terms.

Langdon (1989) warned that if we recognize, that many or perhaps the majority of artisans who create baskets are operating in an instrumental way that is they are following well-defined mathematical procedures, there is a danger of assuming too much about ethnomathematics within culture. He then suggests that students acquire a better understanding of mathematics by discovering it is already part of their environment than by studying cultural examples. Langdon (1989) writes that learning mathematics is synonymous with learning mathematics used by a specific cultural group.

D'Ambroisio (1985) on the other hand emphasizes on the need to acknowledge student coping mechanisms and to consider the way individuals manage situations in life. Since the way people attach meanings to phenomena is a function of culture, therefore D'Ambroisio signifies of the importance of mathematics derived from the environment. This does not mean that all activities need to have originated from the local community,
groups or workers, but ethnomathematics by D'Ambrosio's definition incorporates individual ways of using mathematics in the individual's environment. Unfortunately it seems the students' acceptance and use of ethnomathematics in the classroom has been limited by a restricted view of culture and cultural mathematics and therefore its relevance to all students.

On the other hand researchers like Biembengut (2001) argue that ethnomathematics can be effectively taught through art and design. In this case Biembengut (2001) suggest that art and design stimulate creativity and heighten interest through activities, which places students in contact with nature (considering its beauty, charm and harmony). Art and design involves drawing, cutting and measuring, this develops in students the concepts of isometry (translation and reflection) and geometry (points, segments, parallels and perpendiculars). Therefore ethnomathematics in education based on perception and composition of ornamental design can enable a child to better understand mathematical concepts, improve the discernment of values and the conceptions of the past. The hidden mathematics within such artifacts can be explored and re-discovered by pupils of ones' cultural background and history in mathematics education has been viewed as a factor that cannot only facilitate learning but increases pupils confidence and self-esteem.

Even though certain elements of geometry are universal, teachers can help students understand geometry derived from real life situations, by exposing them to ethnomathematics. Ethnomathematics methods will however vary according to interest motivation of both the learner and the teacher.
2.9 Mathematics instruction in a cultural context

Mathematics instruction is more effective when you place pupils in a cultural context. Fasheh (1988) noted that a common misconception in teaching of mathematics has been, and is still the belief that mathematics can be taught effectively and meaningfully without relating to culture or to the students' immediate environment. After teaching mathematics from a non-traditional approach (cultural perspective), Schultes and Shannon (in Ascher, 1991) discovered that many students gained a greater appreciation for mathematics.

So what can be expected is that students can easily assimilate the mathematics problems depending on how they have been presented. For instance when teaching the geometrical transformations, teachers need to come up with the materials that are easily accessible to the pupils from their cultural backgrounds and place them in contexts where these materials can be used in conjuring out various transformations (Keeney, 2002).

Although context is a powerful determinant of learning mathematics, misconceptions still prevail such as the belief that mathematics of the everyday life is easier than the abstract equivalent and learning of mathematics in an everyday context can ensure the transfer of knowledge. As indicated in the chapter one should not forget that pupils when they enter into a mathematics class they already loaded with their own perceptions of shearing and stretch, which vary from one child to the other. To put children in a concrete problem situation does not always mean that it is coming from a real life situation. Children's reality is also their world of fantasy and imagination Tenuta (in Hamiti & Xhevdet, 2002). The teacher should then come up with a situation that reconciles all the various perceptions. This could mean that the pupils maybe placed in a context that might
complicate the whole issue than what could have been done by the abstract equivalent.

Lave (1988) argues that specific contexts within a mathematical task are better, for they help determine the mathematical procedure and hence the performance. Gerdes (1985) concurs with the above assertion, as he purports that setting a task in a cultural context leads to an understanding that mathematics may be used to 'transform reality'. In this he reconstructs the mathematical components of the Tshokwe drawings in Angola and the rotational symmetries being used in the tattoos of the Makonde of the northern Mozambique. Gerdes (1985) explains how symmetries such as of order 2 can arise naturally in solving problems in areas of weaving. Gerdes then turns to geometry of the line drawing made by the Tamil women in South India during the harvest month.

Through reconstruction of these original patterns some geometrical knowledge is made explicit like transformation and geometrical algorithms. In this case Gerdes (1985) explores the educational implications of their activities and highlights the utility of mathematics, and its involvement in the real world. So this puts ethnomathematics at the center stage of instructional methodology. But how to engage and motivate pupils who are from different backgrounds and with different interests, to apply ethnomathematics in the teaching of shear and stretch remains a challenge.

2.10 Arguments against the use of ethnomathematics
A lot of literature on ethnomathematics seems to point that improvement in instruction can only be attained through the incorporation of culturally relevant material in the teaching of geometrical transformations. Improvement of instruction can however only
take place if the teacher draws his examples, teaching materials from the local environment. But on the other hand, Orey & Rosa (2004) noted that for several years it has been argued that the present school curriculum does not foster a genuine disposition for an ethnomathematics education. And as a result ethnomathematics has not been useful much to the mathematics educators. The argument being that there is not enough time to develop the content that enables teacher to come up with meaningful pedagogical plans. Concern is also on the lack of textbooks and other materials that addresses the issues of ethnomathematics and multicultural education.

Orey & Rosa (2004) argue that there are no assessment instruments that are appropriate to the ethnomathematics program. So in teaching geometrical transformations from a cultural perspective, they warned, there will be a danger of teaching shallow, superficial, and folkloristic material that lack depth and dimension. Orey & Rosa (2004) also noted that because of the lack of personal experience and academic training, teachers are often unwilling to try the cross-cultural methods. For example in the teaching of transformation geometry, it is very difficult for teachers to come up with examples from a cultural context that demonstrate a shear.

Sokal quoted in Greene (2000) noted that there is danger for covering up incompetent teachers who do not really understand mathematics. She alluded that this could undermine the rigor of providing pupils with quality mathematics education by giving teachers with 'math-phobia' of teaching something other than formal mathematics. So in essence the standards of mathematics education will be compromised in Zimbabwean schools.
Sokal quoted in Greene (2000) also noted that ethnomathematics maybe useful but should not be regarded as a 'panacea'. Since problems bedeviling mathematics education have many facets including shortages of qualified teaching personnel to teach mathematics (in this study a qualified mathematics teacher is the one who is a holder of a teaching certificate not just a mathematician), shortages of teaching resources and many others.

Much of the research on ethnomathematics has been undertaken from an anthropological perspective. Dowlings (in Vithal, 1993) criticized 'mathematical anthropology' from the way it was presented in the writings of Gerdes (1985), D'Ambroisio (1985) and Bishop (1988). His criticism of ethnomathematics is that is a 'western' anthropological construct based on, and defined from the western perspective of 'western' mathematics and interpreted in its terms.

Vithal (1993) noted that indigenous people might not on their own accord recognize their practices as mathematical. Nor do people at a work place, who engage in mathematical tasks, necessarily define their activities as mathematical. Dowling (in Vithal, 1993) disagreed with the notion of removing ideas from their social and cultural contexts and defining them as mathematics. In this regard they criticize the work of Gerdes who demonstrates that there exists some 'hidden' or 'frozen' mathematics in traditional African activities such as weaving, fishing and building.

While the above arguments may militate against the implementation of ethnomathematics it is therefore imperative for researchers and classroom practitioners, for them to come up with a program, which will enable goals of ethnomathematics education to be attained. In
my view, despite the shortcomings listed above, ethnomathematics remains a very powerful pedagogical tool for teaching geometrical transformations in the sense that teachers will be proceeding from what the pupils already know. This approach allows students to make connections with historical developments of mathematics and the contributions made by diverse groups and individuals.

2.11 Summary

This chapter has reviewed the relevant literature that supports the incorporation of ethnomathematics in order to improve the teaching of transformation geometry concepts from the ethnomathematical perspective. Although a lot of literature seems to suggesting the adoption of ethnomathematics in order to improve instruction in schools, little progress has been made towards the integration of ethnomathematics education into the mathematics curriculum in Zimbabwe. Detailed studies, concerning the nature of mathematical activity in varied cultural contexts (Gerdes’s basket weaving, Eglash’s fractals, Laves’ grocery shoppers) have shown that’ mathematics is recognized as such mainly by researchers, but not by the practitioners. This means that the reconstruction of mathematical activity through such contexts in its western sense (that is the way it is conventionally represented in mostly current curricula) demands to re-contextualize such practices in didactic situations with a focus on ‘mathematising’. Such a realization demands attention; otherwise the use of such contexts may result in superficial learning experiences. The questions that still need to be answered are about the attitudes of the practicing teachers towards the integration of ethnomathematics, in the teaching transformation geometry, and how this can be effectively integrated.
Chapter THREE

Research Methodology

3.0 Introduction

In this chapter, the researcher gives an outline of the research design and investigates the teachers’ views towards the incorporation of ethnomathematics in the teaching of ‘O’ Level transformation geometry concepts of shear and stretch. In this section the data collection methods will be discussed. In addition the data to be collected and the analytical tools to be used to test the hypothesis of this treatise are also presented.

3.1 Research design

A research design provides materials that cement the research project together. A design is used to structure the research, to show how all the major parts of the research project, the samples or the groups, measure treatments or programs and methods of assignment. This study takes the form of a developmental study. This involved an intensive investigation of the mathematics activities of the local communities. This information was used to compile materials that were used to develop an ‘ethnomathematics program’ (see page 35) that was used in the participating schools. The ethnomathematics program was developed to address the requirements of the 4008/4028 ‘O’ level mathematics syllabus.

A case study evaluation approach, was use, to establish the views of mathematics teachers from the three Bindura urban secondary schools. The teachers were workshopped on how the ethnomathematical materials like basket weaving patterns,
patterns on fabrics, traditional interior design décor and models of structures drawn from cultural backgrounds like the ‘dara’ can be appropriately used to teach the concepts of shear and stretch. A questionnaire on teachers’ views towards the incorporation of the ethnomathematical approach to the teaching of the concepts of shear and stretch was administered at the end of each of the workshops held at these schools. Questionnaires were used because they are familiar to teachers.

3.2.0 Attitude questionnaire

The attitude questionnaire was developed using arguments put up by the researcher about the advantages of introducing an ethnomathematical approach in the classroom and the necessary things to be done if the approach is to be successful.

The themes below formed the basis of the questionnaire construction:

- Personal data of the respondents
- The ways in which ethnomathematics can effectively be incorporated by teachers in the teaching of transformation geometry
- To investigate attitudes of teachers in the use of ethnomathematics in the teaching of transformation geometry (shear and stretch).

In order to guide against the threats to validity and also to find out the reliability of the teachers’ responses, some of the questions were repeated (but in a different form), in other words what was changed was the wording, but the essence of the question remaining the same.
3.2.1 Structure of the questions

Open-ended questions and the Likert scale were used. In an open-ended question, the respondents were given the freedom to answer in a manner they felt like, in this case teachers were asked about their opinions on the integration of ethnomathematics towards the teaching of the concepts of the concepts of shear and stretch, the ways through which ethnomathematics can be effectively incorporated- into the teaching of these concepts. In a Likert scale, most of the questions asked, were concerned with the teachers’ perceptions on the teaching of concepts from an ethnomathematics perspective, then each respondent was asked to rate each item on some response scale. For instance they could rate each item on a 1-to-5 response scale where:

1= Strongly disagree, 2=Disagree, 3=Neutral, 4=Agree, 5=Strongly Agree.

3.3 Target Population

The target population for this study was the “O” level mathematics teachers, especially those teaching the form fours since they might already have identified the problems of their students in the teaching of the concepts of shear and stretch from their assessment.

3.4 Procedure

The researcher made school visits where he conducted workshops with 'O' level mathematics teachers in each of the three schools visited. A total of thirteen mathematics teachers attended these workshops, 4 from Chipindura High School, 5 from Chipadze High School, and 4 from Hermainn Gmeiner. In each of the workshops conducted, the researcher made presentations on the current Square board and geoboard, and ethnomathematical approaches to the teaching of concepts of shear and stretch. The
teachers were then asked to compare both approaches.

The teachers together with the researcher worked through these ethnomathematical materials presented and their suggestions and comments were discussed. As a result of the activities and subsequent discussions, the teachers understood the ethnomathematical approach to the teaching of the transformation geometry concepts. The questionnaire on teachers' attitudes was then administered.

3.5.0 'The Ethnomathematics Program'

3.5.1 Introduction

From the ZIMSEC examiners reports (2000, 2001, 2003, 2004) it has been noted that the performance of pupils in the area of geometrical transformations especially the concepts of shear and stretch is very poor. The main area of difficulty being the failure to calculate the shear and stretch factors, use of vectors and matrices in describing the transformation and among other things the failure to identify the invariant lines. In the Nziramasanga Commission of Inquiry into Zimbabwean Education (1999) report about the education system of Zimbabwe argues that students should be taught mathematics from their own cultural perspective. Such an approach is what is today known as ethnomathematics, which shall be presented below.

There are two approaches that are described in this study. The first one is the Squared Board and /or Geoboard approach that is currently being used in most schools. This shall be briefly discussed since most of the teachers are aware of this approach. The second method is the Ethnomathematics approach, which forms the basis of this study. The teachers shall also be required to give their opinions with regard to the
'Ethnomathematics Approach' in comparison to their current teaching methods.

3.5.2 Objectives of the workshop

- To enlighten or make teachers aware of ethnomathematics approach to the teaching the concepts of shear and stretch.
- To investigate the attitudes of teachers on the ethnomathematics approach to the teaching of the concepts of shear and stretch.

3.5.3 The use of the geoboard and/ or Squared Board in the teaching of Transformation geometry

In 'O' Level mathematics, the 4008/4028 syllabus requires that students be able to carry out the shear and stretch transformations in the x-y plane, including the identification of the invariants and the calculation of the shear and stretch factors.

The teaching methods

Shear

The most common approach by teachers in the teaching of the concepts of shear and stretch is that of using the squared board and in some instances the use of the Geoboard. In this case the teacher demonstrates the concepts of shear and stretch by first drawing a shape on the squared board and ask the students to note the co-ordinates of the shape as illustrated below
Figure 1: Showing a Shear Transformation

The shearing processes which students are required to visualize, as the shape now have new coordinates, then deform the shape. The actual shearing process, which involves the movement of points, cannot be demonstrated on the chalkboard except the product of the shearing process. The mental constructs of each student of what would have happened (or what was involved in that shearing process) are ignored and treated as being insignificant. The teacher then guides the student to identify the line that is fixed (invariant). For example in figure 1, OC along the x-axis is invariant. The points on both sides of the invariant line move by an amount that is proportional to their distances form the fixed line. For instance, by comparing OA' B'C with OABC the students are then required to calculate the shear factor as follows:

Shear factor = distance moved by any point
distance of that point from the invariant line

In order to calculate this, students are required to count the squares on the squared board in order to ascertain the distances moved by the point away from the invariant line. Matrices are also used in describing the transformations. In this case the image of the point is found by multiplying the pre-image with the transformation matrix. For
students to understand there is need for a greater appreciation of matrix algebra by the students. Students should be able to multiple matrices for them to describe the transformation fully.

**Stretch**

In a stretch the teaching approach is similar, that is of using the squared board or the geoboard. The teacher draws the shape on the board and the students are required to note the co-ordinates. The shape is then deformed by stretch transformation and the teacher then demonstrates how to calculate the stretch factor, which is given by the following formula

$$\text{Stretch factor} = \frac{\text{distance of image of point from fixed line}}{\text{distance of the original point from the fixed line}}$$

In order to find the distances the students will be required to count the squares on the grid to ascertain the distances of the numerator and the denominator.

This is illustrated in figure 2 below.

![Figure 2: Showing a Stretch](image)

In figure 2 above the stretch factor is given by \( \frac{AB'}{AB} \)

The transformation above describes a one-way stretch. It is also possible to combine the
two one-way stretches in order to come up with a two-way stretch.

Just like in a shear, matrices can also be used to describe a stretch and this would also require a greater appreciation of matrix operators on the part of the students in order to appreciate the concept of stretch.

3.5.4 Problems associated with the use of the ‘squared board’ and ‘geoboard’ teaching method

The problems associated with this teaching approach are that not all students have a sound appreciation of the co-ordinate geometry, that is some students will fail to locate the co-ordinates of the both the pre-image and the image on the squared board. This also affects pupils who have problems with directed numbers who will find it difficult to identify the direction of shear.

Pupils, who have problems with matrix operators, will find it difficult to manipulate the matrices in order to come with the required image or pre-image.

3.5.5 The Ethnomathematics Approach

This approach involves the identification of ethnomathematics activities and resources that could help teachers plan an ethnomathematics lesson on the concepts of shear and stretch. Having identified the relevant activities and materials, this study also provides an insight as to how these can be used to teach the ethnomathematics lesson.

3.5.6 Identification of the ethnomathematics materials

In this approach teachers need to learn more about students cultural backgrounds. In this the teachers need to explore the geometry that is found in the various aspects of the daily activities of their students, such as weaving, art, architecture, games, pottery, carpentry and shape of buildings.

3.5.7 Weaving

Basket and mat weaving have been in existence in Zimbabwean culture for many years.
Students can 'mathematize' on the various geometrical shapes that appear on mats, fabrics and the baskets that they see in their daily lives. For example in figs 3 below there are baskets that display various geometrical designs.

(Picture courtesy of Gerdes, 2004)

Figure 3: Weaving Patterns on Baskets

From the way the patterns are presented, they reflect some transformation geometry concepts of stretch, reflection, rotation and translation. The student will then be required to 'mathematize', on these patterns and figure out the various transformations thereby
unfreezing' the mathematical thinking, which is 'hidden' or 'frozen' in these techniques (basket making). Students can visualize the relationships between shapes, changes in the size of shapes, brings attention to particular transformations like stretch. While changes in the shape with changing the area may depict a shear.

3.5.8 Architecture and art

Many civilizations have left much information about their cultural development in their architectural designs. For example in Zimbabwe, the Great Zimbabwe ruins and other ruins reveal that there is a lot of mathematics embedded in the Shona people cultural systems. The cultural designs on fabrics, pottery and the interior décor in most rural buildings provide significant information to the studies of transformation geometry concepts of shear and stretch. Some shearing and stretch are reflected in the basic shapes that normally characterize the designs, which are the rectangles, square and triangles.

There is also evidence that the paintings are carefully planned and done with some degree of accuracy (Gerdes, 1990). Since these paintings reveal a lot of geometrical shapes to which pupils become familiar to, teachers by taking the photographs of these shapes and ask students about how they are done, lays a firm foundation on the teaching of transformation geometry. Not only does this enhance the understanding of the concepts, but also pupils begin to realize their relevance to their daily lives. Students are always eager to discover new things, the teacher by bringing various ethno mathematics materials into the lesson may help to stimulate learners' curiosity, which maybe damped when the teacher stick to the chalkboard as the only means of delivering the lesson.
3.5.9 Teachings of the concepts of shear and stretch from an ethnomathematical perspective

The ethno mathematics approach has some constructivist connotations, in which students are required to construct their own knowledge with the help of the teacher. The teacher needs to bring into the lesson, basket weaving patterns, and/or mats. The main argument being that, these materials are familiar to students and by making students 'mathematize' on these materials they can quickly understand the mathematics behind. As indicated above, they quickly see the relevance of the concepts under discussion to their lives, and this may stimulate their curiosity.

How to teach the concept of stretch

In this study the square mat in figure 4 can be used to demonstrate the teaching of the concept of stretch.

Figure 4: A Square Mat

(Picture courtesy of Gerdes, 2004)
The geometry concepts on the mat that need to be explored by students are:

- Firstly students need to identify and describe the main shapes on the mat. In the above figure, the main shape is a square, which is divided into four parts.
- Students are then required to reconstruct these shapes on pieces of paper.
- By concentrating on the single small square for instance (a) in the first quadrant, the students need to describe how this small square can be transformed into square (b) in the second quadrant with one side remaining fixed (invariant). This however describes a one-way stretch. By identifying the corner points on their sketches, of square (a), and calling it A, and the corresponding corner point on square (b) and labeling it as A' the students can easily measure the distances of the point away from the fixed line of the both the image and the original point using rulers and then calculate the stretch factor.

The transformation that maps the square onto the larger square is a two-way stretch.

Basket weaving patterns can also be used to teach a stretch transformation as shown in figure 5 below.

Figure 5: Basket Weaving Patterns
Figure 6: Basket Weaving Patterns
(Pictures courtesy of Gerdés, 2004)

These weaving patterns are visually appealing to the eye in the sense that sometimes they are colored. Therefore, they quickly attract the learner’s interest. This also enables students to make connections with prior knowledge, that is, having encountered these patterns at home it will be easier for the students to assimilate the transformations depicted by the patterns. From the above figure 5a, it can be seen that the series of patterns have been numbered. Each number may be taken to represent the distance from some fixed line.

Activities

The students should firstly note the patterns and define the shapes depicted by the patterns in fig 5a
• From the patterns make them visualize the locus of points that traces the geometric shapes they have identified. The students should also note the measurements used.

• Make the students visualize and describe the relationships that exist between the patterns. And make them demonstrate how each pattern can be mapped to another

• By fixing the pattern labeled 1, and taking the pattern numbered 4, by stretching it to the pattern numbered 8, the student can easily calculate the stretch factor by calculating the distance of the original pattern numbered 4 from the fixed pattern numbered 1 and the distance of its image numbered 8, by counting the number of patterns between them in this case they are 3. The numbers shows the stages, which were moved by the pattern to its new position. In this case the stretch factor is

\[
\text{Stretch factor } = \frac{8-1}{4-1} = \frac{7}{3}
\]

This transformation illustrates a one-way stretch and the pattern numbered 1 will act as the invariant line.

These are not the only material that can be used to teach the transformation geometry concepts but a lot more can be used depending on the cultural backgrounds of the students. The students can then be given ethnomathematics materials that they can work on and then given an exercise later. The essence of an ethnomathematics approach is that students learn by doing, and that teaching becomes learner–centered, rather than it being teacher centered. The materials that students learn by doing are not easily forgotten, than materials that are lectured to them.

It is imperative that the teacher helps to visualize the relevance of a stretch in the students’ daily activities, such that students appreciate the reasons as to why they are learning these concepts in class.
Shear

The concept of shear requires a great deal of creativity on the part of the teacher. While it has been noted that in the first approach that the students have problems in visualizing the shearing process. So this might call for a practical approach.

Approach I

One approach would require students to design a model that would help them demonstrate the shear process. The essence of this teaching approach is to keep in line with the cultural backgrounds of the students. So the structures the students should design should be familiar to them and some should be found in their homes.

The simplest model that students can make in groups, which can be easily used to demonstrate the concept of shear is a “dara”. A “dara” is a four-legged structure that is used in most rural homes for drying plates. It is made of wooden poles, and the shape resembles a table. While a “dara” is used mostly by women, a structure that is similar in shape is a “mutanho” which is used for storing crop husks for supplementing animal feeds in the dry season. A “mutanho” is larger than the “dara” but these structures can effectively demonstrate the concept of shear. For the structures to shear the students should ensure that it remains fixed in one position, it will also be easier for the students to identify the invariant line.

Activities

- Firstly students are required to design the above models using any material that they can get hold of like, small sticks, bamboo sticks, reeds or grass.
- Students are required to describe the geometrical shape that they have created, outlining the measurements they have made.
• The teacher should then help students demonstrate the shearing process, through applying some force on the model, while the object is fixed on one place.

• The teacher should allow students to verbalize the process.

• The teacher should then allow the student; translate these shapes of these patterns onto their pieces of paper. Firstly the shapes before undergoing a shearing process, and after the shearing process. The students should then be able identify the invariant lines. By measuring the distances of the specific point, for example the distances between by the corner points it then becomes easier for the students to calculate the shear factor and ascertain the direction of shear.

Approach 2

Another approach would involve the engineering of materials that or patterns designed on objects that students are familiar to, for example baskets or fabrics. The teacher may choose basket patterns that depict a shear from the weavers or ask them design the shape under his supervision for use in class, for example, the patterns that are illustrated in the fig 6 below.
Figure 7: Shearing Patterns

If these patterns appear on basket or garments they may quickly attract the students' attention. And since some of the patterns would be colored, they visually appeal to the eye.

Activities

- Just like in the above approach let the students describe the geometrical shapes that are depicted in the above diagrams.
- Let them note the measurements used and let them translate these onto pieces of paper.
- Let them describe the relationships that are depicted on the diagram.
- The teacher should help identify the invariant lines and as well as calculate the shear factor.

Teachers should make students understand the relevance of a shear in the real life situations for instance, when building structures are poorly supported they tend to shear, so there is need to guide against this process for it could be dangerous. Shearing can also be observed on the fencing materials when the fencing poles are poorly supported.

3.5.10 Summary of the ‘Ethnomathematics Program’

While these are some of the examples that can be adopted by teachers in the teaching of
the concepts of shear and stretch, these are not the only ways, but there are so many ways. So teachers are encouraged to look for ethnomathematical activities in their communities. They could also use their pupils to uncover the hidden mathematics in their communities.

3.6 Data Analysis
The frequency of each response was counted and recorded. Responses to similar questions were compared and were expressed into percentages. The data was also qualitatively with the goal of documenting the teachers’ accounts of their pedagogical practices a line-by-line analysis of answers provided will be made in order to identify the emerging themes. The focus was also on using teachers’ perceptions of their practice and describing them from the researchers’ perspective in relation to the current knowledge in the field.

3.7 Summary
The focus of this chapter was on research design and methodology of the study. Data was collected through questionnaires and the frequency of responses was recorded. Presentation, analysis and discussion of the data that was collected shall be the basis of the next chapter.
CHAPTER FOUR

Data Presentation, Analysis and Discussions

4.1 Introduction

The central aspects investigated in this study are the challenges being faced by the 'O' level mathematics teachers in schools in the incorporation of ethnomathematics in the teaching of the concepts of shear and stretch and also finding out ways in which the teaching of the concepts can be improved.

In this chapter the research findings presented pertain to the personal information of the teachers who participated in the study, with regard to their sex, professional and academic qualifications, and their teaching experience. Attitudes of teachers on the use of ethnomathematics in the teaching of the concepts of shear and stretch forms the second part in which the results of the study are presented and analyzed. Techniques of integrating ethnomathematics in the teaching of the concepts of shear and stretch have also been discussed including the possible ways through which these can be effectively integrated into the teaching of the concepts of shear and stretch.

4.2 Personal Information

Of the 13 teachers who participated in the study 4 of them were female while 9 were male. In terms of their academic and professional qualifications all the teachers who participated in the study were qualified teachers, 5 of them hold Bachelors of Science Education degrees (BSc Ed) and 8 of them with college teaching diplomas. In terms of their teaching experience, 6 teachers had taught for more than 5 years. While 4 had less
than 5 years teaching experience and 3 had taught more than 10 years.

4.3 Teachers perceptions and attitudes towards ethnomathematics

The frequency table 1 below shows the perceptions of teachers towards the incorporation of ethnomathematics in the teaching of transformation geometry concepts of shear and stretch.
### Table 1: Percentage of teachers’ beliefs about the use of ethnomathematics in the teaching of transformation geometry

<table>
<thead>
<tr>
<th>Beliefs</th>
<th>SA (%)</th>
<th>A (%)</th>
<th>N (%)</th>
<th>D (%)</th>
<th>SD (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>The teaching of the topic on shear and stretch can be improved by using example drawn from pupils' home backgrounds</td>
<td>5(38)</td>
<td>6(46)</td>
<td>2(15)</td>
<td>0(0)</td>
<td>0(0)</td>
</tr>
<tr>
<td>Ethnomathematics is the same as academic mathematics being taught in schools.</td>
<td>0(0)</td>
<td>5(38)</td>
<td>2(15)</td>
<td>6(46)</td>
<td>0(0)</td>
</tr>
<tr>
<td>It is difficult and time consuming to prepare ethnomathematics material for a lesson on shear and stretch.</td>
<td>7(54)</td>
<td>4(31)</td>
<td>1(8)</td>
<td>1(8)</td>
<td>0(0)</td>
</tr>
<tr>
<td>It is difficult to assess students who have been taught the concepts of shear and stretch from an ethnomathematics context.</td>
<td>4(31)</td>
<td>1(8)</td>
<td>2(15)</td>
<td>6(46)</td>
<td>0(0)</td>
</tr>
<tr>
<td>There are no textbooks that have addressed the concepts of shear and stretch from an ethnomathematics orientation.</td>
<td>6(46)</td>
<td>6(46)</td>
<td>1(8)</td>
<td>0(0)</td>
<td>0(0)</td>
</tr>
<tr>
<td>Teaching the concepts from an ethnomathematics makes the content on shear and stretch shallow and superficial</td>
<td>2(15)</td>
<td>0(0)</td>
<td>3(23)</td>
<td>7(54)</td>
<td>1(8)</td>
</tr>
<tr>
<td>It is difficult to incorporate ethnomathematics in the teaching of transformation geometry concepts because we were not trained to do so at college</td>
<td>1(8)</td>
<td>6(46)</td>
<td>1(8)</td>
<td>4(31)</td>
<td>1(8)</td>
</tr>
<tr>
<td>Ethnomathematics can facilitate the use of student-centered approaches in the teaching of the concepts of shear and stretch.</td>
<td>5(38)</td>
<td>3(23)</td>
<td>3(23)</td>
<td>1(8)</td>
<td>1(8)</td>
</tr>
<tr>
<td>Leaning does not proceed as a one-way transmission of knowledge from teacher to student but results from the interaction of the learner with the social environment</td>
<td>7(54)</td>
<td>3(23)</td>
<td>1(8)</td>
<td>2(15)</td>
<td>0(0)</td>
</tr>
</tbody>
</table>

**Key**

SA = Strongly Agree, A = Agree, N = Neutral, D = Disagree, SD = Strongly Disagree

The frequency table was used to represent the statistics of similar responses, with the
purpose of identifying the emerging themes. The table has been categorized into the belief section and responses categorized into Strongly Agree, Agree, Neutral, and Disagree and Strongly Disagree. The Strongly Agree and Agree sections represents the teachers’ responses, which are in line with the belief stated. In the Neutral category the teacher will not be taking any side. The last two sections the teachers are in disagreement with the stated belief.

From table1, of the teachers who participated in the study, 86%(11), indicated in their reflective comments, after the presentation of the ‘ethnomathematical program’, that they are of the opinion that the concepts are better taught from an ethnomathematical context. This implies that the teachers' beliefs are not an impediment in the attempts to teach mathematical concepts from a cultural perspective.

Teachers were asked their views with regard to the differences between academic school mathematics and ethnomathematics. This question helps the researcher to ascertain whether the teachers realize the differences between academic mathematics and ethnomathematics, for this affects the way they handle concepts in didactic situations. From the table above is seems the majority of the teachers ascribe to the belief that academic school mathematics is different from ethnomathematics, whilst about 38% do not recognize any difference between the two and about 15% are indifferent or neutral.

Teachers were also asked whether it is difficult and time consuming to prepare ethnomathematics material for a lesson on shear and stretch. The question is conceptualized around the fact that the apparent failure to incorporate ethnomathematics by teachers maybe that the teachers find preparation of ethnomathematics cumbersome. About 54% of the teachers strongly agreed ethnomathematics lessons were time consuming and very difficult to prepare, 31% agreed meaning that they were of the same
opinion, whilst 8% were neutral and only 8% disagreed with this assertion.

From the question which sought the teachers' attitudes on whether it was difficult to assess students taught from an ethnomathematics perspective, about 61% of the respondents disagreed with the research findings, arguing that its not that assessment is difficult, but the assessment methods required by the syllabus maybe not be congruent with those that are ethnomathematics oriented.

The majority of the teachers tend to agree textbooks pose a greater challenge towards the integration of ethnomathematics in the teaching of transformation geometry. About 92% agreed that the issue of ethnomathematics is not well represented in textbooks, whilst about 8% were neutral. No one seemed to disagree that textbooks are an impediment to the incorporation of ethnomathematics into the teaching of transformation geometry.

In order to establish the impact of ethnomathematics on the depth of the mathematical content teachers were asked of their dispositions on the impact of ethnomathematics on the content. The question asked sought to establish whether the failure to incorporate ethnomathematics was not a result of teachers regarding it as inferior in other words regarding it as shallow and superficial. From the research findings it was noted that the majority of the teachers disagreed with the assertion that ethnomathematics makes the content shallow and superficial. From the above table 15% of the respondents strongly agreed that the teaching the concepts from an ethnomathematics perspective make the content on shear and stretch shallow and superficial. Whilst 23% were neutral, 54%
disagreed with 8 % of them strongly disagreeing.

About 8% of the respondents indicated that they strongly agreed that it is difficult to incorporate ethnomathematics in the teaching of the transformation geometry concepts because they were not trained to do so at college, about 46 % agreed while 8% were neutral. On the other hand about 31% disagreed while 8 % strongly disagreed with the notion arguing that teacher education in universities is adequate for a teacher to use any method of teaching. But an analysis of this variation reveals that the majority tends to support the above assertion. In this assertion concern is on how well equipped the teachers are to implement ethnomathematical methodologies. In Zimbabwe most institutions of higher learning like the Bindura University and the University of Zimbabwe as shown in their prospectuses they do not offer an ethnomathematics course in their teacher education programs. With this lack of direction it is difficult for teachers interested in an ethnomathematical approach to implement it in class.

Teachers’ dispositions on whether ethnomathematics can facilitate the use of a student-centered approach were also asked. About 38% of the respondents indicated that they strongly agreed that ethnomathematics facilitates the use of pupil centered approaches, 23% agreed, while 23% were neutral. On the other hand 8% indicated that they disagreed. An analysis of this variation indicates that the majority of people support the above view.

About 54% of the respondents indicated that they strongly agreed that leaning does not proceed as a one-way transmission of knowledge from teacher to student but results from
the interaction of the learner with the social environment, 23% agreed, while 4% were neutral. On the other hand 8% indicated that they strongly disagreed while 8% disagreed with the above assertion. An analysis of this variation indicates that the majority of people support the above view. The main argument is that students should not be regarded as passive learners, since they have their own ways in which they view the world. In this case they tend to make their own mental constructs of what shearing and stretching are which in most cases will be in contrast with the way these concepts are represented in textbooks. Their learning develops through experience and interaction with the environment, cultural materials and dialogue with knowledgeable others. Teachers’ intervention will thus be geared towards primarily enabling pupils to assimilate and accommodate the curriculum content matter and context.

4.4.0 Teachers’ dispositions on the techniques of integrating ethnomathematics in the teaching transformation geometry

The data collected in the study revealed the following teacher's perceptions:

4.4.1 Use of ethnomathematics approach in the teaching of mathematics concepts

Most of the teachers agreed that the ethnomathematics approach presented to them was indeed important in the teaching of mathematics concepts, and below are some of the teachers’ responses of the question which required them to state their opinions with regard to use of pupils' home experiences in the teaching of the concepts of shear and stretch.

The majority of the teachers regarded the use of cultural experiences as a good idea enabling the pupils to master the concepts better than the squared board and/or geoboard approaches that are currently being used in the teaching of the concepts of shear and
stretch. They argued that the ethnomathematics approach was necessary since mathematics does apply to the environment surrounding us so ethnomathematics need to be incorporated in the teaching of transformation geometry. They also highlighted of the need for teachers to provide clear explanations and links of these cultural experiences to mathematical concepts like shear and stretch with mathematics embedded in their traditional cultural practices.

Some argued that the implementation and imposition of ethnomathematics such as cultural drawings to students would enhance and improve the acquisition of knowledge and skills on concepts of shear and stretch to pupils with more vivid visualizations. This method will only be effective, if the teacher is more informed about the cultural backgrounds of the students whom he is dealing with. But in most cases teachers may not be aware of students’ cultural backgrounds and may find it difficult to use the ‘ethnomathematical approach’ in class.

4.4.2 The problems of integrating ethnomathematics in the teaching of transformation geometry concepts

The teachers noted the following problems to be associated with the ethnomathematics program:

Some students have some negative attitudes towards the integration of ethnomathematics in classroom situations since they might feel that the use of cultural material makes the subject look inferior. Furthermore if proper examples are not used this will serve to confuse the pupils even more. Some felt that since no formal mathematics was used in the designing of artifacts used as teaching aid, some do not have accurate measurements therefore this makes them unreliable.
Problems will be faced in explaining things outside the textbook and most pupils. Some teachers felt that the ethnomathematics in not suitable if the students are to sit for an exam, which is time, framed. Some teachers also indicated that the program maybe a good when introducing the concepts, but it would not be helpful enough when you progress with concepts. In most cases student are likely to fail to relate terms like the invariant line, shear factor and so on to the cultural material you will be using. Teachers included in the study also cited the following as some of the major problems they are likely to face whenever they try to integrate cultural experiences into the teaching of transformation geometry of shear and stretch.

It should not be taken for granted that some of the students from an urban environment may fail to figure out of their own traditional cultural experiences that will be relevant to classroom discussions on the concepts of shear and stretch. Furthermore some of the traditional knowledge has been lost and it needs some retrieval (Garoutte, 1999). In this regard pupils have difficulties in realizing the relationship between mathematics used in their traditional rural backgrounds with what they do in class.

The cultural backgrounds, maybe broad and diverse such that the teacher will be required to hunt for information, which maybe difficult to get hold of. In addition some of the cultures have limited cultural experiences on transformation geometry that illustrate the concepts of shear and stretch. Some teachers also argued that, it is difficult to come up with examples from rural cultural backgrounds of the students and also to procure the ethnomathematical materials that are required in the teaching of transformation geometry
like baskets and mats.

There is no guarantee that the use of ethnomathematics may improve the teaching of the concepts but otherwise aggravate the students’ problems with the concepts of shear and stretch, or may cause some misconceptions that maybe difficult for the teacher to correct.

4.4.3 Students’ problems of learning concepts of shear and stretch from the modern approaches

Teachers’ opinions of the causes of the students’ difficulties on comprehending some concepts on transformation geometry concepts were sought in order to be aware of teacher related causes of students’ difficulties on the learning of the concepts of shear and stretch. The following emerged from the teachers' comments as the probable reasons, which make the topic difficult:

The topic seemed difficult to students and some of the teachers because the content matter seemed to be divorced from the everyday cultural experiences of the students. Also the examples in textbooks used were difficult to understand since some, of them are not drawn from their cultural backgrounds. And in addition students are easily put off by big terms like invariance; shear factor, stretch factor, and how to figure the direction of stretch. The students also find it difficult to apply the materials from other topic like matrices to represent the transformations.

No practical illustrations were done in class, the teacher's are fond of teaching the topic using the squared board (geoboard) to draw the various illustration which are difficult to follow no matter the number of times they repeat them. The main teaching approach was
teacher centered such as the chalkboard explanations, question and answer technique and individual practice when it comes to the writing of exercises.

Among the teachers who participated in the study, some argued that the students and administrators often judge the teachers by their ability to cover the syllabus in time. So in order to avoid blame some teachers allocate less time to the topic. Since most teachers are bend on finishing off the syllabus they will quickly rush through the topic. While other teachers upon realizing that they themselves have difficulties with the topic will not allocate enough time to the topic.

At the workshops conducted, some teachers noted that no matter the effort and the amount of time they allocate to the topic, students will still find the topic difficult, and unfortunately some of the students did argued that they do not take the subject seriously, and it was not expected that they would take the transformation geometry concepts seriously. The math 'phobia' which some of the students have makes the topic even more difficult because they cannot link the concepts of these geometric changes to realistic challenges they meet in everyday life.

4.4.4 How to improve the teaching of the concepts of shear and stretch.

In order to improve the teaching of the topic some of the teachers advocated for the need to adopt an ethnomathematical approach and allocate the topic more time. Their argument being that if the ethnomathematics exposes pupils to the terminology and materials to which they familiar to, such that they can easily understand the concepts. However some teachers indicated that the syllabus pressures and timetable pressures
were some of the factors that militated against the addition of an extra mathematics lesson to make them seven or eight other than the average six lessons in most schools such that the ethnomathematics program can easily be implemented.

Some of the teachers who participated in the study, noted that the textbook examples were difficult for students to follow. Maybe as result of the students not understanding the language used or they would be out of context. Some of the teachers that the use of the geoboard will disadvantage students especially those who had problems with coordinate geometry, for this they argued that teachers should vary their teaching techniques. Teachers’ also noted that there was need for them to vary the teaching styles in order to appeal to all students who have different learning abilities. Teachers should desist from using the geoboard or the squared board as the only means for illustrating the transformations but should involve students in practical activities that involves manipulation of objects that are drawn from the students cultural backgrounds, in other words pupil centered methods should be used. In other words ethnomathematics should form the basis of classroom instruction.

Some teachers argued that in order to make the topic seem easier to pupils there was need for the curriculum planners to introduce the concepts at an early stage as early as the Junior certificate level, in order to afford pupils more time with the topic. It was also the duty of the teacher to break the topic such that the concepts like rotation, reflection, enlargement and translation are taught first and the shear and stretch are taught later rather than teaching them at once which will only serve to confuse the students.
Teacher usually bring in the concepts of shear and stretch factors without a thorough explanation of the origins of these factors such that the students ends up memorizing the facts at the expense of knowing the origins of these factors and their significance. Life becomes more difficult when they are required to use matrices to represent the transformations without a thorough knowledge of the of matrix operators. So in order to avoid this, instruction should proceed from what students know as articulated in the ethnomathematics program.

Some teachers noted the math 'phobia' as one of the major problems with students such that no matter the amount of the effort they put in making the student understand the concepts of shear and stretch, students will still find these concepts difficult. So there is need for the teachers to cultivate a positive attitude towards the subject, and likewise the concepts of shear and stretch.

4.5.0 Improvements that need to be done on the Ethnomathematics program

4.5.1 Resource materials

The majority of the teachers indicated that schools should avail ethnomathematics resources to both teachers and students such as those noted in the ethnomathematical program presented in chapter 3. This will encourage students to use a wide variety of resources when answering questions on transformations and avoid sticking to the recommended textbooks like the New General Mathematics and the Focus on Mathematics and other resource materials like question papers. This will also help dispel the myth that the recommended sources are the only sources that give good explanations
and examples on the teaching of the concepts of shear and stretch and that any other sources is not necessary.

The ethnomathematics program should be sensitive to the syllabus requirements and should specify what needs to be used for each concept so that little time is lost as teachers run around searching for materials that are appropriate to each situation. Their main argument was that the syllabus restricted their activities, and the Zimbabwean curriculum seems to be centered on the examinations system and teachers were assessed by the public on the basis of the performance of their pupils in the public examinations. This restricted view of the curriculum militated against any reform or initiative by the teachers.

Other teachers also noted that students cannot readily appreciate the concepts of shear and stretch in their daily lives and can only be aware of them only after having been taught in the classroom, and after the lesson they tend to forget the concepts together with their application in their daily lives. It is imperative that ethnomathematics program should strive to include materials that pupils use in their daily lives not only the traditional cultural materials. The program should also be responsive to the dynamism of culture. Rather concentrating on the traditional, it should seek to draw its material from the immediate pupils environment. This will avoid the following problems:

- The difficulty of relating examples drawn from their cultural backgrounds to the questions asked in class, because they did not know how to do it.
- The belief that the subject is not of African origin so it becomes difficult to use
examples from their rural backgrounds to link to the euro centric questions.

- Some students have never been to rural areas before so it becomes difficult to relate to experiences that they are not familiar to.

4.5.2 Setting of tests and examinations

The ethno mathematics program should include an assessment scheme as to how the students can be assessed after being taught from an ethnomathematics perspective. The assessment scheme should also be sensitive to the demands of the ZIMSEC syllabus (4008/4028) since Zimbabwe has a centralized examination system. Without this scheme would be difficult linking ethno mathematics content to the current scheme of assessment in schools, taking into cognizance that the majority of the teachers have not been trained to do so at college and Universities which do not seem to offer pedagogy on ethnomathematics and multicultural mathematics education in their teacher training programs. Which means that the majority of the teachers will not bother hunting for cultural materials that can assist them in delivering lessons on transformations. In addition the resources available to teachers in schools have no rural backgrounds orientation.

4.6.0 Discussion

4.6.1 Transformation geometry concepts are better taught from an ethnomathematical perspective

From the study it has been ascertained that majority of the teachers are of the opinion that the concepts of shear and stretch are better taught from an ethnomathematical context. Shirley (2001) noted that culture determines the student’s feeling towards the participation in class, initiating questions, acceptance of authority, memorization of facts,
seeking innovative ways of understanding, and many other aspects of classroom
education. As noted by Shirley (2001) misreading the cultural signs can cause teachers to
misunderstand the students’ learning process or even mistake some students’ responses to
the difficult concepts (like shear and stretch) as an unwillingness to learn. In this vein
Shirley (2001) emphasized on the teachers’ knowledge of students’ interests and
experiences as the key to successful instruction.

4.6.2 The difference between ethno mathematics and academic mathematics

Research literature tends to support the view that the two are different, in that Gerdes
(1996) asserts that before and beyond the ‘imported ’ school mathematics there existed
some other forms of mathematics.

As a way of making the differences more explicit Gerdes gives a range of terms that have
been coined which refer to ethnomathematics:

*Indigenous Mathematics* is the term that has been used by Gay and Cole in criticizing the
education of the Kpelle children in western oriented schools in Liberia in the
1960's(Gerdes, 1996).

*Socio-mathematics* is the term that has been used by Zaslavsky to refer to the
mathematics used everyday in Africa (Gerdes, 1996).

*Informal mathematics* is the term used by Posner to refer to the mathematics, which is
transmitted and learned outside the formal system of education (Gerdes, 1996).

All the aspects referred to by the above terms are embedded in what D'Ambroisio today
refer to as ethnomathematics. Bishop (1990) criticized imported academic school
mathematics which he regards as Euro-centric and serving the interests of western imperialism. He sees the integration of some indigenous cultural aspects as making the subject relevant to the needs of the society. As illuminated in the research findings, the challenge of incorporating ethnomathematics in the teaching of shear and stretch is not linked to the teachers’ beliefs since the majority seems to understand the differences that exist between academic school mathematics and ethnomathematics.

4.6.3 The difficulty of preparing ethnomathematics lessons

The majority of the teachers in the study agreed that ethnomathematics lessons were difficult to prepare and time consuming. It is however true that the ethnomathematics lessons are time consuming and requires that teachers make a thorough preparation. This program could be necessary in that it guides against the use of recycled materials like old notes by teachers, some of whom are adamant, to change their approaches despite their shortcomings. It is also true that ethnomathematical lessons are time consuming and are difficult to accommodate in the 35 to 40 minute lessons that normally characterize, the lesson time allocations in most schools. Similar conclusions were made by

Mogari (2004) concluded that not all the teachers were able to use an ethnomathematical approach in their lessons due to the difficulty of preparing the ethnomathematics lessons and as well as the syllabus pressure particularly in the senior classes. Mogari (2004) noted that of the teachers who were able to adopt the ethnomathematical approach indicated that the students were fascinated by the approach but the teachers complained that more time was required when using such an approach. Nyaumwe and Mavhunga (2005) noted of the existence of what they referred to as the “crowded 'O' level curriculum” this does not allow teachers to allocate a lot of time for students’
experimetalations.

Mogari (2004) also noted that some teachers, whom upon realizing that the ethnomathematics is a learner-centered approach lamented overcrowding in schools being the major obstacle in the adoption of an ethnomathematics program. Large classes are also a characteristic of Zimbabwean schools today could also be another impediment towards the teaching of mathematics concepts from an ethnomathematical context.

Ethnomathematics also requires that teachers understand students' backgrounds. In this case teachers would have to hunt for materials from the students cultural backgrounds that are relevant to the teaching of the concepts of shear and stretch. The engineering of materials that appeals to pupils from different backgrounds would be difficult, so this implies that teaching and planning for ethnomathematics lessons places a large amount of stress to teachers.

4.6.4 Assessment.

This question sought the teachers' attitudes on the school examinations, about whether they do not stand as the major impediment in the integration of ethnomathematics in the teaching of 'O' level mathematics in the teaching of the concepts of shear and stretch. The majority of the teachers were of the opinion that it was difficult to assess pupils taught from an ethnomathematical perspective.

Mogari (2004) noted that the factors such as examinations and the dearth of collegiality in some schools are some of the factors that pose a threat to some pedagogical initiatives. But on the other hand scholars like Ginsburg quoted in Gerdes (1998) in his paper
entitled 'Poor Children, African Mathematics and the Problem of Schooling' argues that if poor children do badly on some tests, there is a greater chance that there is the problem with the test itself than with the child. For this he argues that the teaching of basic skills could be merely effective if the curriculum was oriented to the particular styles of each culture.

While research seems to indicate that assessing students from an ethnomathematical perspective, with some advocating for a research in the way of assessing learning in schools, a change from either a norm-referenced to either criterion referenced or domain referenced -referenced will facilitate the reform.

4.6.5 Textbooks

The majority of the teachers who participated in the study are of the opinions that the absence of textbooks that address the topic on transformation from ethno mathematics perspective was the major impediment in the integration of ethno mathematics in the teaching of the concepts of shear and stretch. These research findings have been corroborated by research literature, which seem to support the view that there are no textbooks that address the concepts of shear and stretch from an ethnomathematics perspective.

Some teachers argued that in their practice they have noticed an over reliance on textbooks by students. The teaching of the content that is not documented in textbooks is likely to create some problems with students since most of the students believed that textbook material is all what they should know, they did not trust any other material
besides the material represented in the textbooks.

Orey & Rosa (2004) noted that there are few if any textbooks published in English that teach mathematics from an ethnomathematical perspective. While the other problem would be that foreigners publish most of the textbooks, but for those that have been published by locals, Wilson quoted in Sibanda & Sialulenga (2004) describes a high level of adaptation of most textbooks, which he describes as falling short of presenting mathematics from an Afro-centric perspective. In addition most the textbooks are written in English. It is not clear how language (although is the main component of ethnology) impacts on the teaching of mathematics (Sibanda & Sialulenga, 2004, Nziramasanga Commission, 1999).

Sibanda & Sialulenga (2004) argue that in real life situations the reasoning capacity of an individual is largely determined by his/her verbal utterances. Whorf quoted by Sibanda & Sialulenga (2004) argue that the way people think is largely determined by the way they speak. This implies that in most Zimbabwean schools where the majority of the students take English as a second language are likely to have difficulties in the comprehension of terms like invariance, shear and stretch factor. Although the main aim of teaching students mathematics is for them to develop skills and use them, but the ability to tackle the problems requires comprehension and interpretive skills.

4.6.6 Content depth

The majority of the teachers seem to disagree with the assertion that ethnomathematics material tends to make the content matter shallow and superficial. The following philosophical question emerged and it generated a debate among the participating teachers, ethnomathematics makes the content superficial or shallow to whose standard?
The research findings from this study tend to dispute, the arguments by scholars opposed to ethnomathematics like Orey & Rosa (2004) argues that use ethnomathematics methodologies like fun and games in mathematical activities results in the loss of academic achievement.

Similar arguments have also been advanced by those opposed ethnomathematics like Jennings quoted in Orey & Rosa (2004) argues that since the major goal of Ethnomathematics is to bring connections between various fields of mathematics; an overload of cultural material will make students unaware of basic laws and fundamentals of mathematics. Cultural diversity tends to militate against ethnomathematics as a teaching approach especially in Zimbabwean urban schools where the teacher has to appeal to students from varied cultural backgrounds. Orey & Rosa (2004) argues that the more multicultural the teaching material becomes, the more diverse the audience the teacher has to appeal to and the greater the likelihood that mathematical lessons become shallow and superficial.

4.6.7 Use of the ethnomathematical approach in the teaching of the concepts of shear and stretch

From the above research findings, it can be deduced that the teachers are of the opinion that the use of ethnomathematics in the teaching of transformations maybe a good idea but they are still skeptical as to how this can effectively be implemented. Their argument was that there is seems to be a conflict between academic school mathematics and personal construct of the students. Volmink (1993) made similar conclusions when he discovered that students often do not realize that mathematical concepts acquired through formal geometry, bear any relation to their common sense notions (constructs). Basing
his study on the notion of congruency, Volmink (1993) argued there are many intuitive experiences out of which students could develop a rich set of representations often come into conflict with formal definitions of congruence imposed on the students in classrooms, this is also true of with the notion of invariance in the case of a shear. In an effort to resolve this students keep these two types of knowledge separate and ascribe to each a different set of meanings.

This should not be seen as a failure on the part of students, but should be seen as a very natural and healthy reaction to the way mathematical knowledge is most often presented to them. Students often try to blend their own constructs with the language and formal definitions acquired in the classrooms. They are left with the impression that if these are in conflict with the formal way of knowing should prevail and the language 'mathematics' should be used to validate their thoughts.

4.7 Summary

There was a general feeling among teachers who participated in the study that ethnomathematical activities could be useful in bridging the gap between mathematics and the children’s cultural activities. Some teachers believe that in order for ethnomathematics to be successful, more time is needed in the classroom, or that the syllabus should be reduced. Their worry was that the approach is time consuming and pupils would not be able to successfully complete the activities within the stipulated times of the lesson. What makes things even worse is the high teacher pupil ratio.

The majority of the mathematics teachers agreed that ethnomathematical activities
encouraged learner-centered approaches. The teachers expressed the need for textbooks and teaching aids with an ethnomathematics orientation and also of the need to provide teachers with the requisite knowledge that would enable them to vary their teaching approaches. The majority of the teachers also felt that the syllabus pressures were the major impediment towards the integration of ethnomathematics towards the teaching of transformation geometry.

The methodology used involved designing an 'ethnomathematical program' to teach transformations and conducting a workshop with teachers on the program to teach transformations and establishing their views of the program by means of a questionnaire. From the study it was established that the majority of the teachers agreed that ethnomathematics activities improved the teaching of the concepts of shear and stretch. The also identified that hinder the integration of ethnomathematics education include the shortage of textbooks that teach transformations from an ethnomathematics perspective. Teacher education program that does not include ethnomathematics and the 'mania' for testing that grips the Zimbabwean education system.
CHAPTER FIVE

Summary Conclusions and Recommendation

5.0.0 Introduction

This chapter provides a summary of the research findings and also offers some research strategies to make the teaching of the concepts of shear and stretch from an ethnomathematical perspective effective. This chapter also offers a scope for future research.

5.1.0 Summary

The study was concerned with the teacher's attitudes towards the incorporation of ethnomathematics in the teaching of transformation geometry concepts of shear and stretch. The investigation sought among other issues to identify how ethnomathematics can effectively be incorporated into the teaching of the concepts of shear and stretch. The methodology used involved designing an ethnomathematical program to teach transformation geometry and conducting workshops at each school for teachers, in order to enlighten them of this approach and then establishing their attitudes towards the integration of this approach in the teaching of the concepts of shear and stretch.

It was established from the study that the majority of the teachers who participated in the study agreed that ethnomathematics improved the teaching of the concepts of shear and stretch. It was also established that a lot of obstacles could hinder the effective integration of ethnomathematics in schools, and among these included the dearth of materials, the
shortage of textbooks that teach transformations from an ethnomathematics perspective, teacher training programs that equip teachers with enough skills to teach ethnomathematics and the mania for testing that grips the Zimbabwean education system. Also another deterrent is the lack of a clear-cut education policy on indigenous knowledge systems, ethnomathematics and science.

5.2.0 Conclusion

It has emerged from the study that while teachers had positive attitudes towards the ‘ethnomathematics program’ the challenge of integrating ethnomathematics in the teaching of ethnomathematics in the teaching of transformations is with the curriculum structure, which places too much emphasis on the examinations. While teachers and researchers all agree that the teaching of the concepts of shear and stretch can be improved if a learner centered ethnomathematical approach is adopted. The most daunting impediment is the examination system, which promotes the engineering of resources that are meant to help students pass the exams, but unfortunately this scenario promotes teacher-centered approaches like drill.

5.3.0 Recommendations

In order to improve the teaching of transformations it is imperative that the curriculum planners examine the Zimbabwean mathematics education system and appreciate that there is indeed a problem as reflected by the poor results and also as reported by the Nziramasanga report. After this they also have to appreciate the cultural constraints on learning transformation geometry by the students within the context of the main curriculum. Once they appreciate these problems, below are some of the strategies, which
they can adopt in order to help teachers improve the teaching of transformation geometry.

5.3.1 **Teaching of the concepts from an ethnomathematical perspective**

What emerged from the research findings was that the teachers had little or no exposure of teaching mathematics from a cultural context, which means that some in-service workshops should be done in order to provide the teachers already in service, with some knowledge and experience with some activity based teaching approach like ethnomathematics. Emphasis should be placed on equipping teachers with some knowledge on how to use cultural artifacts (like the basket weaving and other materials that portray geometry as used by people in their daily cultural activities) and activities in didactic situations. This would enable them to:

- Provide their students with opportunities to learn by doing. Teachers must encourage the participation of all students and they must also emphasize on the value of each and every student’s contribution to learning.

- Use models and examples to demonstrate concepts from the local environment and resources. In this regard students will be able to recognize and apply mathematics outside the classroom.

- Use diagrams, images, charts, models from the cultural contexts to convey concepts and information. Students learn by trying out ideas, so there is an atmosphere of trust where students will feel free to express their ideas. In essence, the student personalizes the given mathematical information in order to develop a stronger understanding of mathematics, making it easier to remember and utilize by way of making ‘connections’.

Teachers should also endeavor to enable students to:
• Foster verbalization of mathematics by using the local environment and teaching methods that emphasize on students' own experiences. This will enable students to develop communication skills, which would enable them to communicate their mathematical thinking, coherently and clearly to peers, teachers and others.

• Should introduce self-assessment of work to avoid alienating students through criticism

With all these considerations it becomes clear that ethnomathematics is central to the process of teaching and instruction in the teaching of concepts of shear and stretch in Zimbabwe.

5.3.2 Sequencing of the materials

The students need to be exposed to the concepts at an early stage, as early as the junior certificate level. The idea is to make the students be acquainted with some of the terminology of transformation geometry at an early stage so that they have more time to deal with these concepts. The topic should be broken down such that the transformations that preserve congruency are taught first while the concepts of shear and stretch are taught later.

It is imperative that teachers ensure that students understand the topics like matrix algebra before introducing to them some complex transformation geometric operations that require the use of matrices.

5.3.3 Examinations

The pernicious effect of examinations was evidenced by the way both; teachers and students approached their learning tasks. They have the impression that learning is all
about passing exams. This perhaps more than anything else stifles creative thought in mathematics and robs students of the freedom to explore. Item writers should also include items that are sensitive to the cultural backgrounds of the candidates so that students the see the relevance of mathematics to their societies. They should not only replace names like John, Peter and so on with names like Chipo, Nyasha and so on but should also include the content matter as well. In the long run, the educators should do away with a centralized examination system, for it only serves interests of a small group while alienating others. An examination system that is sensitive to the needs of pupils from diverse cultural backgrounds will improve the pupils’ performance in ‘O’ level concepts of shear and stretch.

5.3.4 Large classes

- Since ethnomathematics is a learner-centered approach it is not ideal for large classes (Mogari, 2004). So there is need to split these classes into smaller groups, so that the teacher can easily implement the student centered approach in the teaching of transformation geometry.

5.3.5 Timetable

Since the ethnomathematical approach requires more time, it was important that mathematics lessons are given more time on the schools' timetable from the usual six periods to about eight so that teachers are afforded more time to explore.

5.3.6 Textbooks

Most of the mathematics textbooks are written by foreigners and are written not from the
local perspective. So it is important that the Curriculum development unit should invite mathematics educators to come up locally published materials on transformation geometry. They should involve both learners and teachers in building up a pool of knowledge on transformations and this should be published in local languages and be made available to schools which then bequeath students with knowledge. This would also require the engineering of cultural materials that can be used in mathematics education. In order for teachers to improve the student's understanding of the concepts of the transformation geometry concepts, teaching resources should be availed in schools including the materials that would enable the students to explore

5.3.7 Teacher education

Ethnomathematics courses should be introduced in institutions of higher learning. The basic tenet is that a sound understanding of ethnomathematics both as a body of knowledge and as a teaching approach is fundamental, if teachers are supposed to use this knowledge in the teaching of transformation geometry. For them to develop such an understanding, a development program specifically dealing with the conceptual and instructional intricacies relating to ethnomathematics is a necessity. Teachers' must learn special instructional skills to accommodate pupils from different cultural backgrounds and different learning strategies, this will go along way in enhancing the learning and performance of pupils in the area of geometrical transformations.

5.3.8 Conflict between formal mathematical students' knowledge and personal constructs.

In any situation, when the ability of the students to construct their own meanings is respected and in an atmosphere where meaning and understanding are not seen as goals,
students' mathematical experience will not be educative and the structure of knowledge will remain a shrouded mystery. Mathematics education will have to build into the teaching learning process, mechanisms to bridge the gap between formal and informal knowledge of students. This can be done through the incorporation of ethnomathematics into the mainstream curriculum. According to D' Ambrosio(1985) ethnomathematics bridges the gap between culture and mathematics together forming a connection between the surroundings of the child and the world of mathematics.

5.3.9 Educational Policy

The need for policy on indigenous mathematics and science education cannot be overemphasized. The present chaotic manner in which the field is pursued is the direct result of a lack of insight on the part of the government and practitioners in the field.

5.4.0 Implications for future research

As illuminated in the findings of this study, the majority of teachers do understand that there is a difference between ethnomathematics and academic mathematics. But this is not reflected in their pedagogical practices. Further research must be undertaken for teachers to gain a fuller understanding of the relationship of ethnomathematics, academic mathematics and the curriculum. Implicit in such a research is the search for both similarities and differences. This research can then inform curricula decisions about for instance, what and how ethnomathematical knowledge should be integrated into the mainstream curriculum.

While the main aim is to develop a curriculum that is responsive to the cultural needs of
the students, this should be considered within the broad framework of the intended, implemented and attained curriculum perspectives.

At the intended level research should address the following questions: What do curricula based on an ethnomathematics perspective entail at school and national level? How should the issue of dichotomy between ethnomathematics and academic school mathematics be approached?

At the implementation stage research should seek to address the following questions. What does the move from integration of ethnomathematics into the mainstream curriculum involve for the teacher? What approaches are available to teachers to integrate ethnomathematics in the teaching of transformation geometry and other topics? What are some of the problems and consequences of transition to ethnomathematics at the school and classroom level? In this case the focus will be on the impact ethnomathematics will have on the understanding of the concepts of shear and stretch.

Research should also seek to investigate the likely problems and consequences of the transition to ethnomathematics in the teaching of transformations at school and classroom level with respect to classroom dynamics, assessment, evaluation and resources (Vithal, 1993). In the same vein, Mogari (2004) suggest that a study is necessary to determine whether, as part of teacher development program, changing the way of assessing in schools from norm-referenced to either criterion or domain referenced may facilitate reform. Finally research should seek to find the implications of an ethnomathematics perspective for teacher education.
At the attained level the research on the gap between out of school mathematics and academic school mathematics highlights the need for a greater understanding of the characteristics of the school mathematics culture and the way in which it allows or prevents the children from using ethnomathematical knowledge (Vithal, 1993). The question is what factors, situations or classroom conditions affect the passage between learners' informal mathematical knowledge and school mathematics? A much clear understanding of the kinds of knowledge and experiences learners bring to the school is required (Vithal, 1993). A question of 'ownership' of knowledge in mathematics education should be addressed. In this case, Vithal (1993) argues that this is how ethnomathematics can be harnessed to make children feel that they 'own' mathematics.

Pompeu (1992) argues that if an ethnomathematical approach is adopted, since it is child centered, basing on activities and situations taken from the pupils' background participation of the whole society is important. The implication being that unless the wider society accepts an ethnomathematical perspective, attempts to introduce it into the mathematics curriculum in any meaningful way might result in it being marginalized or relegated to the status of an optional subject and viewed in the same way as 'practical' or 'vocational' or 'functional mathematics' (Vithal, 1993). In this regard it is unlikely to have any major impact on student attainment because 'real' mathematics remains equated to 'academic' mathematics in the minds of the students and the wider society.

In conclusion, further research will bring greater clarity and understanding of the construct of ethnomathematics and also provide clear implications for the curriculum.
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APPENDIX A

Van Hiele Geometry Learning Model

Dian van Hiele Geldof and her husband Piire van Hiele both did a doctoral dissertation in 1984 and dealt with students learning geometry and they came up with what can be referred to as the van Hiele assessment tool.

Visualization (Level 0)
In this level students are aware of space. Geometric shapes are recognized holistically by their appearance without paying attention to the components parts. Students functioning at this level can reproduce them upon request. These students can recognize squares and rectangles but do not realize the presence of right angles, opposite sides of the same length etc.

Analysis (Level 1)
Students begin analysis of geometric figures are recognized. Generally definitions are repeated but are not explained. Students would be able to conclude that opposite angles of a parallelogram are congruent.

Informal deduction (Level 2)
Definitions now make sense. Informal arguments about why things are as they appear begin to be formulated. Students know there are relations between properties of a figure. They also become aware of connections between groups of figures.

Formal deduction Level 3
Students begin to understand the role of axioms, rules, terms theorems, definitions and how they are interwoven. The ability to construct, not just memorize proofs emerges.

Rigor Level 4
Abstractions are comprehended. Students can investigate and compare geometries. Students can produce short statements to justify a conclusion logically and can understand that deduction is the method of establishing geometric truth.

Adapted from Aspects of Teaching Secondary Mathematics: Perspectives and Practice by Linda Haggarty (2002).
APPENDIX B

Teachers Questionnaire

A Personal Information
1.1 Department

- Age
  a) below 30 years
  b) 30-40 years
  c) 41-50 years
  d) 51-60 years

1.3 Sex: Tick the appropriate box

- Male
- Female

1.4 Academic Working Experience in years.
   a) Less than 1 year
   b) 1-2 years
   c) 2-3 years
   d) 4-5 years
   e) Over 5 years

1.5 Job status (tick the appropriate box)
   a) Qualified teacher
   b) Temporary

1.6 Academic Qualification (tick the appropriate box)
   a) BSc.Ed
   b) Diploma
   c) CE
   • Any other
B. Teachers Perceptions on ethnomathematics

Please tick in the spaces provided what you think is the appropriate answer to the questions below.

Key:
1 = Strongly Agree, 2 = Agree, 3 = Neutral, 4 = Disagree, 5 = Strongly Disagree, 6 = Don't know

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<thead>
<tr>
<th>Question</th>
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<tr>
<td>The teaching of the topic on shear and stretch can be improved by using example drawn from pupils' home backgrounds</td>
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<td>Ethnomathematics is the same as academic mathematics being taught in schools.</td>
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<td>It is difficult and time consuming to prepare ethnomathematics material for a lesson on shear and stretch.</td>
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<td>It is difficult to assess students who have been taught the concepts of shear and stretch from an ethnomathematics context.</td>
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<td>There are no textbooks that have addressed the concepts of shear and stretch from an ethnomathematics orientation.</td>
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<td>Teaching the concepts from an ethnomathematics makes the content on shear and stretch shallow and superficial</td>
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<td>It is difficult to incorporate ethnomathematics in the teaching of transformation geometry concepts because we were not trained to do so at college</td>
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<td>Ethnomathematics can facilitate the use of student centered approaches in the teaching of the concepts of shear and stretch.</td>
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<td>Learning does not proceed as a one-way transmission of knowledge from teacher to student but results from the interaction of the learner with the social environment</td>
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C. Techniques used to integrate ethnomathematics

- What is your opinion on use of ethno mathematics materials such as cultural drawings in the teaching of shear and stretch?

- What problems do you think are likely to be faced in the incorporation of student's cultural backgrounds in the teaching of the concepts of shear and stretch?

- What do you think are the main problems being faced by students of your students in the learning concepts of shear and stretch using your current teaching approaches?

- In what way do you think the ethno mathematics approach can improve the performance of your students on the concepts of shear and stretch?

. What do you think should be improved on the ethnomathematics program so that its shortcomings can be developed so that teachers can effectively adopt it. Briefly explain your answer.

Briefly explain your answer above.