ETHNOMATHEMATICS: AN INVESTIGATION OF THE MATHEMATICS EMBEDDED IN THE CULTURAL ACTIVITIES OF THE DAMARA PEOPLE IN THE KHORIXAS AREA

MASTER OF EDUCATION

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APPROVAL PAGE

This research project has been examined and is approved as meeting the required standards for partial fulfilment of the requirements of the master of education degree

Internal examiner 1: _____ Date: _____

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External examiner: _____ Date: _____

STATEMENT OF ORIGINALITY

I testify that the research project: 'Ethnomathematics: an investigation of the mathematics embedded in the cultural activities of the Damara people in the Khorixas area', was completed by the author for the University of Namibia. This is the original work of the author except where references are made and these are reflected accurately in the reference section.

_____ _____

Signature of Student **Date**

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DEDICATION

This thesis is dedicated to my late father, Engelhard Charlie /Awaseb, late aunt Mathilde /Huises, late uncle, Titus /Huiseb, late grandmother, Salinde !Gorases for memorable times we spent together. Their wisdom, love and gentleness will always be remembered and the memories of the quality times we shared shall last forever. It is also dedicated to my mother, Frederika /Awases to whom I would like to say “thank you for being such a wonderful mum and for always being there for all of us when needed”. Lastly but not least, to my beloved husband Barthos /Hara-#Gaeb, and our loving children Jacqueline, Rajiv and Bornoz for playing a very important role in my life.

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LIST OF ACRONYMS

BETD	=	Basic Education Teachers Diploma
BTEC	=	Basic Teachers Education Certificate
MHETEC	=	Ministry of Higher Education, Training & Employment Creation.
CGSSS	=	Cornelius Goreseb Senior Secondary School
WJSS	=	Welwichia Junior Secondary School
UNAM	=	University of Namibia
SADC	=	Southern African Development Community
NUFU	=	Norwegian Council for Higher Education Programme for Development Research and Education

ABSTRACT

Ethnomathematics, deals with mathematics that is practiced within different tribal groups and is mainly influenced by the norms, beliefs, and the values that are important to these groups of people. The mathematical practices among the cultural set-ups normally include symbolic systems, spatial designs, practical construction techniques, calculation methods, measurement in time, space, and specific ways of reasoning, which can be translated into formal mathematical representations within identifiable cultural groups. Thus, it is very important to enhance the understanding of cultural diversity of mathematical practices, and to apply this knowledge to the development of teaching and learning of mathematics.

Cultural mathematics means the way people use their own measuring units in their daily lives, when shopping or in any other activities that require measurement. In its activities, people use their cups, pots or any other object available as measurement units.

The present study was aimed at investigating the type of traditional activities that the Damara people were involved in. The emphasis was placed on those involved in traditional sewing and house construction. Quota-sampling techniques were used to select the above-mentioned sample from the sites since there were few people involved in traditional sewing and house construction in Khorixas. Interviews were used to obtain the information from them. The results indicated that the Damara people were involved in various types of cultural activities and practices, and included traditional sewing, house construction, cooking, counting and games. These practices and activities embodied different principles and aspects of mathematics.

Furthermore, this study sought to determine the type of Damara cultural activities that the learners from the grade 10 mathematics classes were acquainted with and how these traditional Damara activities could be linked with the mathematics taught at school at the grade 10 level as well as whether this could enhance better learning of mathematics that is currently perceived to be a very difficult subject in most parts of the world. Random sampling techniques were used to select the two schools (CGSSS and WJSS) at the junior secondary school level in the Khorixas area. The learners were purposively selected from the three mathematics classroom the researcher was given by the host schools and the teachers included in the study were those teaching mathematics to those learners.

The researcher spent a week teaching ethnomathematics to the learners at these schools and administered a test at the end of one week of instruction. The results showed improved performance for these learners although low and the learners were interested in ethnomathematics and requested for more lessons and the immediate incorporation of the Damara cultural aspects into their mathematics lessons.

The grade 10 mathematics teachers were of the view that school mathematics expressed the Western cultures, and that the incorporation of the learners' own cultural activities and objects into the teaching and learning processes of mathematics might be of great value towards developing learners' problem solving skills and positive attitudes.

In conclusion, the study found, that most of the Damara traditional activities contained mathematical elements, which, if investigated, might serve a very important purpose in the classrooms today. Therefore, it is very important to link the way in which people are doing things in real life situations with what is happening at school.

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CHAPTER ONE

INTRODUCTION

BACKGROUND

Mathematics that takes into consideration the culture in which it has arisen, is known as ethnomathematics. In order to gain a deeper understanding of the cultural aspects, which encompass mathematical structures, one needs to consider ethnomathematics as the development of structures and systems of ideas involving numbers, patterns, logics, and spatial configurations. This further involves the examination of the origins of such concepts and how these are used in various cultures (D'Ambrosio, 1985).

More specifically then, ethnomathematics is mathematics as practiced among identifiable cultural groups, such as national-tribal societies, labour groups, children of a certain age bracket, professional classes, and so on. Its identity depends largely on the foci of interests on motivation and on certain codes and jargons, which do not belong to academic mathematics (D'Ambrosio, 1985).

Many people are unconsciously applying mathematical skills in everyday life without realizing its importance. There is a great probability that such skills, if transferred to schools, could advance the teaching and learning of mathematics. The main reason why mathematics is taught at schools is to sharpen real life practices such as counting, ordering, sorting, measuring, weighing, etc. (Ascher, 1991). Therefore, the skills of those applying mathematics in their cultures, without any formalized training, could contribute positively towards better performance by the learners in the classroom. This simply means that the teaching and learning processes in mathematics would benefit greatly if cultural mathematical forms of each society or ethnic group are appreciated, without being underestimated or regarded as primitive, and transferred to schools. The pedagogical potential of, for example, design, counting, geometry, metric systems, weighing, etc. used in cultural mathematical activities are very important, and are closely associated with the beliefs in everyday life of various ethnic groups.

Any type of mathematics, including ‘Western’ mathematics, is greatly influenced by ideas and activities that are important in specific cultures and therefore, should be respected and not taken as primitive. It is only when one comes closer to the people, interacts with them and establishes closer

links that one can really appreciate the importance of what they are doing or involved in.
Some of the mathematical skills observed at grass-root level are often taken for granted, and not considered important or appreciated. Such skills can be witnessed from the day-to-day activities taking place in the environments where uneducated people are continuously involved in income generating initiatives from local resources. The mathematics they apply ranges from simple to complex concepts without them being overtly aware of it. The importance of the cultural aspects of mathematics in such cases can only be realized if studies are done on such activities and published. It should thus not be ignored that people in societies or cultures that do not use mathematics in the way it is done in the formal education systems, also do engage in many cultural mathematical activities that require complex reasoning about space, time, and number (Gerdes, 1986).

There are many ways to use the cultural aspects found in mathematics. Examples range from the study of arithmetical relationships, symmetry and similarity among others. Some human activities that require forms of mathematics are found in architecture, soap making, weaving, sewing, agriculture, games. For example in architecture, construction of houses, other buildings, bridges, terraces, etc. are involved. In soap making, mixing and cooking fat with some chemicals, cooling and cutting into small pieces of soap are involved. Making of textiles and baskets, with or without design and ornaments are found in weaving. In sewing, flat pieces of cloth or animal skins are turned into clothing or shoes that fit. In agriculture, e.g. devising calendars to mark seasons, planning for quantity and storage facilities, layout of gardens and fields, counting animals and other properties are found. Games reveal a highly developed mathematics. Products from wires such as toy cars and other products are made by using right angles and other mathematical principles (Gerdes, 1999).

Mathematics taught in most schools has had its origins from the cultural findings that mainly emphasized the Greek, ancient Egyptian and the Western cultures. All these cultural findings provide a rich source of material about numbers, numeration systems, written numerals, computational methods, and applications (D'Ambrosio, 1985).

A growing awareness of the societal and cultural aspects of mathematics and mathematical education worldwide began to emerge within the ranks of mathematicians in the early 1970s. Wilder (1974), who intensively investigated the cultural influence in the teaching and learning process of mathematics, spearheaded the understanding of culture to describe the processes of

mathematical development in the West.

During the mid-1970s, these processes were intensively developed by the Brazilian, Ubiratan D'Ambrosio, who coined the term "ethnomathematics", and has since made important theoretical contributions as well as laid down research guidelines in ethnomathematics (Gerdes, 1996).

D'Ambrosio (1985), also known as the father of ethnomathematics, described the mathematical practices that include symbolic systems, spatial designs, practical construction techniques, calculation methods, measurement in time, space, and specific ways of reasoning, which can be translated into formal mathematical representations within identifiable cultural groups. With these efforts, D'Ambrosio, like Zaslavsky (1990), attempts to enhance the understanding of cultural diversity of mathematical practices, and to apply this knowledge to the development of teaching and learning of mathematics.

A narrow Eurocentric approach to mathematics programmes in schools severely restricts the learning of mathematics by children and adults from diverse cultural backgrounds. Learners from multicultural backgrounds bring different cultural patterns to the classroom through language use, space and time interactions, problem-solving techniques, and inter-actionable styles. They also bring different prior experiences and frames of reference for imagining concrete applications to abstract ideas. By employing teaching methodologies that support varied cultural styles and experiences thus help students to connect the different mathematical ideas. Therefore, efforts in education should have, as a main focus, the intention of raising the level of cultural consciousness and developing self-esteem through the unbiased promotion of the use of diversified modes of coping with, managing and explaining the concepts. This will help students to become aware of the role of mathematics in society, realize that mathematics is a dynamic, growing, and changing human activity, and to learn to appreciate other cultures (Zaslavsky, 1990).

Furthermore, in most cases learners do not associate mathematics in the classroom with the daily life (Fasheh 1980). There is hardly any connection, for example, between simple arithmetical problems and the cultural mathematical activities outside the classroom. Those on the streets, applying cultural mathematical skills do not even realize the value of these skills or the impact they would have when transferred to classrooms, and used to solve mathematical problems. For example, people from the informal sector, selling their products on the street have sound

mathematical knowledge that they are unconsciously applying during the marketing process.

It is possible to negotiate with these people on prices but whatever decision taken, they will make sure that they benefit as well from the transaction. If a similar mathematical problem is given to be solved in the classroom situation, the learners will find it very difficult to link it to the real life situation and may fail to solve it. The reason for this is that the learners study mathematics without understanding it or linking it to the way in which things are done in their living environments.

Another example is, some children who normally bend wires and make wire cars or other products use different angles and shapes. They do this, without realizing that they are applying the Pythagorean Theorem or other mathematical principles (Gerdes, 1986) in creating the wire cars.

The mathematics teachers, the learners, their experiences, and their culture are extremely important factors in teaching and learning mathematics. Hence, teaching and learning mathematics through cultural relevant and personal experiences will help the learners to know more about reality, culture, society and themselves. It will in turn, help them become more aware, critical, appreciative, and self-confident of themselves. It will also help them build new perspectives and syntheses, seek new alternatives, and will enable them to transform some existing structures and relations into constructive mathematical ideas and concepts (Fasheh, 1980).

Namibia is a multicultural country with 11 ethnic groups, upon which dominating Eurocentric cultural systems were imposed during colonialism. Within the cultures of all the ethnic groups in Namibia, there exist powerful mathematical ideas in many different contexts such as agriculture, woodcarving, basket weaving, sewing, games, etc. Today, in independent Namibia, it is very important to modify mathematics education so that it can effectively build upon and reinforce the diverse cultural traditions in Namibia. This is extremely important because by engaging students in a variety of cultural mathematical activities, from examples in their environments, learners' beliefs about mathematics will provide them with the opportunity to see the relevance of mathematics in their own lives. Such an approach would demystify abstract mathematical concepts greatly, and act as an empowering tool in getting to grips with the subject.

Namibia's colonial past (spanning over 100 years notably under German and Apartheid South African occupation) proved to have been immensely disruptive and destructive of traditional

societies, economies and established authorities. The ability of indigenous communities to control their own destinies or their environment was undermined by heavily centralized colonial authorities. Similarly, the colonial economies practically wiped out traditional rural industries like weaving, pottery and metalwork of which the political, economic and socio-cultural developments that accompanied this general process were built in almost all parts of the colonized world (Wilder 1974).

Kapenda, Kasanda & Onstad (2001) conducted studies on what type of knowledge is used in the market place among the Ovambo people in northern Namibia, to what extent this knowledge differs from the mathematics taught in schools and how it can be incorporated in the classroom situation. They found that this knowledge was mostly based on pure estimation and simple addition. Furthermore, they established that there was a gap between the classroom mathematics and real life situations and proposed that this gap be filled by incorporating the practical or cultural aspects of mathematics into the school curriculum.

Like in all other societies, culture plays a vital and profound role in everyday aspects of the existence of the Damara people. The Damara people are known for their beautiful decorative art. These range from the colourful textiles, cloth, bedcover sets, dresses with geometric motifs to repeated patterns, impressive animal skin mats, bags, shoes, etc. that provide an excellent medium for analysis of symmetry.

STATEMENT OF THE PROBLEM

The Damara people, who are about 100 000 in number and make up 7% of the entire population is the oldest ethnic group who speak a *Khoisan* dialect and live in South Western part of Namibia. (http:www.namibian.org/travel/namibia/population. 2003). They are mixed farmers who keep life stock and cultivate crops in semi-nomadic gardens and their traditional crafts include leather goods, glass and metal beadwork, wooden bowls and buckets, clay pipes and bowls, and more recently 'township art' such as wire cars. The Damaras are divided into several small kingdoms and chiefdoms. Damara women share similar Victorian style of dress as the Herero and Nama.

The present study sought to identify the mathematical constructs existing in the Damara cultural activities in Khorixas in the Kunene Region. In addition, it investigated the type of influences these cultural aspects have on the performance of learners in mathematics at schools.

QUESTIONS OF THE STUDY

1. What type of mathematics is found in the cultural activities of the Damara ethnic group in the Khorixas area in traditional sewing and house construction?
2. Which mathematical principles and laws at the junior secondary level would be applicable to the cultural activities of the Damara people in Khorixas and how could they be applied in the teaching and learning processes of mathematics?
3. How can teachers integrate cultural mathematical activities of the Damara people into the teaching and learning processes of mathematics at the junior secondary school level in Khorixas?
4. How can the mathematics embedded in the Damara cultural activities be integrated into the teaching and learning processes in the mathematics classrooms at the junior secondary school level in Khorixas?

SIGNIFICANCE OF THE STUDY

This study was important because of the following:

- Traditional, economic and cultural activities of the Damara people such as animal skin shoes, mats, blankets production, etc. were threatened with extinction during the colonial era, that extremely a large part of the original activities have disappeared. Some cultural elements, however, survived the colonial scourge, and remained important socio-cultural heritance of the Damara people. The present study thus concentrated on illuminating surviving culturally specific mathematical thinking/activities of the Damara people in the Kunene region, and attempted at sensitising the community to the value thereof.

- Through this, the study attempted to rediscover the power and beauty of the nearly forgotten and devalued cultural mathematical activities of the Damara people.

- This is the first study to investigate 'ethnomathematics' among the Damara people. It is hoped that the study would familiarise the readers on the cultural mathematical activities found among the Damara ethnic group in Khorixas in the Kunene Region.

- The present study motivated learners and teachers at the junior secondary level in Khorixas to apply mathematical activities, found in their own culture such as in agriculture, games, needlework, etc. in the classrooms.

- It investigated whether the use of mathematical activities embedded in the Damara culture enhanced the learning of mathematics in the classroom.
- It made proposal to mathematics teachers in Khorixas about the culturally relevant approaches to teaching mathematics at schools that could be integrated into the mathematics lessons for motivation, as well as to encourage improved results.

DELIMITATIONS OF THE STUDY

The first part of the present study was restricted to the Damara cultural mathematical activities that are found outside the classroom environment among the Damara people. The second part was to determine the types of Damara cultural mathematical activities that could be transferred to the school and how these could be used in the teaching and learning processes in the classroom.

LIMITATIONS OF THE STUDY

The problems encountered in carrying out of the present study were as follows:

- Financial and transport problems to reach all the targeted schools and people to be interviewed in Khorixas and its surroundings.

- Many of the Damara cultural activities were not sustained during the colonial era. Because of this only few people have continued practicing Damara traditional sewing and house construction. Accordingly, the researcher was forced to make use of quota-sampling techniques as well as of what the situation offered.

- Lack of sufficient literature to support this study. It is hard to find books and articles on ethnomathematics in Africa in general and Namibia in particular, therefore the researchers relied heavily on the resources from the internet.

DEFINITION OF THE TERMS

The following are definitions of terms used in this study:

Culture:

Culture comprises traditional ways of making sense of and conducting oneself in the world. Culture applies to any group with coherent norms and traditions that help members to engage themselves in the world around them (Olivier, 1998).

Ethno:

The term ethno includes all culturally identifiable groups with their jargons, codes, symbols, myths and specific ways of reasoning and inferring (D'Ambrosio, 1985).

Ethnomathematics:

Ethnomathematics is the study mathematics as embedded in the cultural context of each society.

Damara:

Damara is an ethnical group that is classified under the *Khoi-Khoi* tribal group in Namibia and is mainly settled in the South Western part of Namibia in the Kunene Region.

Damara traditional/cultural activities:

The indigenous practices that the Damara people are involved in.

Damara traditional clothing:

Victorian type of clothing that is uniquely worn by the Damara women.

Khoi-khoi tribal group (*Khoisan*):

The Damara, Nama, and San speaking ethnic groups, sharing the same vernacular in Namibia.

Khoi-khoi Gowab:

The native vernacular spoken by the *Khoi-khoi* tribal group.

Initiation period:

In this study the initiation period refers to the time when a young girl got her menstruation for the first time.

CHAPTER TWO

REVIEW OF RELATED LITERATURE

INTRODUCTION

In this chapter written materials on ethnomathematics in Africa and elsewhere is reviewed. The chapter addresses the following aspects:

- Definition of Ethnomathematics.
- Type of mathematics found in the cultural activities of the non-European people.
- Interpretation of the cultural mathematical activities in different cultural environments.
- Integration and application of cultural mathematical activities in the teaching and learning process of mathematics at schools.
- Application of mathematics principles and laws in the teaching and learning process of mathematics.
- Integration of mathematics embedded in the cultural activities into the existing mathematics syllabus.

DEFINITION OF ETHNOMATHEMATICS

Ethnomathematics is defined in a variety of ways. D'Ambrosio (1985) gave a broad definition of ethnomathematics as the mathematics, which is practiced among identifiable cultural groups, such as national-tribal societies, labour groups, children of a certain age bracket, professional classes, and so on. Gerdes (1996) defines ethnomathematics as the cultural anthropology of mathematics and mathematical education and explains that ethnomathematicians emphasize and analyse the influence of socio-cultural factors on the teaching, learning and development of mathematics.

On the other hand, Zaslavsky (1979) deals with, what she calls, the 'sociomathematics' of Africa, whereby she considers the applications of mathematics in the lives of African people. Zaslavsky discusses written, spoken and gesture counting, number mysticism, concepts of time, numbers and money, weights and measures, record-keeping (sticks and strings), mathematical games, magic

squares, graphs, and geometric forms and describes ethnomathematics as a discipline that studies mathematics as embedded in the cultural context of each society. She argues that Africans certainly had developed counting systems and systems of weights and measures for trade and other purposes before colonialism. Zaslavsky draws heavily on this idea and concludes that Africans must have employed mathematical principles in the construction of massive buildings and used geometry in the design of lovely textiles and other works of art. According to Bishop (1988), ethnomathematics is a discipline that has adopted a broad conception of mathematics, including in particular, counting, locating, designing, playing, and explaining. Powell and Frankenstein (1997) used the broader definition of ethnomathematics by D'Ambrosio and perceived ethnomathematics to be more than just the study of mathematical ideas of non-literate peoples. Sierpinska (1996), on the other hand, states that ethnomathematics is the study of mathematical thinking in different cultures. Although meaning the same thing, different approaches are being used by different cultures to come to the same conclusions. These ideas might prove instructive if transferred to the learning situation in schools.

Type of mathematics found in the cultural activities of the non-European people

Colonialism played a crucial role in denying or subduing the contributions made by non-European peoples to the development of mathematics. Apart from that, most histories of mathematics generally ignored the history of mathematics in Africa. As a result, today there is hardly any literature available to provide witness of the mathematics that Africans have been involved with. D'Ambrosio (1985),

Bishop (1988), Gerdes (1996), Zaslavsky (1975) and others, consider mathematics as a pan-cultural phenomenon and propose a broad conception of it to include counting, locating, measuring, designing, playing, explaining, classifying, sorting etc. D'Ambrosio, Bishop, Gerdes and Zaslavsky intentions have been to investigate the mathematical cultural activities that different ethnical groups are involved with and to discover the important mathematical laws and principles that are hidden in the everyday lives of non-Europeans.

D'Ambrosio (1985) places ethnomathematics between the history of mathematics and cultural anthropology and notes that ethnomathematics has a life of its own, and evolves as a result of societal changes. He argues that new forms of societal development simply replace former ones. Because of this, the cumulative character of ethnomathematics is rarely recognized, and its status as

a scientific discipline becomes questionable. This means that ethnomathematics is not recognized as a structured body of knowledge, but rather as a set of ad hoc practices, which implies that ethnomathematics should not be viewed in its own light, but rather be incorporated into the western mathematics.

D'Ambrosio (1995) talks about two categories of mathematics, an academic (school) and cultural mathematics. He explains the differences between the two main categories of mathematics, ‘academic' and 'cultural' and refers to the criteria of rigour, nature, domain and breadth of their pursuit. He examines the areas in which these categories can be used, why they are pursued and practised, and why they progress. The conclusion drawn when comparing the ‘academic’ and ‘cultural’ mathematics is that because the essence and importance of mathematics in modern society has been associated with the academic mathematics only, low achievement in school mathematics has been persistent because of the learners who become less and less interested in school mathematics, which mainly emphasizes the academic mathematics.

D'Ambrosio (1995) further points out that ethnomathematics reveals all mathematical practices of day-to-day life of professional practitioners and multicultural mathematics. This also includes the "academic mathematics", taking into account the historical evolution, with the recognition of all natural social and cultural factors that shaped human development, he adds.

Powell and Frankenstein (1997) also challenged the Eurocentrism in mathematics education and compared practical (cultural) mathematical knowledge found in the traditional mathematical communities with the abstract, and theoretical (academic) mathematical knowledge valued highly by the Western world. They argue that the study of ethnomathematics is a powerful means to validate students' live experiences.

An individual who is not capable and proficient in practical or every-day mathematics cannot deal with the complexity of daily life (D'Ambrosio, 1995). He notes that society as a whole is becoming more mathematised, and that individuals can be more capable in coping with situations, which, require more cultural mathematics or" ethnomathematics".

D'Ambrosio (1997) explains that much of the research in ethnomathematics today has been directed at uncovering small achievements and practices in non-Western cultures that resemble Western

mathematics. Although the Western mathematics remains the standard of rationality, D'Ambrosio (1997) suggests that if other cultures had a few more centuries of development, they might have reached higher stages of rationality. The thinking behind this is that the Western civilization, referred to by D'Ambrosio as a 'colonial enterprise' globally, threatened and halted developments in non-Western cultures by imposing inferior knowledge to societies without considering their needs, cultures and aspirations.

Interpretation of the cultural mathematical activities in different cultural environments

To argue for a more culturally situated approach to mathematics pedagogy, Fasheh (1980) discusses the differences between the mathematics that he has studied and taught, and the mathematics that his mother used on a daily basis. He believes that the mathematics he had been practising has no power to make connections with anything in his community. This school mathematics is connected solely to symbolic power without the ideological support system, he maintains. He is convinced that the mathematics his illiterate mother used in the household was much more needed than the mathematics he studied and taught. His words provide a powerful critique of the abstract, symbolic and academic mathematics taught in our schools.

Gerdes (1999) investigated the cultural mathematical activities of the Tchokwe (Sona) people, from Angola in the Lunda Region. He describes and discusses the mathematical aspects found in their decorative art, ranging from the ornamentation of plaited mats and baskets, iron works, ceramics, engraved fruits and tattoos into calabashes, paintings on house walls and sand drawings. He concludes that incorporation of the Sona tradition in the mathematics curriculum, both in Africa and the other parts of the world might contribute to the revival and valuing of the old practices of the Sona people. It might also reinforce the appreciation of the value of the artistic and scientific heritage of the African continent, and may contribute towards the development of a more productive and more creative mathematics education.

Gerdes (1996) illustrates the relationship between culture and the ways in which people engage in mathematics in their daily lives. For example, he analysed the Nigbe Alladian, a game played in West Africa. His analysis revealed sophisticated calculations and notions of probability that are found in this game.

D'Ambrosio (1985) argued that culture depends on groups of individuals sharing a common

environment and means of communicating with each other. However, one should not ignore intercultural differences. It is obvious that individuals sharing different social environments, or belonging to different groups/communities, show different patterns of behaviour. It is thus very important for cultural differences to be taken into consideration during the teaching and learning processes in schools if learners of diverse cultural groups are to be successful in the classroom.

Fasheh (1980) reasons that mathematics should not only be taught within one culture and as separate from other cultures. He explains that advances in one culture, which are to be translated to fit the borrowing culture, should be understood and welcomed by other cultures. To illustrate this idea, Fasheh gives an interesting example of imported fridges from France that are filled with Arabic foods in Palestine. With this he shows that although accepted and encouraged, meanings and implications of the imported ideas should be locally processed. To be more precise, the school mathematics should be adapted to fit into specific societal frames of reference.

Sierpienska (1996) emphasizes that a person's beliefs, cognitive norms, his/her world view could all be sources of hindrance to understanding the theoretical framework of contemporary scientific knowledge.

She believes that development is a cultural affair. Sierpienska recommends that the mathematics teachers should provide learners with experiences in which they can investigate a variety of problem situations and explore problems, which involve the processes of scientific and social decision-making.

Drawing from the discussions above, ethnomathematics entails all cultural mathematical activities and thoughts that are consciously or unconsciously practiced within different social cultural set-ups which, although similar might be interpreted uniquely because of the different environmental influences.

Integration and application of cultural mathematical activities in the teaching and learning process of mathematics at schools

In support of Fasheh's (1980) argument, Gerdes (1996) notes that one of the principles of good teaching lays down the importance of understanding the cultural background of the pupils and relating the teaching and learning process to it. In order to succeed in challenging students' perceptions of mathematics, teachers should instead look for opportunities to construct lessons using cultural objects that are found in the students' immediate surroundings. This will only be

realistic if the classroom teachers are provided with practical ideas of how to create more comprehensive mathematics teaching using objects within their environment.

Mogege (1999) investigated the relationships between cultural games and the teaching and learning of mathematics. The main aim of his work was to look at various cultural and traditional games that are found in different cultural settings, with a view towards making use of these games in the mathematics classroom. Through the interaction with learners' everyday activities in the context of the mathematics classroom, Mogege analysed how mathematical knowledge was structured and developed within the cultural and traditional games. The results from this study were that the mathematical concepts hidden in the cultural games would be very motivating and useful in the teaching and learning of school mathematics.

Application of mathematics principles and laws in the teaching and learning process of mathematics

Gerdes' (1999) work explores mathematical concepts found in the context of handicrafts such as basket weaving, woodcarving, and symmetrical metal grate patterns found in cultural products and paintings in Mozambique. He discusses the more abstract mathematical principles found in counting practices and mental arithmetic. He further examined how some of the ideas invented by the Sona women from Angola in the Lunda Region can be related to the Pythagorean Theorem and acknowledges the diversity, richness, and pleasure of mathematical ideas found among the Tchokwe people.

Gerdes (1999) also proposes that the school curricula should be multicultural in order to improve the quality of mathematics education. This realization forces Gerdes to opt for educational systems that are more firmly grounded in traditional African experiences and practices that emphasize the importance of cultural compatibility in pedagogical methods.

Fasheh (1980) has advocated for ethnomathematics as an approach to mathematics pedagogy that may be more appropriate for the needs of students. He deals with the interaction between mathematics instruction and established cultural patterns of belief, thinking and behaviour in the Third World countries. Fasheh points out the importance of culture in influencing the way people see things and understand concepts, as well as the importance of using culture in making the teaching of mathematics more effective and meaningful. He further points out that in the developing

countries, mathematics is usually taught as a set of rules and formulas that students have to memorise, and consists mostly of a set of nonsensical problems that students have to solve. Based on this point, one can assume that the main reason for studying mathematics for most students in the developing countries is to pass examinations, irrespective of whether the content was understood or had a meaning to their day-to-day activities. This is where the misconception in mathematics teaching is, that mathematics can be taught effectively and meaningfully without relating it to culture or to the individual student's cultural experiences, where it can be used to stress one's own culture with its special characteristics.

Powell and Frankenstein (1997) analysed the role of students' cultural mathematical activities in the mathematics classroom and noted that better understanding of ethnomathematics will serve as a means to improve teaching and learning of school mathematics. This view is, in support of Sierpienska (1996) who indicated that Ethnomathematics emphasizes that the teaching of mathematics in schools should be grounded in such problems and contexts that are familiar and meaningful in the cultural environments of students and encourage them to use whatever means they like to approach these problems.

Integration of mathematics embedded in the cultural activities into the existing mathematics syllabus

D'Ambrosio (1995) proposes for a more global, clearly holistic approach when incorporating the results of anthropological findings into the mathematics syllabus. He suggests that these inclusions should be part of the curriculum development in the developing countries because, when mathematics in schools is associated with European thoughts only, it proves to be a hindrance to learning of mathematics by children from other diverse cultural backgrounds.

Gerdes (1996) also examined several practical applications of cultural mathematical activities with the aim of developing a culture-oriented curriculum. He argues that mathematics and culture have a lot in common and should not be dealt with in isolation from one another when it comes to teaching and learning processes at schools. This will enhance motivation for learning mathematical concepts and principles, he concludes.

During her investigation of the effects of multicultural mathematics in the curriculum, Zavlavsky (1979) proposes for the incorporation of ethnomathematical research findings into mathematics

education. She indicates that African countries face the problem of low levels of attainment in mathematics education because many children experience mathematics as a strange and useless subject, imported from outside Africa. Zaslavsky reasons that one of the causes is that goals, contents, and methods of mathematics education are not sufficiently adapted to the cultures and needs of the African peoples. Like Fasheh (1980), Zaslavsky suggests that the mathematical heritage of the peoples of Africa be valued and African mathematical traditions be embedded into the school mathematics curriculum.

Zaslavsky (1991) offers suggestions for introducing a multicultural perspective into the mathematics curriculum. She reasons that incorporating ethnomathematics in the classroom will effectively validate students' cultural identity and hence encourage them to learn to respect and appreciate the contributions of all peoples in all parts of the world. She further explains that the introduction of multicultural, interdisciplinary perspectives into the mathematics curriculum has the following points in its favour:

- Students become aware of the role of mathematics in all societies. For example, students realize that mathematical practices arise out of people's real needs and interests.

- Students learn to appreciate the contributions of cultures different from their own.

- They take pride in their own heritage.

- The students develop self-esteem and become more interested in mathematics (Zavslavky, 1991).

CHAPTER THREE

RESEARCH METHODOLOGY

INTRODUCTION

In this chapter the following aspects were addressed:

Research design, population, sample, sampling techniques, research instruments, pilot study, data collection procedure and data analysis.

Research design

The present study was descriptive, quantitative and exploratory in nature. Accordingly, it enabled the researcher to scientifically and logically describe the responses from the respondents. By using the naturalistic inquiry with a holistic emphasis, the researcher's role was more neutral in gathering, elucidating and interpreting of the data. The study was conducted in a natural situation whereby what was happening as it naturally occurs was observed without any manipulation of variables, simulation, or imposing an external structure on the situation. This means that the researcher described the context in qualitative terms without imposing own value systems on the situation. Most of the theory development was based on the data collected and the qualitative design chosen was important in a sense that it made room for flexibility and adaptability in this study which implies that most of the questions automatically come from the inquiries, and during interactions and observations (Borg and Gall, 1989).

Population

The population composed of the Damara community involved in the cultural activities in traditional sewing and house construction in Khorixas in the Kunene Region.

Sample

The sample for this study comprised of 65 individuals of whom twelve were females between the ages of 30 to 64 years, involved in traditional sewing; five were males, between the ages of 42 to 59 years, involved in traditional house construction. Forty five were learners from three mathematics classrooms in grade 10, of whom 14 females and six males were from Cornelius Goreseb Senior Secondary School (CGSSS); seven females and six males were from classroom A, while seven

females and five males were from classroom B. Both classes were from the Welwichia Junior Secondary School (WJSS). Three were the grade 10 mathematics teachers, of whom one was from the Welwitchia Junior Secondary School, and the other two from Cornelius Goreseb Senior Secondary School.

Sampling techniques

In order to make use of what was available at the site, quota-sampling techniques were used and the researcher relied on accidental choice within the population. A quota sample is a convenience sample with an effort made to ensure a certain distribution of demographic variables. Subjects are recruited as they enter the research situation and the researcher assigns them to demographic groups based on variables like age and sex (http://www.cmh.edu/stats/definitions/quota.htm, 2003). In this study, this meant that because there were very few people involved with cultural activities in Khorixas, the researcher was forced to make use of the sample that the situation offered.

Random sampling techniques whereby each item or element of the population has an equal chance of being chosen at each draw, were used to select the two schools in the Khorixas area. Random sampling was appropriate for this purpose in order for every school at the junior secondary level to have a chance to be included in the study.

The learners were purposively selected from the three mathematics classes that were given to the researcher by the host teachers. A purposive sample was chosen by the researcher subjectively in an attempt to obtain a sample that appeared to be representative of the population (http://www.gifted.uconn.edu/siegle/research/Samples/purposivesampling.htm, 2003).
The teachers were those teaching grade 10 mathematics to the learners included in the study.

Research instruments

Primary data-gathering instruments through out the present study were the interview, questionnaires and non-participant observations of the sample. The questions were derived from the literature that was read.

Informal interviews were carried out with the sample involved in traditional sewing and house construction in order to observe what they were actually involved in and to capture their responses and actions sufficiently.

Questions were asked to those being observed in an attempt to clarify what was happening and to capture their opinions effectively. The main reason why interviewing and observation tools were chosen on the site was with the assumption that, the sample that was dealt with had only little or no reading and writing skills and that this might have caused difficulties if other instruments like questionnaires were used. However, only 11% of the sample dealt with turned out to be illiterate that no difficulties were experienced with regard to proper communication with the rest of the sample. A photo camera was also used to capture numerous cultural activities and traditional objects of the Damara people.

Questionnaires with structured and close-ended questions were used to obtain information from both the teachers and learners on how they felt about the integration of Damara cultural mathematical activities into the teaching and learning processes in the classroom.

Pilot study

The pilot study was carried out to find out whether the research instruments to be used were valid and reliable to provide appropriate information to the research questions. Questions were revised on the basis of the responses obtained. The lesson plans were also scrutinised and vetted by the supervisor of the researcher before their use in research classes.

Data collection procedure

First of all, permission was obtained from the Permanent Secretary at the Ministry of Higher Education, Training & Employment Creation (MHETEC) to enable the researcher to carry out the study in the Khorixas Educational Region. Further permission was sought from the Regional Director in Khorixas and the principals of the two schools the researcher intended to include in the study. The principals of the two schools were briefed about the study and were then requested to permit the researcher to do the study at their schools by being actively involved in teaching ethnomathematics for one week.

At the same time, the Damara Cultural Programme leader, who is based in Khorixas was telephonically contacted to enlighten the researcher on what type of cultural activities the Damara people in Khorixas were involved in as well as where they could be found. The researcher then made an appointment to meet the sample in Khorixas.

At the traditional house construction site and the sewing place

Data from interviews consisted of direct quotations from people about their experiences, opinions, and knowledge regarding mathematics they apply. Data from observations consist of detailed descriptions of experiences from the sample.

Furthermore, a non-participant observation approach was used by taking into account the social context in which the data was collected. The sample was very corporative that the interactions and discussions with them went smoothly and the required data was provided to the researcher without any difficulties.

By continuously asking questions, in the *Khoi-Khoi Gowab*, the local vernacular of the Damara people, 12 females and five males at the traditional house construction site and needle work places were observed with the aim to establish the use of mathematics in their day-to-day activities. Interviews were conducted on questions that focused around whether the people involved in traditional sewing and house construction were aware of the type of mathematics they applied; whether they were able to scientifically interpret the mathematical concepts they were involved in; and how they related the mathematics they applied in their settings with what took place at schools (Best and Kahn, 1993).

Responses from the informants were noted in the interview format. The photo camera was used to capture as accurately as possible all the activities the sample was involved in. Interpretation of data from the interviews consisted of direct quotations from the sample about their experiences, and knowledge and the data from the non-participant observation, which consisted of detailed descriptions and processes that were part of the observable experiences of the informants.

At the Schools

After appropriately linking up the findings from the sample from the two sites, with what was happening in the classroom, some aspects of cultural mathematical activities found among the sample on the building construction site and needlework places were taught to the learners at CGSSS and WJSS at the junior secondary school level in Khorixas for one week. The intention was to establish whether if transferred to schools, the cultural mathematical activities of the Damara people could serve as motivating factors to the learners.

During the teaching and learning processes, attempts were made to establish whether the learners

were motivated by the integration of Damara cultural mathematical activities, and whether the use of mathematical activities embedded in the Damara culture enhanced the learning of mathematics in the classroom. This was done by administering a test to the learners at the end of the week and by using these results to justify the findings. Furthermore, a questionnaire was administered to the three mathematics teachers from Cornelius Goreseb Senior Secondary School and Welwitchia Junior Secondary School in order to find out their opinions on what implications Damara cultural mathematical activities had on the performance of learners at school. Since the teachers had positive attitudes towards Damara mathematical cultural concepts, they were encouraged by the researcher to integrate some aspects of Damara cultural mathematical activities into the mathematics lessons for motivation purposes of learners.

Data analysis

Descriptive and quantitative data in the present study were obtained from the sample. Tables, pictures, figures, measures of central tendency and variability, and histograms were used to present the data.

CHAPTER FOUR

PRESENTATION AND DISCUSSION OF RESULTS

INTRODUCTION

This chapter presents the research findings, interpretations and discussions of the results, of which the data was dealt with as indicated below.

- Female respondents involved in Damara traditional sewing.
- Male respondents involved in Damara traditional house construction.
- Teachers from grade 10 mathematics classrooms.
- Learners from grade 10 mathematics classrooms.
- Damara cultural activities outlined by the female and male respondents involved in traditional sewing and house construction.
- Damara cultural activities outlined by the grade 10 mathematics teachers.
- Damara cultural activities outlined by the grade 10 learners from the mathematics classrooms.

BIOGRAPHICAL INFORMATION

In this section, biographical information of the different respondents is given.

Respondents involved in Damara traditional sewing

Table 1 provides the information with respect to the female respondents involved in Damara traditional sewing.

Table 1. Biographical data and experience in sewing of the female respondents (N = 12)

Age	Highest grade achieved	Age at which needlework was started	Skills in traditional sewing obtained from:		
			Basic needlework classes	Observation and imitation of mothers and grandmothers	Making small clothing for self-made dolls
30	9	11	-	✓	-
31	10	30	-	✓	-
43	9	14	✓	-	-
43	4	8	-	✓	-
46	6	10	-	✓	-
50	6	10	-	✓	-
50	4	17	-	✓	-
50	-	15	-	✓	-
52	8	8	✓	-	-
53	3	19	-	-	✓
63	-	11	-	✓	-
64	3	12	-	-	✓

The highest education grade that the female respondents involved in traditional sewing had achieved was grade 10 and the lowest was grade 3 with the mode being grade 8. Two respondents had not undergone any schooling and another two had gone to school only up to the grade 3 level. The early age at which the respondents started-off with the needle work was 8 years and the later age 30 years. Sixty seven percent of the respondents learned the sewing skills through observation and imitation of their mothers, grandmothers, and elderly females in the community; seventeen percent gained experience from attending basic needlework classes as well as by attending workshops offered through the community centres. Another 17% of the sewing skills were gained from producing small clothing for the self-made dolls while they were still very young.

Respondents involved in Damara traditional house construction

Table 2 provides the information with respect to the male respondents involved in Damara traditional house construction.

Table 2. Biographical data and experience in house construction of the male respondents (N = 5)

Age	Highest grade achieved	Age at which house construction was started	Skills in traditional house construction obtained from	
			Basic house construction courses	Observation and imitation of fathers and grandfathers
42	3	15	-	✓
47	BED	5	-	✓
53	BTEC	5	-	✓
56	6	11	-	✓
59	3	8	-	✓

The ages of the five males, involved in traditional house construction within the Damara speaking community in Khorixas ranged from 42 to 59 years with the mean year of 53. One of the teachers had a BED and another one a BTEC. From the rest of the respondents, two had gone only up to grade 3 and the remaining one up to grade 6. The early age at which the respondents started with the traditional house construction was five years and the later age, 15 years (see table 2). All five male respondents replied that they had gained the skills they possessed in traditional house construction through observation and imitation of their fathers, grandfathers and elders of the community. One of the male respondents explained that, he "got blessings from his grandfather on his dying bed" to be involved in traditional practices, such as house building and medicine, at the age of five years.

Although, the researcher's initial aim was to get only those respondents involved in traditional sewing and house constructions at the maximum of grade 4-qualification level, the study tended to be dependent on what the situation was offering. The study investigated the depth and origins of the mathematics that the informants were consciously or unconsciously applying to the day-to-day cultural activities that they were involved in. Furthermore, information was sought on the sources from where the informants gained the mathematical skills and knowledge they used in their day-to day activities and whether they were able to interpret or explain the mathematical concepts that they were applying.

The grade 10 teachers

Questionnaires were administered to three male teachers teaching mathematics to grade 10 learners in Khorixas. Two of the teachers were aged 30 and 41, with the teaching experience of eight and six

years respectively. These two taught mathematics at Cornelius Goreseb Senior Secondary School. The third teacher was 26 years old, with two years teaching experience, and was from The Welwitchia Junior Secondary School. All teachers taught mixed ability classes which they described as opportunities for all learners, especially the gifted ones. The teachers believed that mathematics enabled them to solve numerous problems by using mathematical laws and principles in everyday life and that linking up these with the cultural backgrounds of the learners would be of good use in the mathematics classroom.

The grade 10 learners

Table 3 shows the ages of the grade 10 learners at Cornelius Goreseb Senior Secondary School and Welwitchia Junior Secondary School.

Table 3. Ages of the grade 10 learners at CGSSS and WJSS (N = 45)

Age	Frequency		
	Males	**Females**	**Total**
15	1	3	4
16	3	6	9
17	3	7	10
18	6	7	13
19	2	4	6
20	2	1	3
Total:	**17**	**28**	**45**

Twenty-eight female and 17 male grade 10 learners between the ages of 15 to 20 years, from three mathematics classrooms, of which one was at Cornelius Goreseb Senior Secondary School, and two at Welwitchia Junior Secondary School participated in this study. Fourteen females and six males were from Cornelius Goreseb Senior Secondary School and 25 from Welwichia Junior Secondary School (seven females and six males from classroom A, seven females and five males from classroom B).

This was based on the number of learners found at these two schools in each of the classrooms that were purposively selected. The reason for involving only one grade 10 classroom at Cornelius Goreseb Senior Secondary was that the teacher for the remaining classroom was under pressure to complete the syllabus and could not afford to release his students during that time for the ethnomathematics classes. All learners had mathematics from grade 1 to grade 10.

The Damara cultural activities and practices

With the intention to find out mathematical concepts, principles, and laws embedded in the Damara traditional activities and practices, this study attempted to investigate different types of cultural activities and practices that the Damara people were involved in and whether they were able to interpret the mathematics they applied in their natural environments. From the findings, it is very difficult to draw a fine line between the Damara cultural activities that survived colonialism and those that have disappeared. The respondents provided the following answers upon being asked why some Damara traditional practices are no longer available:

"Modernisation and westernisation has taken place with strong influence".

"Our culture is dying out because of modernisation".

"Traditional cosmetics and perfumes were replaced with Western products".

"Televisions, radios and computer games have replaced traditional games, music and story telling that the young generations used to be involved with".

"Roots from which traditional medicines and perfumes were produced are no longer freely available in the forests".

"Calabashes from which traditional milk used to be produced were replaced by milk processing machinery".

"Hospitals and medical doctors are now available every where that traditional medicine is rarely used".

"It is very sad that indigenous cultural practices are dying out and that the Western culture is being advantaged".

"Pride of own culture should be uplifted and cultural activities continuously practiced".

The respondents explained that this was due to the fact that the Damara people were scattered in

many regions of the country and that their cultural or traditional practices have tended to differ slightly from one another. Therefore, some Damara cultural practices were sustained and became more influential in some regions or villages than others. For example, Damara cultural activities identified to be still practiced by some respondents, were declared by others to have disappeared with time. This further implies that in some regions or villages, modernization has taken place to such a greater extent that some Damara cultural activities were no longer practiced at all. Against this background, it is difficult to make a clear distinction between the Damara cultural activities that survived colonialism and those, which did not. However, the Damara cultural activities and practices identified by 76% of both the female and male respondents were: Child rearing practices; traditional sewing by using small pieces of material or animal skins; traditional music and dances; traditional cosmetics, ointments and perfumes; traditional medicines; indigenous legends from elders; traditional house construction; traditional crop cultivation; traditional brewing; traditional food preparation; traditional games; and taking pride in using donkey carts as means of transport.

Occasions upon which traditional activities were commonly practiced were identified by 80% of the respondents as follows; before and after the weddings, annual Damara King's festival, initiation periods or ceremonies, before and after giving birth, cultivation, funerals, hunting, and wild berry collection which is very rare currently.

Traditional ceremonies before and after the wedding

Although, being combined with the modern ways, weddings in the Damara communities are still highly influenced by tradition. There are traditional ways in which ceremonies are conducted before and after the wedding. All female and male respondents indicated that before the wedding, there was a long and most difficult process of asking for a woman's hand in a traditional way. They explained that the family members of both the woman and man intending to get married, gathered together on several occasions for long hours, in order to familiarize themselves with each other, reach consensus on the decision of the couple to get married, and give them a blessing to go ahead with it.

The following were the responses provided by the respondents on how the wedding process was undertaken:

“Just married brides used to stay in-house for few days after the wedding for counselling on marriage life by the elders”.

“Nowadays, women are also bread winners and have to go back to jobs that there is no time to maintain the traditional practices after the wedding has taken place”.

“We used to make our wedding dresses in a traditional way”.

“Modern societies are not motivated in traditional wedding practices”.

The respondents said that “in the olden days, brides used to wear traditional wedding dresses (picture 2k,*l*,m) which were now overtaken by the modern dresses in most cases”. Another thing mentioned about the traditional way of wedding was “that before the wedding, the bride was kept in-house for a week, and served on all her demands by a special lady attached to her for that purpose”. According to information provided, the groom was required to kill a cow or a bull intended for the festival with a knife, before the day of the wedding, and only elderly women were allowed to eat the pelvis bone of the slaughtered cow or bull. “The just married bride was to stay in-house for a few days after the wedding”, one female informant said. She explained that this was done so that the elders within the family could provide the bride with guidelines on married life and instruct her on how to handle it to be successful.

However, these days, some traditional ways of wedding ceremonies such as keeping the bride in the house at the village for a week after the wedding have disappeared because women have to go back to work since they were also breadwinners. These practices were explained to be very important to the Damara people because in comparison to modern ways of wedding ceremonies that were highly influenced by Western cultures, the respondents said that there were great values attached to weddings conducted in the traditional ways. The elders within the communities believed that traditional ways of wedding ceremonies reinforced respect, mutual understanding, responsibility, role modelling, and durability of the marriage. Another thing was that by going through such a difficult process to be handed over the bride, the relatives were assured that the couple was serious and determined to get married.

Damara King’s Festival

During the funeral service of the late king David Goreseb (succeeded by honourable Justus //Garoëb), in 1977 at Okombahe, a decision was taken to make the day, on which he was buried a commemorative day in the history of the Damara people. This day was declared as the Damara

King's festival that is annually held at Okombahe, in the Erongo Region, with highly influential Damara cultural activities and practices. The previous kings of the Damara people were also buried in Okombahe and during the festive season, a great number of Damara people from all over Namibia, travelled long distances to participate at the King's festival and become involved in numerous traditional activities and performances, as well as place flower bouquets on the graves of all the late kings.

Picture 1a below shows the Damara King, Honourable Justus //Garoëb, third in cream suit, and waving to the audience. Picture 1b shows women in Damara traditional outfits, on their way to place flower bouquets on the graves of the previous Damara kings, during the King's festival in 2003.

Picture 1a. The Damara King Justus //Garoëb in cream suit

Picture 1b. Damara women with flowers

Traditional clothing and different ways of traditional sewing

The female respondents explained that shorter traditional dresses extending over knee-height were worn by young ladies occasionally, and the long dresses by the elderly ladies on a regular basis, with head covers in a distinct way in both cases. They said that traditional dresses were mainly produced by joining small material pieces with different geometrical figures in symmetrical ways. However, the respondents emphasised that with the modernization and the westernization, today, young ladies dress up mostly in western styles and use their traditional type dresses only during traditional events such as weddings, funerals, etc.

Among other, identified traditional products by both female and male respondents of the Damara people were mats, handbags and clothing made in stylish ways from animal skins; traditional waist

bags made from animal skins and kept by elderly women under their dresses; blankets, bedspreads and pillow covers made from small material pieces; beads made from ostrich eggs shells, seeds, and nuts, from which necklaces and rings were produced or traditional leather work such as handbags, or pouches, were decorated with.



Picture 2a, 2b and 2c. Damara traditional dresses for younger ladies



Picture 2d, 2e and 2f. Damara traditional dresses for elderly women

Picture 2g, 2h. and 2i. show symmetrical figures in Damara traditional dresses.



Picture 2g, 2h and 2i. Symmetrical patterns in Damara traditional dresses

Damara traditional dresses with distinct head covers are shown in picture 2j.

Picture 2j. Damara traditional dresses with distinct head covers

Damara traditional wedding dress is shown in picture 2k, *l* and m.

Picture 2k. A Damara traditional wedding dress

Picture 2*l*, m. A Damara traditional wedding dress

Picture 3a and 3b displays traditional types of bedspreads whereby the one in figure 3b is made by joining smaller material pieces together.

Picture 3a. Damara traditional bedspread in symmetry

Picture 3b. A colourful Damara traditional bedspread (*!khons*)

Picture 4a, 4b and 4c show a pair of trousers produced from a zebra skin, a mat from a goat's skin and also a mat made from a cow's skin.

Picture 4a. A pair of handmade trousers from a zebra skin

Picture 4b. Handmade mat (#ai-am*#goas*) from a goat's skin

4c. Traditionally made mat from a cow's skin

Picture 5a and 5b show traditional waist bags used by elderly women whereby in figure 5b, colourful beads were used for decoration purposes.

Picture 5a. Damara traditional waist bags (*horosaudi*) from animal skin

Picture 5b. Symmetrically decorated handbags with colourful beads

"With modernization, and enforcement of nature conservation, animal skin products have decreased drastically and domestic animal skins are also for sale these days", said one of the respondents. The respondents argued that because of poverty, people opted to sell the animal skins rather than producing products out of them. Another thing mentioned was that, everything was easily available on the market in the modern world and with it the hard labour was simplified in a way. However, they concluded that modern practices and products will never replace the cultural pride and values attached to their indigenous cultural activities and the way of life.

Reasons why some Damara traditional activities were no longer available

It was explained by one of the male respondents that colonialism was one of the reasons why some of the Damara traditional activities were no more or rarely practiced. The same respondent said that "during colonialism, the lives of the Damara people, similarly to all other ethnic groups in Namibia, have drastically been torn apart in terms of the indigenous ways of living"; "the Damara people were driven out of their natural environments to living in confined area, which was later on adopted as the 'Damara land', where they were now marginalized and restricted in terms of building the environment they inhabit". It was further explained that with this, traditional habitats of the Damara people were increasingly destroyed and replaced by new forms of environment with restricted measures and unpleasant natural conditions such as poor rainfall, desertification, and soil erosion. In conclusion, it was mentioned that because of this situation, some indigenous practices of the Damara people were threatened with destruction and were no longer sustained or rarely practiced.

Mathematics embedded into the traditional products of the Damara people

As clearly visible from the inserted pictures (2g,h,i; 3a,b; 4a,b,c; and 5a,b) 90%, of the female respondents involved in traditional sewing explained that symmetry plays an aesthetic role in the traditional clothing of the Damara people. Although various types of geometrical figures, such as triangles, rectangles, circles, parallelograms, trapeziums, were observed in their work, the women emphasized that symmetry was being maintained in numerous designs of traditional clothing for beauty. According to their explanation, much of the symmetry used, in traditional clothing was obtained through estimation with naked eyes and not by any measuring or calculation. Symmetry in the Damara traditional products can be observed in pictures 2g,h,i; 3a,b; 4a,b,c; and 5a,b showing traditional dresses and bedspreads made from small pieces of materials, trousers from a zebra skin, mats from goat's and cow's skins, and bags from animal skins. From observation and information obtained, there was no doubt that the Damara women involved in traditional sewing were using sophisticated mathematical laws and principles such as trigonometry, measuration and Pythagorean theorem, of which they were unaware of in most cases.

The following were the verbatim responses given by the respondents on how they used mathematics in traditional sewing and house construction:

"Estimation on the required measurements is made by head".

“Another material piece is used as reference point to make a round shape during sewing”.

“Measurement is carried out directly on a person by using a thread”.

“A pattern is developed with a paper or with old dresses when sewing”.

“ I determine lengths according to the length of my arm, elbow, feet, etc”.

“We use plates and pots to get round or rectangular shapes”.

“We draw circles by placing a stone in the middle and surrounding it with sticks by maintaining the equal distance through estimation”.

The traditional clothing of the Damara people with the rich mathematical aspects embedded in them, could serve as useful tools for motivating the learners of the Damara culture to investigate the wonders of mathematics underlying their tradition. For example, the geometrical shapes visible in picture 4b could be used to solve problems involving Pythagoras theorem or geometrical ratios. As described by two of the female respondents, the Damara women adored the traditional Victorian style of dressing by the German women during the German colonial period of Namibia. This resulted in the Damara women getting involved in imitating the German women’s dresses by sewing small material pieces together since they could not afford to purchase the required meters of materials for their dresses because of poverty and colonialism explained by the respondents. “With time”, they said, “the Damara women created unique patterns for their dresses by cutting out and joining small material pieces with mixed colours together and this practice was carried over from generation to generation with distinct long dresses worn by elderly women, and the shorter dresses by younger ladies”. “However, most women can now afford to buy the material needed for their dresses, but this is now our culture and we take pride in it that we are even cutting whole materials in small pieces to make our cultural dresses”, one of the respondents elaborated. “It is a must that every Damara woman should have at least one traditional dress”, a female respondent observed. From the data collected, there was evidence that till today, the Damara women take pride in their traditional way of dressing and as they explained, “it became a common practice among the Damara culture that efforts were made by women to prepare new traditional dresses with sophisticated geometrical patterns (see picture 2a,c,d,f,g,h, and 2i) for different traditional events such as

weddings, baptism, King's festival, or even for attending funerals".

Traditional cosmetics, ointments, and perfumes

The respondents argued that modern life had taken over most of the products they used to find in their natural environments and that some of these have died with the elders or are rarely practiced. They argued that this was happening as a result of nature conservation and land ownership since some places where they used to obtain the raw materials from were now under strict conservation or ownership. Another contributing factor they indicated was the extinction of traditional cosmetics, ointments and perfumes with modernization and that people now preferred the western products that were easily obtainable directly from the shops than the traditional ones.

Although, traditional cosmetics, ointments, and products were still to be found within some communities, they were close to extinction and were no longer easily and freely available as in the past. Accessories shown in the picture 6 were used to prepare Damara traditional perfumes and served the following purposes, according to the informants: "The pestle was used to pound the log, obtained from a special tree, known as 'a*u haib'*, into powder which was then stored into a tortoise shell and applied as perfumed powder because of its pleasant scent. This represents science in action.

Picture 6. Accessories used to produce traditional ointments

Apart from the tortoise shell, traditional powder or even tobacco was stored in special containers made from young lamb skins and called *//hōb* in the *khoi-khoi Gowab*, as shown in picture 7.

Picture 7. A Damara traditional tobacco container, the "*//hōb*"

Traditional medicine

Ten of the female respondents consistently explained that numerous traditional medicines used for different illnesses such as stomach ache, cough, sores, headache, cold and flue were still available with the elderly people within the Damara communities. The respondents maintained that effective traditional medicines for most illnesses, used in the olden days, were rarely known today by the young people because of modernization. The reason for this was: "The doctors and hospitals are in place in today's world, and again the nature conservation is another contributing factor to the extinction of the traditional medicine because the roots from which traditional medicines were produced were no longer freely available in the forest because of private ownership of land". "The use of traditional medicines at homes should be encouraged" two of the male respondents emphasized. One male respondent has kept a record of the many types of traditional medicines with their usages as well as the dosages to be taken. He observed that there was a huge demand from the community to buy medicines from him.

One male respondent mentioned that there were also traditional healers with sophisticated knowledge of indigenous medicines that existed within the Damara community and provided

services to the people according to the needs and demands.

Another explanation given by the respondents was that, "the same mixture prepared with the accessories shown in picture 6 and used to prepare the traditional perfumed powder were also used as medicine against cough and stomach ache". Upon being asked on how they used to measure the dosages to be given to a sick person, the answer given was "by counting the number of teaspoons to be given or number of cups of water needed to boil the mixture". This seems to imply that measurements were being used in order to determine the quantities to be consumed for the cure of coughs and stomach aches.

In picture 8, one of the female respondents is shown with the different types of traditional medicines and explained the use of each one to the researcher.

Picture 8a,b. Samples of different Damara traditional medicines

Mathematics embedded in the traditional cosmetics, ointments, perfumes and medicines of the Damara people

In the preparation of the traditional cosmetics, ointments, perfumes, and medicines, the respondents said that they were, "only aware that measurement of the volume of the ingredients to be mixed, consumed or used by means of cups, spoons or other objects they used", was involved. Although not very precise some kind of unit of measure was used.

Initiation period

Initiation period as explained by the female respondents, "was the period when a young girl got her

menstruation for the first time". "During this period, a young girl was kept in a specially made traditional hut, known as the '*haire-oms'*, shown in picture 9, for a week being prepared for adulthood by elders" it was further clarified. Apparently, lessons with regard to appropriate behaviour and attitude, cleanliness and hygiene, house keeping, as well as marriage life were taught by elders to a young girl during her initiation period. "The young girl used special traditional cosmetics, perfumes and anointments during the initiation period without any exposure to the sun and looked very beautiful and attractive when coming out of the hut after a week", the female respondents explained.

The respondents indicated that, "with modernization, the initiation periods have become rare, because no parent can afford to keep his/her young girl away for a week from the school". "Otherwise, modern means are available to keep the young girl comfortable during her first menstrual experience and the girls do not even inform their parents that they are on initiation period, as well as modern products make it possible that nothing is noticed by parents", the respondents concluded. The females argued that "schools and peer groups also played very important roles in preparing girls for their first initiation periods". However, above all, they argued that, "the very important aspect of it was that the young girls were missing out on experiences of the lifelong guiding cultural values and beliefs that were attached to the initiation period".

Picture 9. Traditional hut, the *haire-oms*, in which a young girl experiencing the first initiation period was accommodated for a week

Similarly to the initiation period for the young girls, information obtained from the male respondents was that young men between the ages of 12 to 15 years, used to be circumcised in a traditional way in order to be prepared for manhood. “This was done by elderly men by removing the fore skin of the penis with a sharp knife and by applying traditional medicine for cure without giving any anaesthetics”, said one male respondent. Furthermore, it was explained that, “the motive behind male circumcism was for a young boy to show his braveness, be prevented from sexual diseases when growing up, as well as to grow healthily”. However, as explained in the case of initiation periods for young girls, this practice too was said to have been taken over by the hospitals and doctors.

Traditional practices before and after giving birth

Among others, indigenous traditional prenatal and post natal practices outlined were that pregnant ladies, whenever involved in any kind of needlework, had to wear arm bands, made from black thread on their fingers in order to avoid complications during deliveries. The respondents said that, “the mothers of newborn babies were to stay in-house without doing any work for a month after giving birth in order to recover fully and gain the energy back”. Another thing mentioned was that a “traditional ceremony was being held when the newborn baby was to be taken outside the house for the first time”. Apparently, the baby was anointed with protective anointments and provided medicated neck bands, when being exposed among the strangers or the outside weather for the first time in order to withstand possible infectious diseases or viruses found within the people or in the air. A baby carrier made from animal skin (picture 10) was used by the Damara women to carry babies on their backs.

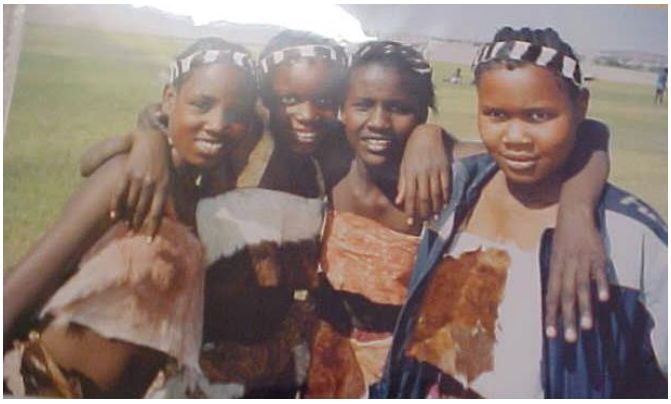
Picture 10. A traditional baby carriage known as” *//hanis*”

Traditional music, songs, hymns, and dances

Data collected from the respondents revealed that the Damara people have great pride in their traditional music, songs and dances. They said that there were many types of music, songs, hymns, and dances available which were unique for each occasion or seasons. According to the respondents, there were some songs and dances known as "forbidden ones", that were restricted for use on special occasions only. For example, some songs were sang only when the people were in communication with the ancestors during which specially mixed traditional ointments for such occasions were used, and these types of songs were never sang at any other time. Occasions upon which communication with the ancestors were involved were when people were calling for rain, or entering areas known for bad luck. One of the common types of dances was called the guitar dance, whereby the guitarists entertained the dancing audience by playing a guitar and singing simultaneously all night through. "Oh! we love the guitar dance", one male respondent cried out. However, they said that they were disappointed that, with modernization, discos, cinemas, televisions, radios, and western music have affected the traditional type of entertainments to a great extent. A famous Damara traditional dancing group, based in Khorixas, led by Mr Doëseb (picture 12a), and known for their involvement in Damara traditional activities, and normally performing during important national events all over Namibia as well as in the Southern African Development Community Region (SADC), known as the '*Apas //khoab*' (taste of a calabash) cultural group is shown in picture 11a,b; 12b and c. They help keep alive Damara culture. Indeed the Damara dances involve counting steps back and forth, an activity that may prove useful in improving proficiency in addition and subtraction.

Picture 11a,b. *Apas //khoab* cultural group from Khorixas in action

Picture 12a. Mr Doëseb the leader of the *Apas //khoab* cultural group in action at the Damara King's festival in Okombahe in 2003



Picture 12b,c. Dancers from the *Apas //khoab* cultural group

Damara traditional games

The most common traditional game, known as *//hus* is played by two opponents sitting on the opposite sides of the game and facing each other and is known as the *"tchadji* game" in other countries such as Mozambique, Botswana, and South Africa. *Tchadji* game is played by two people on a wooden board consisting of rows of depressions (holes). When wooden boards are not readily available the holes are often dug out of the earth or sand. This game usually consists of four rows of 12 holes each. The rules involved in playing *tchadji* were described as follows: "At the start of the game, 17 holes of each pair of rows are filled with small stones (see picture 13). The game is played

by two people of whom each person moves the stones in the two rows nearest to him/her in an anticlockwise direction. The goal was to immobilize the other player to move the stones or capture all the opponents' stones subject to a set of rules".

The illustration of *the //hus* or *tchadji game on board* with four rows of 12 holes each is shown in picture 13.

Picture 13. The *tchadji game (//hus)*

***//Hus (tchadji)* and Mathematical Thinking**

However the *tchadji* game revealed planning and counting strategies to a great extent, it is also related to other aspects of mathematical thinking, such as infinity, probabilistic thinking, arithmetical thinking, logical thinking and visualisation. From observation, while playing *//hus* the players were forced to count the number of stones in a hole; recognise similar patterns of stone distribution on the board; visualise extended moves; think in a logical manner to best decide which option to take to play and to capture an opponent's stone(s), and to assess objectively in the course of the game their chances of winning or losing. In some cases it happens that a move was not terminate, which relates to the concept of infinity as observed by Bell & Cornelius (1988).

Damara traditional practices during funerals

According to the information obtained, the Damara culture has very strong spiritual beliefs that influenced the way things were done during the periods of bereavement. The traditional practices maintained during and after the funeral were outlined as follows:

- No raw meat was to enter the house from where the burial had to take place as well as no one was allowed to carry raw meat home for personal use.

- The fireplace for cooking was to be made at a specially identified place and removed in traditional ways after burial.

- The meat without any salt or spices was to be eaten and bones were not to be chewed.

- Black tea or coffee was to be served with fritters throughout the whole process.

- Children were not allowed to attend funerals.

- Widows were to wear black clothing for at least one month after the burial and not to touch pots.

- Purification processes were to be carried out after the funeral whereby each family member was to be washed early in the morning in cold water, mixed with ointments by elders in order to take away the bad luck or spirits.

However, some of the practices during the funerals were now very rare or had been modernized. The reason being that the extended family relationships that used to exist in the past were now dying out, and people hardly found someone to baby sit their children when going to the funerals. The respondents said: "with modernisation, families became so small that no one is available to look after others' children; in today's life, there are no differences between the weddings and the funerals when it comes to dressing up or preparing food because expensive outfits and food similar to the ones prepared during weddings make funerals expensive in comparison to the past, whereby only black tea, coffee was served with fritters, and meat without any spices or salt eaten".

Damara traditional food

Several Damara traditional dishes, known to be very delicious were identified as stiff porridge, whereby maize meal was stirred into boiling water and served with meat, or fish prepared in different ways with or without stew and fresh or dried spinach; soft porridge made from a mixture of pumpkin, fresh milk, butter, salt, sugar, and bread flour. Preparation of the different ways in which the traditional dishes were prepared did not come out in detail during the study. However, the main thing highlighted was the way in which traditional milk and fat were prepared in a calabash known as '*apas'* (picture 14a,b). This was explained to be done as follows: "after milking, the milk was

stored in a storeroom without any refrigeration for a day in order to get a sour taste. Then it was put into the calabash and shaken until fat was formed and separated from the milk. Both the fat and milk were then removed from the calabash and the fat boiled in a traditional three-legged pot until the remaining milk covering the fat condensed, became brown in colour and sunk to the bottom of the pot. The fat was then ready for use and poured into a special container. Similarly, the remaining milk in the calabash was poured into a separate container and drunk by the elders and preferred by children with porridge". Again, the respondents said that these practices were also no longer common these days, because of the technology that made provision for the machinery to be used for this purpose. "The main difference between the fat prepared in the calabash and the one prepared with modern machinery was that the milk and fat prepared in the traditional way tasted far too good and natural than the modern ways of doing these", they said.

Picture 14a, b. Calabash (*apas*) used to prepare traditional butter from cow's milk

Mathematics used by the Damara people when preparing traditional food

The respondents said that they used to do measurements in their minds without being conscious that they were using mathematics. For example, they explained that they measured the salt to be used by placing it on their palms, the amount of porridge to be used by observing the thickness of the mixture with water, or by using a pre-determined number of cups of water. They did not know how to explain the type of mathematics they were using during their cooking. But it is clear that estimation was being used and also a unit of measure (palm).

Other Damara traditional practices

Damara people are well known for their means of traditional transport, the "donkey carts" which are now associated with poverty with modernization. This might be true, but the important thing was that there was cultural pride attached to the donkey carts that it became a must that every family in the villages, regardless of owning a car also possessed a donkey cart for posterity. Today donkey carts are also being seen as tourist attractions.

Picture 15a and 15b show a proud family next to their donkey cart, which they used as a means of transport.

Picture 15a,b. A donkey cart (*donki-gunis*) with proud owners

Another belief is that the fire must always be kept burning at home with water in a three-legged black pot on it. The reason being that visitors were expected to turn up unexpectedly, and the water for the tea or coffee had to be kept ready at all times for them. This type of practice is also dying out because the firewood or water is not easily available as in the olden days because of nature conservation and lack of rain. It was a common practice that the community members used to go into the bush to collect wild berries according to the seasons. This is almost not available again because of nature conservation and land ownerships which restrict the people to enter the areas from which they used to collect the berries freely.

At nights, there used to be story-telling by the elders around a fire. This is now rarely done, because everybody returns home tired from work, or has to attend to children's' homework. Another thing is that storybooks, cinemas, libraries, videos, DVDs, are now widely available to keep the children busy.

Traditional beer drinking was also identified as one of the common practices among the Damara

communities. In the olden days, brews were prepared by using honey and the respondents kept on talking about its natural sweet taste.

According to the male respondents, animal skins were processed and different products such as very strong ropes, clothing, and shoes were produced from it. Wooden products such as walking sticks used to be made too.

Because of the good rains, and continuously flowing rivers in the past, people used to cultivate numerous crops such as corn, maize, and tobacco on the river banks and had good harvests at all times. Men, as the main breadwinners in the past were responsible for hunting, game meat processing, fire wood and honey collection.

The following were identified as other activities influencing cultural practices of the Damara people:

- People going to traditional healers, that were regarded as possessing skills in chasing away bad spirits or bad luck by using traditionally mixed ointments.
- Children giving their salaries from the first jobs to their parents or grandparents for future blessings.

However, nowadays, the respondents said that some traditional healers were not real or true practitioners, and only pretended to be, with the intention of misleading the people or making money from them. One respondent was also concerned about the relationship between the people that has changed badly in the modern world that there was no trust to use traditional medicines given by others. One respondent said “we are also afraid of witchcraft and do not trust some of the traditional healers”.

To further emphasize, on these, one of the male respondents said that, “nowadays, because of westernization and modernization, everyone aims towards white man's tradition, that traditional healing/medication was replaced with hospitals/clinics/doctors/ and cosmetics with modern make-ups”.

Another argument from the respondents was that, the modern society was not motivated towards traditional practices and that they found comfort in western life instead and became lazy, because

traditional activities/products required hard work to achieve good quality.

Sample of walking sticks produced from natural wood are visible in picture 16.

Picture 16. Traditionally made walking sticks (*!nôadi*)

Illustration of different types of traditional sewing patterns can be seen in picture 17.

Picture 17. Traditional sewing and embroidery by the Damara people

Circular and rectangular shapes of the Damara traditional houses are shown in picture 18a and 18b.

Picture 18a. A circular Damara traditional house plastered with cow-dung (*#hau-oms*)

Picture 18b. A rectangular Damara traditional house build from sheet metal pieces (*bele-oms*)

Counting in the Damara culture

The respondents said that previously, counting used to be based on the combination of fingers and toes, but that it was now done on the basis of ten. Counting done on the combination of fingers and toes was explained to be done in such a way that one hand with five fingers represented the quantity of five, and both hands the quantity of 10. In order to go beyond 10, toes on the feet were added on, which made up a quantity of 20. The researcher then wanted to find out how counting was carried out with larger quantities. The response given was that the eldest members in the family were taken as a reference person to start with and other members' hand and feet were added on as the numbers were getting bigger and bigger.

From the findings, counting in the *Khoi-khoi gowab* was done from one to 10 as follows:

/gui (1), */gam* (2), *!nona* (3), *haka* (4), *koro* (5), *!nani* (6), *hû* (7), *//khaisa* (8), *khoese* (9), *disi* (10).

The counting in the *khoi-khoi gowab* is done on the base of ten and therefore follows a logical sequence with the numbers. This can help the learners to develop a relationship to the numbers and formulate the required numbers by adding or subtracting on the basis of 10.

The table 4 illustrates how counting is done in the *khoi-khoi gowab.*

Table 4. Counting in the *Khoi-khoi gowab*

One (1), */gui*	Two (2), */gam*	Three (3), *!nona*	…,	Ten (10), *Disi*
Ten one (11), *disi /gui /a*	Ten two (12), *disi /gam /a*	Ten three (13), *disi !nona /a*	…,	Two tens (20), */gamdisi*
Two tens one (21), */gamdisi /gui /a*	Two tens two (22), */gamdisi /gam /a*	Two tens three (23), */gamdisi !nona /a*	…,	Three tens (30), *!nona disi*
…….,	…….,	…….,	…,	Nine tens (90), *khoese disi*
Nine tens one (91), *khoese disi /gui*	Nine tens two (92), *khoese disi /gam*	…….,	…,	One great ten (100), */gui kaidisi*
One great ten one (101), */gui kai disi /gui*	…….,	…….,	…,	Two great tens (200) */gam kaidisi*
…….,	…….,	…….,	…,	Nine great tens (900) *khoese kaidisi*
…….,	…….,	…….,	…,	One full ten (1 000), */gui /aodisi*
…….,	…….,	…….,	…,	Five full tens (5 000) *koro /oadisi*
…….,	…….,	…….,	…,	Ten full tens(10 000) *disi /oadisi*
…….,	…….,	…….,	…,	…….,
…….,	…….,	…….,	…,	One million (100000 */gui miljūn*
…….,	…….,	…….,	…,	One billion (1000000000) */gui biljūn*
…….,	…….,	…….,	…,	One billjard (10000000 */gui biljārd*

Ways of passing on traditional skills and knowledge to the young generation by male and female respondents involved in traditional sewing and house construction

The respondents said that they explained to their children about the traditional activities they learned from their parents and grandparents as well as inform them about what their ancestors used to do. This was done by showing and guiding the children in how to practice their traditional activities as they grew up. Furthermore, the respondents shared their values and norms with their children and taught them by being exemplars. The importance of the traditional skills was emphasized during such discussions. Story telling was also another source that was identified as the platform for enhancing the required knowledge. However, some respondents observed that the modernised

society did not show any cultural interest, despite the efforts made to introduce them to cultural activities. One of the respondents said that she taught all her three daughters how to sew and that all of them were doing it with great interest. Another female respondent said that she has told her children to follow the examples of the elders. The respondents argued that they talked to their children in order to evoke interest in the cultural activities and values by being role models to them and teaching them the cultural values. One male respondent said that he shared the knowledge and skills he possessed of traditional medicines and healing methods with his children. He further indicated that the whole family was involved in traditional practices from songs, dances, medicine and all family members belonged to the *"Apas //khoab"* cultural group shown in picture 11a,b; 12a,b, and 12c. A female respondent said; "my sons used to work with their father on car repairs, and other household repairs, and are creative in many traditional ways".

Traditional sewing and house construction

Responses were solicited from the females and males involved in traditional sewing and construction activities with the purpose of determining the objects used for taking measurements in these activities.

It was found that various ingenious methods were used to measure lengths and sizes, without the use of a measuring tape. It was established that ingenious and integrated games and practices were used to figure out measurements. The objects identified as being used for taking measurements during traditional sewing and house construction of the Damara people involved:

- Home-based equipment used by the women in sewing to determine the length and parallel lines for symmetry like a rope, piece of timber, thread, stick, arm's lengths, straight edges of books, and a measuring tape in some incidences.

- Round shaped objects such as cups, plates, pots, other material pieces, hand-made plastic or paper patterns were used by women in sewing to cut out circular material pieces for sewing.

- Body parts were employed as measuring instruments, including the length of an elbow, feet, fingers, and knee height in both sewing and house construction.

- Feet pressed on the ground to measure the shoe size off with a tread.

- A stick placed in the middle and attaching a guiding thread with another stick at the end and going around by maintaining the same distance to draw circles or arcs during house construction. In some cases, curves and arcs were drawn by pure estimation.

- Time was determined by observing the position of the sun, stars and shadows. Some people in the rural areas regarded the first cry of the crow as an alarm, waking up accordingly early in the morning.

- The right hand was used as a guide to determine the direction to the right, and the left hand to the left.

- Stars were used for orientation to the south, north, east, and west, when lost at night.

- Corners of the rectangular shapes were used to draw straight perpendicular lines.

- A standard stick was used in house construction to measure off the length of other sticks needed.

- The directions against the wind were considered when installing doors or windows in a traditional Damara house.

However, in each case, estimation by guessing was a common practice because some objects used, as measuring instruments could not provide exact measurements.

Mathematical laws, concepts and principles underlying Damara traditional activities

The question of the types of mathematical concepts and laws found within the Damara culture was one of the most difficult questions to be answered by the respondents since most of them did not have any mathematical background. Some female respondents did not really know or understand that mathematics was existent in their traditional sewing activities. This did not come as a surprise to the researcher, because, even the learners or the teachers at the grade 10 level never thought of associating the school mathematics with any cultural activities. The following were the responses obtained from the female respondents interviewed on the mathematical concepts and laws hidden in the Damara cultural activities: “I am using counting and use length if I have to measure”; “based on counting”; “I don't know”; “Measurements”; “triangles”; “breath”, “length”, “equality”; “counting”; “taking measurements”; “by measuring”; and “no idea”, they said.

According to the male respondents, measurements, numbers, quantities, time, circles, arcs, lengths, lines, square doors and windows could all be associated with mathematics.

In reality, both the females and males interviewed, consciously or unconsciously applied sophisticated mathematical principles throughout their activities. Against this background, and in order to simplify the work involved, it is very important to link what is happening in our day-to-day activities with what is happening at school.

Importance of incorporating cultural activities in the teaching and learning processes of mathematics

The respondents emphasized that in order to keep the culture or tradition alive, it was very important to lay the basic foundation of ethnomathematics at the junior school level and that the cultural activities should be taught at an early stage, at the junior secondary school level so that the learners could know their culture so that it would not die out completely. They explained that unemployment rate in Namibia is high and hand-made cultural products should be encouraged at schools for self-employment opportunities at the end. The respondents argued that it is very sad that indigenous cultural practices are dying out and that western culture is being preferred, hence, pride in our own culture should be uplifted and continuously encouraged at schools. “Damara cultural activities should be integrated into the learning process in order for the learners to grow up with the knowledge”. “Learners should know about what is happening in their culture because the culture presents the roots of a society and its identity”.

One of the male respondents indicated that the cultural activities were valuable heritages from the forefathers and should be sustained from generation to generation. He explained that the Damara cultural activities should be transferred to schools in order for the learners to know what their ancestors used to do. Another of the male respondents said that the cultural activities should be respected and maintained at schools and that the parents should support schools for cultural sustainability. “School dropouts or unemployed people could also help themselves by producing cultural products, and pass these skills to the next generation and overcome poverty”. Further, another male respondent concluded that traditional activities should be part of school in order for the learners to know how things are called in their own languages and that they should also know about poisonous herbs and trees, as well as about the forbidden practices in the tradition.

How mathematics and culture should be dealt with at school

This was also another question found difficult by the respondents to answer. Twenty three percent of the 17 respondents argued that culture and mathematics should be dealt with separately because they were different. Although, two respondents did not answer this question, some constructive suggestions were forthcoming. The respondents argued that:

- Cultural huts should be built at schools and elders of the community should be involved in showing the learners and teachers the ways in which different traditional houses were constructed.

- Books and materials on various traditional learning activities should be made available at schools.

- Traditional objects and activities in which mathematical thinking is embedded such as needlework, house construction, and games must be used during teaching and learning processes.

- Mathematics is very difficult therefore needs to be taught in a normal and realistic way.

- Perception and vision were very important, hence, traditional objects or materials entailing mathematical problems should be brought to school and used as media for demonstration purposes.

- There should be periods for cultural activities such as dances and songs.

- Sticks and games played with stones should be used to teach counting to children as to enhance better performance in mathematics.

- Calabashes for milk production, traditional pots and food should be introduced in the cooking classes in order for the learners to visualise and apply the measurements underlying such objects and activities.

- Old cultural practices (items such as small goats' skins) should be brought back and be associated with schools.

- Some cultural aspects could be integrated into mathematics and some could run parallel with the teaching and learning processes of related subjects. For instance traditional dances could be integrated into the music lessons at school.

- Traditional house construction plans and patterns from traditional sewing could be used in the teaching and learning processes at schools.

- Traditional dances and house constructions, games played with stones should be part of the mathematics curriculum in order for the learners' interest to be evoked in this subject.

- Integration could be done through developing unique ways of thinking, and creativeness, in order for the learners to explore different cultural values that will enable them to better understand and solve mathematical problems.

- Volumes could be determined by using objects such as different sizes of calabashes in order for the learners to determine quantities not only by calculations but also through observation and estimations.

- Drawings of traditional huts should be used during lessons since this might motivate the learners to develop interest in their tradition and enhance better performance in mathematics.

Cultural values and belief attached to traditional activities and products of the Damara people

Pride, beauty, and self-satisfaction were said to be the main values and beliefs attached to the Damara traditional activities and products by the respondents. The female respondents said that the aim of their cultural products was to advertise their tradition of which they were very proud. They indicated that their cultural products expressed the values of the Damara culture and its originality. On the other hand, the male respondents talked about the originality of traditional products, which "added value to their products" that they took pride in them. They further said that traditional products promoted self-identity and image of the Damara people. Once again, pride of the Damara people in their cultural products and the beauty embedded in these, were said to be one of the main values attached to the cultural products. Respect for elders, kindness, and helpfulness were the additional values mentioned as part of the Damara people.

Determination of values of the cultural products for sale during marketing

"The values (costs) of the cultural products depended on the price of the materials used, quality and attractiveness of the products", the respondents explained. The labour cost including the time spent or the distances travelled were not considered in most cases when costing the product because the products were sold for their (trader's) survival only. Further, those buying were also in need, and no one would buy if the price was too high. In some cases, exploitation of the sellers on their products took place because of poverty that forced them to sell their products at low costs.

Making correct change during selling transactions

In order to establish the level of mathematical reasoning, the researcher asked the respondents how they determined the change to be given back to a customer when the customer gave a high denomination to pay for a product during buying. Although not all respondents answered this question, some responded that they used their fingers to calculate the change. Others explained that they determined the change through mental calculations by rounding up to the next whole number or by using a calculator.

In the olden days, products were mostly exchanged with other products. For example, tobacco rolls, or a bag of maize was exchanged with a livestock estimated to have the same value. Some respondents said that in order to make things easier on themselves and the customers, they set prices based on whole numbers of 10 that did not require complicated calculations for change. For example, instead of charging N$89.95, they would round it up to N$90.00.

Determining whether a profit was made during the selling transactions

The following answers were obtained from the respondents on how they determined whether they had made a profit or not when selling their products:

"According to the estimation of the money spent on material, and other items, electricity cost, time spent, and workload, we would determine if profit was made or not", 50% of the respondents informed the researcher. Others said that this was done through weekly stocktaking when they counted the products still in stock and compared this with the money received for the ones sold. Another way of knowing if profit was made was by determining the cost of what was sold and by making comparisons with what was spent at the beginning. "Sometimes one gained or lost", one respondent explained. Profit was made from tourists, but it was difficult with the local people, because of poverty or over familiarity with customers, friends and relatives.

Stock control

According to the respondents, formal ways of stock control were not commonly used because the stock was often too small, or not available. However one female respondent said that she kept a stock control book in which she recorded the products sold, but not the ones that were still in stock. Another female respondent said that she kept all products sold or in stock just in her mind. "I use different kinds of containers for each stock and distinguish them accordingly," another female respondent explained. A male respondent had this to say: "I estimate the volume of my products such as milk, bread flour or maize meal, and use containers e.g. cups and filling these half way, fully, or according to estimated demands". "We used sticks or stones to count number of livestock we possess", one male respondent said and further explained that it was done in such a way that they used two containers and by the time the livestock left the kraals in the morning, a stick or a stone representing the number of livestock was put into container No.1, and put from it into container No. 2 when the animals came back to the kraals in the evening. If anything remained in container No. 1, this represented the number of livestock that were missing. One female respondent said that she distinguished her livestock according to the colour and pattern of their skins and knew immediately if one was missing.

Determination of the material needed to make traditional products

The researcher's intention was to find out how the respondents determined the amount of materials they needed when they were involved in traditional sewing or house construction. The female respondents replied that measuring was done according to the size of the body of the customer during sewing. This was done by measuring the height, and breadth of the person. Measurements were taken by using a piece of material, a thread, a rope or measuring tape. Sometimes, estimation was made based on the size of a person and the required pattern and material was added if needed. One male respondent was acquainted with measurements in "yards" which is the imperial system of measuring lengths that is mainly used by elders in Namibia because of the trends left by the German colonial period.

MATHEMATICS TEACHERS' RESPONSES

Types of Damara cultural activities the teachers were acquainted with and why these should be encouraged among the learners

According to the teachers, the traditional games, traditional sewing, traditional dances, and

traditional house construction, were common traditional practices within the Damara community that were observable during weddings and traditional festivals. All five teachers responded that Damara cultural activities would enable the learners to have a unique identity and that the learners should keep their cultural heritage and pass it on to the next generation.

Mathematics content to be taught at schools

One teacher did not answer this question, but the other two observed that the mathematics taught at schools did not accommodate the cultural interests of the various ethnic groups in the developing countries since it was based on the western cultural values only. They explained that they perceived the mathematics that was embedded within the cultural activities of the Damara people instructive and valuable.

The teachers were convinced that the integration of ethnomathematics into the mathematics curriculum at school, as well as by multiculturalising the mathematics curriculum, learners would be encouraged to take pride in their own cultural heritage. In addition this would add value to it, and quality of mathematics education would improve since the learners would be motivated to learn and better their performance in mathematics. The teachers had the following to say about the content of mathematics to be taught at schools:

"Textbooks should be revised in order to include relevant topics on ethnomathematics".

"The textbooks as the main sources used must contain pictures, drawings that have to do with the culture of the specific ethnic group".

The teachers recommended that the mathematics textbooks should be revised and aspects of ethnomathematics be incorporated into the relevant topics within the curriculum. In addition, the teachers explained that the textbooks as the main sources of information used, should be compiled in such a way that they contained pictures and drawings that reflected specific cultures.

LEARNERS' RESPONSES

Twenty-eight female and 17 male grade 10 learners between the ages of 15 to 20 years from three mathematics classrooms, one at Cornelius Goreseb Senior Secondary School and two at Welwitchia Junior Secondary School participated in this study. All learners had mathematics from grade 1 to grade 10.

Favourite subjects

Students were asked to indicate their favourite subjects and they responded as shown in table 5.

Table 5. Students' favourite subjects

Subject	Frequency (%)		
	Females	**Males**	**Total**
Mathematics	6 (21)	5 (29)	11 (24.5)
History	3 (11)	1 (6)	4 (9)
Business Management	3 (11)	4 (23)	7 (15.5)
Life Science	1 (3.5)	-	1 (2)
English	2 (7)	3 (18)	5 (11)
Khoi-Khoi Gowab	5 (18)	-	5 (11)
Accounting	3 (11)	3 (18)	6 (13.5)
Geography	2 (7)	-	2 (4.5)
Agriculture	2 (7)	-	2 (4.5)
Afrikaans	1 (3.5)	1 (6)	2 (4.5)
Total	**28 (100)**	**17 (100)**	**45 (100)**

From table 5, it is observable that 24.5% of the learners chose mathematics as their favourite subject. However, 23% of the males selected Business Management as their second best subject, while 18% of the females opted for the *Khoi-Khoi Gowab*. The learners were least interested in Life Science, Geography, Agriculture and Afrikaans.

The main reason why the researcher wanted to find out the favourite subjects from the learners was to establish their interest towards mathematics. The results conveyed that there was a great interest in mathematics, which might imply that if given a chance to link the school mathematics with mathematical practices within the Damara tradition, the learners might perform better in school mathematics, and probably stop perceiving mathematics as a very difficult subject.

Learners' experiences with mathematics

Four of the learners had this to say regarding their experiences in learning mathematics: "If I study mathematics, my mind is cut-off from understanding because I don't understand mathematics"; "Mathematics is the subject that leads me in many ways"; "Without mathematics there is no job out there"; "I like to become a bank manager or a mathematician when I grow up". The first learner appeared to have a negative experience with school mathematics as compared to the last three.

The following are the other responses provided by the learners when asked about their experiences on mathematics:

“Mathematics is a very interesting subject and I love studying it”.

“I want to know everything about mathematics”.

“My experience about mathematics is that it is a subject that involves culture and many more interesting things”.

“Mathematics is very difficult but an important subject”.

“I find mathematics very difficult to understand but I always try my best”.

Fifty percent of the learners said that mathematics was a very interesting and good subject that involved culture and other interesting things and that they were eager to learn more about the geometrical shapes found within the cultural objects. One learner said that his experience with mathematics was “with working with numbers” and that he would “like to be involved in mathematical projects and learn more about mathematics in a traditional way in order to get more experience in mathematical applications found in everyday life situations within the cultural environment”. Another learner said that although she loved the subject, and was trying her best, “mathematics was very difficult for her”.

Learners’ opinions about Damara cultural activities

On this issue, the responses provided by the learners were as follows:

“I am greatly interested in Damara traditional songs, dances, house construction, sewing, games, and cooking”.

“Damara traditional activities are commonly practiced during wedding ceremonies, Christmas time, during birth, funerals and cultivation periods”.

Hundred percent of the learners responded that they were greatly interested in the Damara cultural activities and outlined the following activities that they were acquainted with; traditional songs and dances, traditional house construction, traditional cooking, traditional games, and traditional sewing.

Traditional songs and dances were identified as the most common traditional practices among the Damara people. The learners also said that the most common festivities during which Damara traditional activities were held included Christmas time, wedding ceremonies, cultivation seasons and funerals.

Mathematical laws, concepts and principles underlying some Damara traditional activities

The learners on this question gave the following responses:

Games:

"Traditional games played with stones involve counting and that is mathematics".

"For example, the game we play by digging a hole and putting 6 or 12 stones involves counting too".

"Any game involves ethnomathematics because one has to add, subtract or multiply".

Dancing and singing:

"Dancing involves counting of the steps made, and turning at angles of 90°, 180° or 360°".

"While singing one sometimes count how many times the sentences are to be repeated".

Sewing:

"Measurements of the length and width are taking during sewing".

"Geometry is found in sewing when cutting out squares, triangles, rectangles, etc."

"During sewing, one counts number of materials-pieces to be used".

"Sewing involves ethnomathematics because there is geometry found in Damara traditional dresses with triangular and square shapes in them".

House construction:

"One estimates an amount of cow dung to be used for plastering a traditional house".

"Different shapes such as squares, circles, triangles and rectangles, lengths, breadths, heights, symmetry and triangular roofs are found in traditional house construction".

Cooking:

"In cooking amount of salt, water or food is measured and duration determined".

"Making of round/circular or rectangular bread when baking involves mathematics".

"When cooking the food is divided among the people".

Upon being asked to indicate the reasons why they should study mathematics, the learners responded as shown in table 6.

Table 6. Reasons by the learners for studying mathematics

Reasons	Frequency (%)		
	Females	**Males**	**Total**
Because it is a challenging subject	4 (14)	3 17.5)	7 (15.5)
Because it is a compulsory subject	11 (39)	7 (41)	18 (40)
To pass exams	3 (11)	4 (24)	7 (15.5)
To impress others	10 (36)	3 (17.5)	13 (29)
Total	**N=28 (100)**	**17 (100)**	**45 (100)**

A very high percentage of the learners (40%), responded that they were studying mathematics just because it was a compulsory subject, while only 15.5% of the learners maintained that they were studying mathematics because it was a challenging subject. This contradicted the previous responses given in table 5, in which the majority of learners (24.5%) opted for mathematics as their favourite subject at school. On the other hand, 15.5% of learners indicated that they were studying mathematics in order to pass examinations, while 29% of the learners responded that they just wanted to impress others since mathematics was said to be a very difficult subject. This was again not related to the option of mathematics being studied because it was the best or a challenging subject. Based on the results in table 6, it can be concluded that the learners did not really like studying school mathematics because it was their favourite subject, but for other reasons.

The researcher also wanted to find out about the learners' opinions on the content of mathematics taught at school, and their responses are found in table 7.

Table 7. Opinions on the content of mathematics taught at school

Opinions	Frequency (%)		
	Females	**Males**	**Total**
Insensitive to cultural interests	13 (46)	7 (41)	20 (44.5)
Integrative of cultural interest	2 (7)	3 (18)	5 (11)
Discriminative to cultural interest	5 (18)	4 (24)	9 (20)
No idea	8 (29)	3 (18)	11 (24.5)
Total	**28 (100)**	**17 (100)**	**45 (100)**

Forty four point five percent of the learners insisted that mathematics at school did not take their cultural interests into consideration and that there was a huge gap between what was happening in the classrooms and in the cultural environments of the learners. Furthermore, 20% of the learners indicated that mathematics at school denied the cultural interests of the learners. It did not provide them with the opportunities to explore what was available in their culture and to use these in solving problems in the mathematics classroom. However, 11% of the learners noted that school mathematics was integrative of their cultural interests.

The rest of the learners, (24.5%) did not have any idea what to say on the content of mathematics taught at school and its relationship to the culture of the Damara people.

In table 8, the learners' views and perspectives over the mathematics taught at school and the cultural mathematical activities carried out in everyday lives of the learners are given.

Table 8. Views of the learners on Damara cultural activities into which mathematics is embedded

Views	Frequency (%)		
	Females	**Males**	**Total**
Primitive	4 (14)	1 (6)	5 (11)
Abstract	8 (29)	2 (11.5)	10 (22)
Valuable	9 (32)	11 (65)	20 (45)
Instructive	7 (25)	3 (17.5)	10 (22)
Total	**28 (100)**	**17 (100)**	**45 (100)**

A number of learners, 20 (45%) were in agreement with the view that the mathematical concepts embedded into the Damara cultural activities were of great value to them. However, a minority, of the respondents, 5 (11%) thought it primitive to associate the school mathematics with cultural activities.

The ways in which the academic and traditional mathematical aspects could be dealt with at school were identified by the learners as shown in table 9.

Table 9. Ways chosen by the learners on how to deal with school and traditional mathematical aspects in the classroom

Ways	Frequency (%)		
	Females	**Males**	**Total**
In isolation	1 (3.5)	4 (23.5)	5 (11)
Integrated	7 (25)	4 (23.5)	11 (24.5)
In anyway	20 (71.5)	9 (53)	29 (64.5)
Total	**28 (100)**	**17 (100)**	**45 (100)**

Regarding this question, a high percent of learners (71.5%) did not make any recommendation on how school mathematics and traditional aspects with a mathematical perspective could be dealt with

at school. They left this option to the curriculum developers and mathematics teachers.
In table 9, about one quarter of the learners suggested that school mathematics and cultural activities with a mathematical background should be integrated, while one tenth of the learners opted for these to be handled in isolation.

The researcher further wanted to establish from the learners which cultural objects they would like to recommend to the teachers in teaching mathematics. Table 10 gives their responses.

Table 10. Recommended cultural objects/activities to be used by the mathematics teachers in teaching mathematics

Cultural objects/activities	Frequency (%)		
	Females	**Males**	**Total**
Traditional games	4 (14)	-	4 (9)
Traditional sewing	1 (4)	1 (6)	2 (4.5)
Traditional dances	4 (14)	1 (6)	5 (11)
Traditional house construction	2 (7)	4 (24)	6 (13.5)
All of the above	16 (57)	11 (64)	27 (60)
No response	1 (4)	-	1 (2)
Total:	**28 (100)**	**17 (100)**	**45 (100)**

A total of 60% of the learners' responses with regards to the type of Damara traditional objects to be used by the teachers in order to plan mathematics lessons included games, sewing, dances and house construction. This, they thought would enable the learners to explore the mathematical concepts and principles underlying their cultural objects and activities and to better understand mathematical problems and solve them.

Table 11. Perceptions of the learners on types of concepts/laws of mathematics found within the identified traditional activities

Traditional activities	Concepts/laws of mathematics
Games	Counting and geometry were identified as mathematical concepts that were being used when playing most of the games. Among others, the *tchadji*-game mainly played by grown up people and *"amagus"*, the game played by the youngsters were identified to contain sophisticated mathematical reasoning. When playing the *amagus* game, one has to estimate the distance to be run, which is mathematical. *Amagus* is played by 12 people divided in two teams of six participants each. The participants prepare a rectangular playground and draw additional small rectangles within all corners of it. A big circle is also drawn exactly in the middle of the playground. First, the participants have to decide at which small rectangle they are to start with the game, the direction of running which is normally anticlockwise as well as on the number of rounds (mostly 6 or 8) to be made around the small rectangles in order to win the game. Four participants from a team decide upon, commence with the game with two people from the other team facing each other in the opposite direction on the shortest sides of the playground, and lead the game by throwing the ball to hit those running outside when on their way to enter the small rectangles or the big circle. When the two throw the ball to each other for the first time, the four people in the big circle have to run with the intention to stop at all rectangles by maintaining the sequence and by shouting out *amagus* one, two, three, up to 24 or 32 as they enter each small rectangle. *Amagus* counted up to 4 makes up one round. The motive is for the two people leading the game to hit the participants with the ball while they are on their way to enter the small rectangles before they reach the number of rounds agreed upon. The ball is not to be thrown on them if they are already inside a small rectangle or the circle.

	The participants are to fall out one by one as they are hit by the ball but if they are lucky and one of them counts up to the number agreed upon at the beginning, and shouts out "game", all of them including the ones who had already fallen out, have to run into the big circle without being hit by the ball. In case they lose the game, the other team members take over and the same rules apply to them too.
Sewing	Traditional sewing was identified as a common cultural practice that encouraged measurements. During sewing, material pieces were cut out in forms of different geometrical shapes as the material was measured off. Planning and reasoning are therefore part of geometry and symmetry.
Songs and dances	Counting was identified to be used when dancing or singing. This was done in such a way that the steps were counted and repeated when dancing and melodies counted and repeated when singing. There is also geometry hidden when dancing because one has to stand in parallel lines or circles and when dancing, and takes a step backwards, forwards, or turns at angles of 90°, 180° or 360°.
Traditional house construction.	Geometry was again identified as the underlying principle in traditional house construction. Roofs were normally made of triangular or trapezium shapes. Measurements are taken when building traditional houses. Symmetry, paralellness, roundness, squareness also play important roles in traditional house construction. Amount of cow-dung used for plastering the exterior walls of a traditional house is estimated and placed evenly all over the house.

Suggestions from the learners on how ethnomathematics could be integrated into the mathematics curriculum at school

The learners provided the researcher with the following suggestions on how ethnomathematics could be linked with what is being taught in the maths classrooms at school:

"Teachers having knowledge of ethnomathematics should came and teach at our school".

"Ethnomathematics should be promoted and in order for the learners to understand that it is nothing else but mathematics".

“Ethnomathematics should be part of our life and studied as a subject by the learners”.
“Ethnomathematics should be integrated into mathematics because we know our culture and can easily cope with it”.

“Because ethnomathematics is in the culture it must be encouraged”.

“Some of the learners don't know anything about ethnomathematics, and it must be available at schools for us to learn more about it”. “This will help us (learners) to open our minds and to be interested in their traditional culture”.

“Ethnomathematics should be taught at school because it is the best subject that could be integrated into the school curriculum”.

“Ethnomathematics should be offered as additional mathematics”.

“Ethnomathematics must be compulsory in order to convey different kinds of cultural mathematical concepts”.

“Ethnomathematics should not be taught as a separate subject”.

“More initiative must be brought in to teach learners about different kinds of cultural objects”.

“The Ministry of Basic Education and Culture must instruct the teachers and institutions of higher education to teach us ethnomathematics because it is very important”.

“Ethnomathematics must be integrated in the school curriculum”. “It is legitimate to be consumed in the school, to develop our culture and people to be sophisticated”.

ETHNOMATHEMATICS LESSONS TO GRADE 10 LEARNERS

Lessons on ethnomathematics were presented to the learners during the grade 10 mathematics lessons at Welwitchia Junior Secondary School (WJSS) and Cornelius Goreseb Senior Secondary School (CGSSS) for a week by the researcher. At the WJSS, ethnomathematics was taught to learners in two separate grade 10 mathematics classrooms consisting of seven females and six males from classroom A and seven females and five males from classroom B. Fourteen females and six males were from the CGSSS. The lessons were prepared on different types of patterns found in the Damara traditional sewing and house construction. The learners were requested to bring the

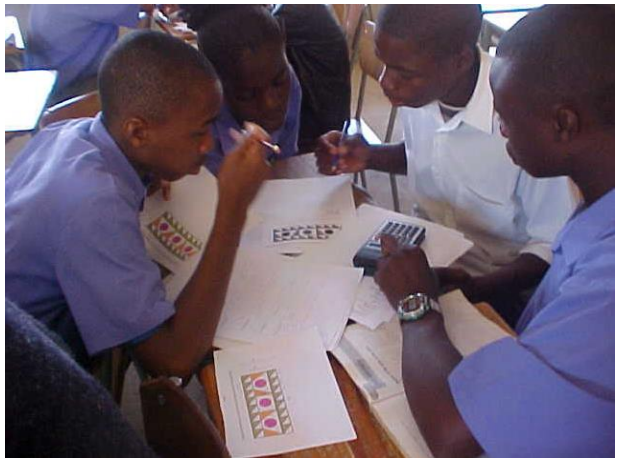
traditional objects they considered to contain aspects of mathematics to the classroom. They were then encouraged to work in groups by identifying the types of mathematics underlying these objects and to solve mathematical problems underlying these. The responses from the learners with respect to bringing to class the traditional objects from their surroundings was overwhelming since they brought to the classroom all kinds of things they considered to contain aspects of mathematics and involved themselves intensively in analyzing and solving mathematical problems. The learners seemed to be motivated by ethnomathematics and demanded more time to involve themselves in investigating mathematical laws and aspects hidden in their cultural objects. Different types of Damara traditional objects brought to the classroom by the learners and the way in which they interacted in investigating and solving mathematical problems underlying these, are shown in picture 19a, 19b, 20a and 20b respectively.

Picture 19a. and 19b. Learners demonstrating the Damara traditional activities they used to solve problems in the mathematics classroom

The lessons presented to the learners on ethnomathematics entailed geometry (lengths, areas, and volumes, and Pythagoras Theorem) and trigonometry (related ratios and angles) contained in the Damara traditional sewing and house construction. The learners had to identify different types of geometrical patterns found within the given examples and solve problems using mathematical laws, and principles underlying these. Furthermore, the lessons focused on how mathematics plays a role in culture and provided the learners with the opportunity to be creative mathematically. The

researcher encouraged the teachers to be creative in teaching mathematics as well as recognising its cultural value.

Picture 20a and 20b show the way in which the learners interacted to solve ethnomathematical problems.



Picture 20a. and 20b. Group work on ethnomathematics

During the teaching and learning processes of ethnomathematics, the learners had difficulties with the application of formulae for different geometrical shapes, changing of the subject of a formula, and conversion of units. These aspects were part of the grade 10 mathematics curriculum, but the learners lacked competencies on these. During the time of the study, lack of prior competencies on these aspects, hindered the progress of the lessons on ethnomathematics to a certain extent. The aim of the study was to teach the learners how to solve mathematical problems using the mathematics embedded in the Damara traditional activities and practices. The researcher gave handouts (see Annex VI and VII) containing basic geometrical figures with appropriate formulae to calculate the lengths, areas and volumes to the learners. However, because of lack of skills in the above, it was impossible for the learners to master all these information within a week.

Ethnomathematics test

By the end of one week, a test containing different patterns in the Damara traditional sewing and house construction was administered to 38 learners (20 females and 18 males) from the two schools. The total of five females and two males did not turn up for the test. The test scores of the male and female learners are shown in Annex XIII.

Measures of central tendency and variability on problems involving ethnomathematics are indicated in table 12.

Table 12. Mean and standard deviation obtained by the male and female learners on ethnomathematics test

Sex	Mean	Standard Deviation
Males	26.00	15.76
Females	19.25	11.89

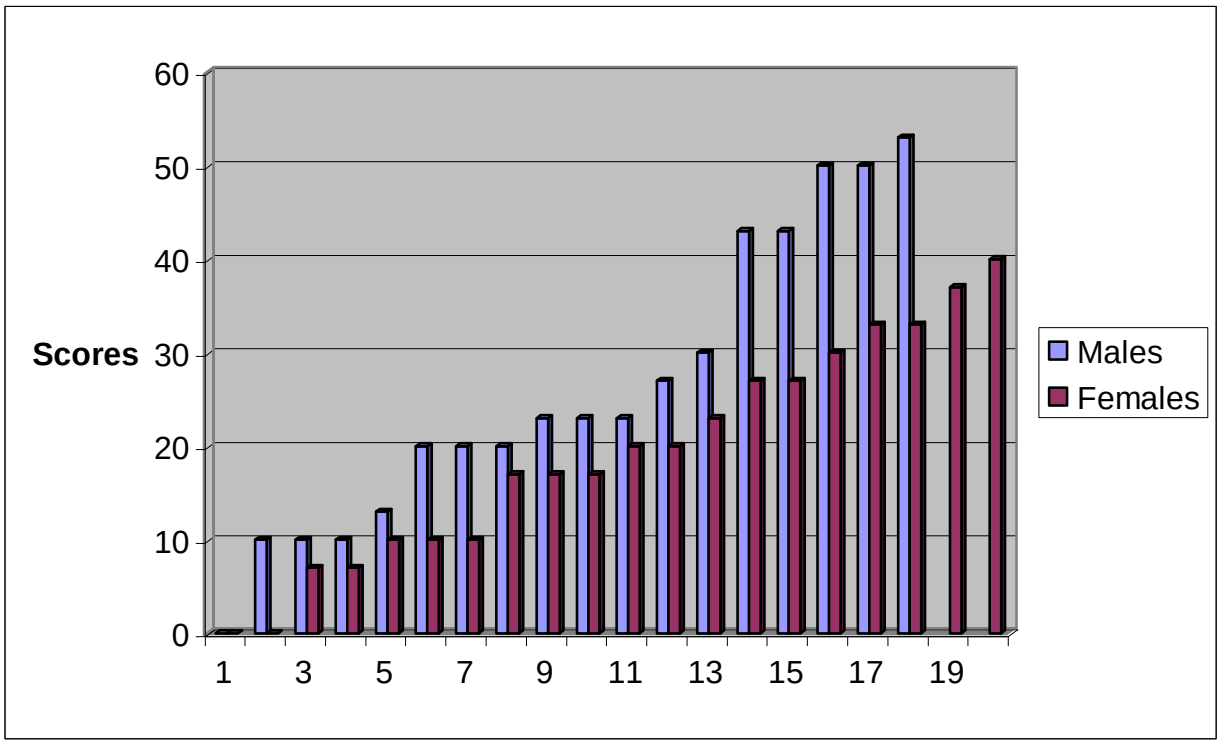
Out of the 38 (20 females and 18 males) learners who sat the test, the 18 males obtained a mean of 26, and standard deviation of 15.76, while the females obtained a mean of 19.25 and a standard deviation of 11.89. This implies that the males did better than the females on the test. But, the scores of the female learners were not spread out very far from each other as in the case of the males.

A t test was used to compare the means of the male and female learners and the difference between the two is considered to be not statistically significant with the value of $t = 1.49$ obtained at the probability (α) = 0.05 and the degree of freedom (df) = 36.

It can be seen in Annex XIII that two of the female learners obtained the lowest score of 0% and one a highest score of 40%. On the other hand, one of the male learners obtained the lowest score of 0% and another one, a highest score of 53%. This indicates that the male learners did better in the ethnomathematics test in general than their female counterparts.

Histogram shown in figure 1 shows the scores of the male and female learners in the ethnomathematics test.

Figure 1. Comparison of the male and female scores in the ethnomathematics test



CHAPTER FIVE

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

This chapter deals with the summary, conclusion and recommendations of the study based on the research findings and discussions.

SUMMARY

The present study attempted to find out the mathematical constructs embedded in the Damara cultural activities in Khorixas in the Erongo Region in Namibia as well as the type of implications these aspects have on the performance of learners in mathematics at schools.

The following four questions were addressed in this study:

1. What type of mathematics is found in the cultural activities of the Damara ethnic group in the Khorixas area in traditional sewing and house construction?

2. Which mathematical principles and laws at the junior secondary level are applicable to the cultural activities of the Damara people in Khorixas and how can they be applied in the teaching and learning processes of mathematics?

3. How can teachers integrate cultural mathematical activities of the Damara people into the teaching and learning processes in mathematics at the junior secondary school level in Khorixas?

4. How can the mathematics embedded in the Damara cultural activities be integrated into the teaching and learning processes in the mathematics classrooms at the junior secondary school level in Khorixas?

Interviews were used to obtain information from the respondents involved in the traditional sewing and house construction.

In addition, two questionnaires were designed to collect information from the grade 10 mathematics teachers while the second questionnaire was administered to the learners.

The researcher also taught ethnomathematics to the grade 10 mathematics learners at Cornelius Goreseb Senior Secondary School and Welwitchia Junior Secondary School for a week.
The different types of Damara traditional practices and activities found during the traditional sewing and house construction, the Damara King's festival, traditional food, perfumes, ointments and medicine preparation, weddings and funerals, and other practices were identified as areas in which ethnomathematics or science were used.

The teachers and learners identified a variety of the Damara traditional activities and practices and proposed that these be integrated in the mathematics curriculum.

Everyday activities were employed that underlined mathematical laws and concepts. These included elements in games, as well as dancing and singing. The geometry found in the Damara traditional sewing and house construction was identified to contain mathematical aspects.

Various responses were given on how traditional forms of mathematics and their employment in determining the sizes and shapes could be integrated in the school curriculum. Both the teachers and the learners felt that ethnomathematics should be actively encouraged and taught at school since it forms a cultural dimension and suggested that it should be made compulsory in order to convey different kinds of cultural mathematical concepts.

CONCLUSION

The present study investigated the mathematical practices of the Damara people in the course of dealing with their traditional sewing and house construction and the following conclusions were reached from the results of this study:

The Damara people carried out mathematical aspects such as counting, measuring, weighting, etc. in radically different ways to those which are commonly taught at school. Both the male and female respondents involved in the Damara traditional sewing and house construction said that there was a need to integrate mathematical cultural activities and practices of the Damara people in the teaching and learning processes in the classroom. They explained that this would establish a better relationship between the school and the culture of the learners as well as enhance better performance of the learners in mathematics.
The respondents identified a variety of traditional objects and activities such as games, patterns

found in sewing, house construction, etc. as aspects of the Damara traditional activities that could be integrated in the mathematics lessons to ensure learners' understanding of school mathematics.

The grade 10 mathematics teachers were also positive about the association of mathematics with the culture and argued that a culturally responsive curriculum might improve performance of the learners in school mathematics and enhance their self-esteem.

The learners showed greater interest in ethnomathematics and insisted on its introduction at their schools.

The findings showed that the Damara cultural activities, mainly the traditional sewing, house construction and games entailed measurements, symmetry, trigonometry, and geometrical laws including the Pythagoras theorem.

Damara traditional activities and practices may enhance the learners' mathematics understanding and performance of the teaching and learning processes at school.

RECOMMENDATIONS

The following recommendations emanate from the results of this study:

1. Inclusion of a variety of cultural aspects embodying mathematics and experiences in the mathematics curriculum might enhance better performance in mathematics. Mathematics in the classroom should therefore be modified in such a way that it is connected to what is happening in the day-to-day lives of the learners.

2. Parents should help their children to practice mathematical skills by introducing them to the cultural aspects with mathematical constructions, and the teachers should provide the learners with mathematics activities that parents could do with their children in the course of everyday activities.

3. The mathematics teachers should provide examples from the learners' environment. In this way, the learners' beliefs about mathematics as an abstract subject will be altered upon seeing the use and relevance of mathematics in their own lives.

4. The teachers should develop lessons that will enable the learners to explore geometrical patterns and other concepts found within their cultural objects as additional curriculum resources. This will help the learners to be involved in tackling challenging activities emphasizing math in the real world, and explaining how symmetry and repeating patterns are important to mathematicians.

5. The mathematics instructions should contain cultural materials designed to enrich the mathematical learning of patterns and shapes and the learners should be provided with opportunities to design their own cultural patterns and investigate mathematical concepts of the geometrical figures within these.

6. Mathematics should not be taught in a neutral way, insensitive to the realities in which people live. The more mathematics becomes owned by the children of the indigenous culture, the more mathematics will be enjoyed and better performance will result. Therefore, the school curricula should be multicultural in order to improve the quality of mathematics education. It should include some culturally based activities or concepts. For instance in the schools in the Khorixas area, examples and values that spring from the Damara context should be chosen.

7. Classroom teachers should create lesson plans that include the use of cultural activities whereby students should bring some ideas to the classroom and use the constructivist approach by actively being involved in constructing their own understanding. Teaching of mathematics should be understood in terms of providing students with the opportunity and the stimulation to construct powerful mathematical ideas for themselves. They should be encouraged to recognize their own powers as mathematics thinkers and learners.

8. The authorities responsible for the whole education system in Namibia should be sensitized towards the incorporation of ethnomathematics into the school curriculum and the introduction of a multicultural curriculum at least up to the grade 10 level. That is, the curriculum developers should understand the role of mathematics in multicultural societies and develop school curricula that include children's games and other cultural aspects into the learning process of mathematics.

9. The teachers should design lessons that would allow the learners to discover mathematical concepts such as the value of pi, circumferences, perimeters, the Pythagorean Theorem, etc. on

their own. By doing this, the learners will gain a deeper understanding, and have a rewarding experience, by figuring out the theorem for themselves.

10. Lastly, mathematics and culture should not be dealt with in isolation because they are interlinked in real life situations. The culture of the indigenous population reflects the social values, norms, traditions and institutions developed over a long period of time and each ethnic group has its own distinct identity though certain features remain common to all. Mathematics should be used to investigate creatively a variety of challenges within the learners' environment which might enhance the development of positive attitudes to mathematics and better performance.

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ANNEXES

ANNEX 1: TRADITIONAL SEWING AND HOUSE CONSTRUCTION RESPONDENTS' INTERVIEW FORMAT

I. BIOGRAPHIC INFORMATION

GENDER: **M** **F** **AGE**:

HOME LANGUAGE:

Please answer the following questions in the space provided.

1. What is the highest grade that you have obtained at the formal school level?

_____

2. How old were you when you started-off with traditional needle work/house construction?

_____

3. Did you undergo any training in sewing/house construction? If yes, describe type of training that you have undergone and its duration.

_____

_____

II. DAMARA TRADITIONAL ACTIVITIES

1. What are the most famous traditional activities/practices in the Damara culture that survived colonialism?

_____

_____

_____

2. Which traditional activities of the Damara people are no longer commonly practiced? Give reasons for your answer.

_____

_____

_____

3. Explain how counting is done in the *Khoi-Khoi Gowab.*

_____

_____

_____

4. How did you learn the traditional skills that you are currently practicing?

_____

_____

_____

5. During which occasions are the traditional activities commonly practiced in your culture?

_____

_____

_____

6. How do you share your traditional knowledge and skills with your children?

_____

_____

III. MATHEMATICS AND CULTURE

1. How do you obtain equal lengths, symmetry, paralleleness, roundness, or squareness in your sewing/house construction?

_____

_____

2. How would you explain the mathematical concepts and laws found in the Damara cultural set-up?

_____

_____

_____

3. In your view, should the Damara cultural activities be integrated into the teaching and learning processes at the junior secondary school level in Khorixas? Give reasons for your answer.

_____

_____

_____

4. In your opinion, how should school mathematics and traditional mathematical aspects be dealt with at schools?

_____

_____

_____

5. Which cultural objects would you recommend to be used by the mathematics teachers to teach mathematics lessons at school?

_____

_____

_____

IV MARKETING

1. What cultural values and beliefs are attached to the traditional activities/products of the Damara people?

_____

_____

_____

2. How do you determine the values of your products after making them?

_____

_____

_____

3. A customer has bought an article costing N$89.95 and gives you 100.00. Describe how you will go about giving the change to the customer.

_____

_____

_____

4. How do you find out whether you have made a profit after marketing?

_____

_____

_____

5. How do you control your stock?

_____

_____

_____

6. How do you determine the amount of material you need for your product?

_____

_____

_____

ANNEX 1I: QUESTIONNAIRE FOR THE GRADE 10 LEARNERS

I. BIOGRAPHIC INFORMATION

GENDER: | **M** | | **F** | **AGE**: |

HOME LANGUAGE: |

Please answer the following questions in the space provided/choose the most relevant answer/s for your situation by placing the corresponding letter in the box provided.

1. What is your favourite subject?

_____

2. For how long have you been studying mathematics?

_____

_____

_____

3. What is your experience about learning mathematics?

_____

_____

_____

II DAMARA TRADITIONAL ACTIVITIES

1. What are your feelings about the Damara traditional activities?

(a) Greatly interested

(b) Not interested at all

(c) Waste of time

(d) No idea

2. What type of Damara traditional activities/practices are you acquainted with?

(a) Traditional games

(b) Traditional sewing

(c) Traditional songs and dances

(d) Traditional house construction

(e) Traditional cooking

3. When within your culture are traditional activities commonly practiced?

(a) During wedding ceremonies

(b) During Christmas time

(c) During cultivation

(d) All of the above

(e) Other (specify)

4. Describe types of mathematical laws, concepts or principles underlying the above selected traditional activities or practices.

(a) Traditional games

_____

_____

_____

(b) Traditional songs and dances

_____

_____

_____

(c) Traditional house construction

_____

_____

_____

(d) Traditional cooking

_____

_____

_____

III. MATHEMATICS AND CULTURE

1. Why do you study mathematics?

(a) Because it is a challenging subject

(b) Because it is a compulsory subject

(c) To pass exams

(d) To impress others

2. How do you view the content of mathematics taught at schools?

(a) Insensitive to cultural interests ☐

(b) Integrative to cultural interests ☐

(c) Discriminative of cultural interests ☐

(d) No idea ☐

3. How do you view the concepts of mathematics embedded in the Damara cultural activities?

(a) Primitive ☐

(b) Abstract ☐

(c) Valuable ☐

(d) Instructive ☐

4. In your opinion, how should "school" mathematics and traditional mathematical aspects be dealt with at school?

(a) In isolation ☐

(b) In integrated ☐

(c) In anyway ☐

5. Which cultural activities would you recommend to be used by the mathematics' teachers to construct lessons at schools?

(a) Traditional games ☐

(b) Traditional sewing ☐

(c) Traditional songs and dances ☐

(d) Traditional house construction ☐

(e) All of the above ☐

6. What are the concepts/laws of mathematics found in the above-identified traditional activities?

(a) Traditional games

_____

_____

_____

(b) Traditional sewing

_____

_____

_____

(c) Traditional songs and dances

_____

_____

_____

(d) Traditional house construction

_____

_____

_____

7. How can the ethnomathematics be integrated into the school curriculum?

_____

_____

_____

ANNEX 1II: QUESTIONNAIRE FOR THE GRADE 10 TEACHERS

I. BIOGRAPHIC INFORMATION

GENDER: | **M** | | **F** | **AGE**: |

HOME LANGUAGE: |

Please answer the following questions in the space provided/choose the most relevant answer/s for your situation by placing the corresponding letter in the box provided.

1. For how long have you been teaching mathematics?

_____

2. What is your experience about teaching mathematics?

_____

_____

_____

3. Grades you are teaching mathematics to are:

_____

II DAMARA TRADITIONAL ACTIVITIES

1. Should Damara cultural activities be encouraged among the youth? | Y | | N |

Give reasons for your answer.

_____

_____

_____

2. What type of Damara traditional activities/practices are you acquainted with?

(a) Traditional games

(b) Traditional sewing

(c) Traditional songs and dances

(d) Traditional house construction

(e) Traditional cooking

3. When within your culture are traditional activities commonly practiced?

(a) During wedding ceremonies

(b) During Christmas time

(c) During cultivation

(d) All of the above

(e) Other (specify)

III MATHEMATICS AND CULTURE

1. How do you view the content of mathematics taught at schools?

(a) Insensitive to cultural interests

(b) Integrative to cultural interests

(c) Discriminative of cultural interests

(d) No idea

2. How do you view the mathematics found in the traditional activities of the Damara people?

(a) Primitive ☐

(b) Abstract ☐

(c) Valuable ☐

(d) Instructive ☐

3. What is your opinion about integration of cultural aspects in the mathematics curriculum at school?

(a) Quality of mathematics education will be improved ☐

(b) Quality of mathematics education will deteriorate ☐

(c) Cultural content will not be a hindrance to learning mathematics ☐

(d) Multiculturalising the mathematics curriculum will enhance better performance in mathematics ☐

4. What is your opinion about the incorporation of ethnomathematics in the mathematics curriculum at the junior secondary school level?

(a) This will discourage the students in learning mathematics ☐

(b) This will motivate the students to learn mathematics and enhance better performance ☐

(c) This will encourage the students to respect their cultural activities and practices ☐

(d) This will encourage students to take pride in their own cultural heritage and value their culture ☐

5. How can the ethnomathematics be integrated into the school curriculum?

_____

_____

_____

ANNEX IV. INTRODUCTION OF ETHNOMATHEMATICS TO THE LEARNERS

BACKGROUND

Etnomathematics is the subject that deals with mathematics that is practiced among various tribal groups and is mainly influenced by the norms, beliefs and the values that are important to these tribal groups.

Many studies have revealed that there are powerful mathematical concepts hidden in cultural practices of various ethnic groups. These exist in many different contexts such as traditional house construction agriculture, woodcarving, basket weaving, sewing, games, agriculture, needlework, games, counting, and other cultural activities.

Because the mathematics taught at school mainly expresses the Western cultures, many authors are making attempts for other cultural values to be part of the school curriculum too.

It is very important to enhance the understanding of cultural diversity of mathematical practices, and to apply such knowledge to the development of teaching and learning of mathematics. Variety of cultural styles and experiences in the mathematics curriculum might enhance better performance in this subject that is perceived to be very difficult in most parts of the world. Thus, mathematics in the classroom should be modified in such a way that it is connected with what is happening in day - to-day lives of the learners to help them know more about reality, culture, society and themselves.

By drawing strongly from examples in their environments, learners' beliefs about mathematics will be broadened and this will provide them with the opportunity to see the relevance of mathematics in their own lives.

People on market places have very interesting ways in which they reason mathematically during the marketing processes. It is amazing to observe the mathematical skills that illiterate people are unconsciously practicing during exchanging their products. Therefore, it is very important to link the way in which people are doing things in real life situations with what is happening at school.

Etnomathematics is part of the indigenous cultural practices, of which mathematical context of each group is different. This means that it is not easy to generalize one group's experiences to any other

group because they are not likely to be repeated again. Speakers of a particular language see mathematical ideas in different ways. Thus, school mathematics should include some culturally based activities or concepts, which were not previously regarded as part of the mathematics. The more mathematics becomes owned by children of other indigenous cultures, the more it will be enjoyed, better understood and performed.

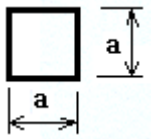
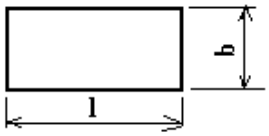
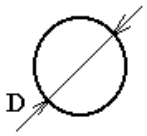
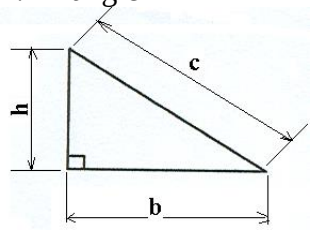
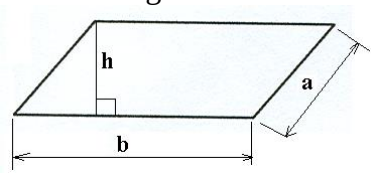
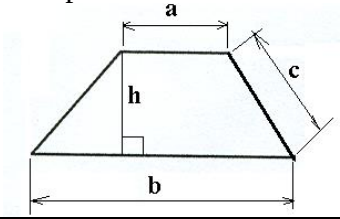
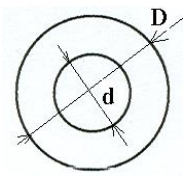
It is amazing to note about how the illiterate people deal with money issues during the exchange of their products, as well as how they control their stock. Cultural aspects of mathematics might serve as motivating factors if transferred to school and incorporated into school curriculum. Mathematics at school should be dealt with as an integrated whole rather than as series of disconnected topics and rules.

ANNEX V. GENERAL COURSE OBJECTIVES

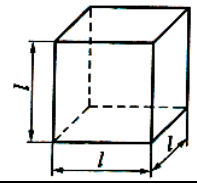
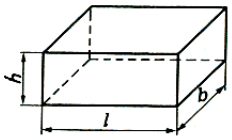
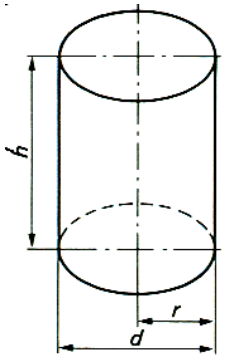
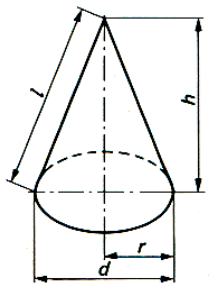
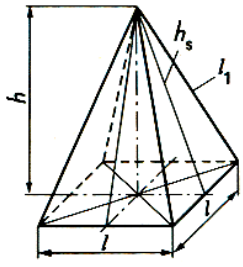
Upon completion of this course the learners will be able to:

- Recognize the role and importance of mathematics in their lives.
- View mathematics as an integrated whole rather than as a series of disconnected topics and rules.
- Identify and solve problems arising from mathematical situations and everyday experiences.
- Demonstrate that there may be multiple ways to solve a problem and that some are more helpful and efficient than others.
- Draw pictures and models (pattern blocks, or other manipulative materials) to represent problems and explain mathematical reasoning.
- Make reasonable predictions, estimations, or solutions when working with quantities measurement, computations, and problem solving.
- Draw logical conclusions about certain mathematical situations using informal reasoning.
- Use mathematical operations, symbols and language to describe and discuss real-world Situations.
- Use formulas to find perimeter, area, circumference, volume, and surface area of prisms, pyramids, and cylinders to a specified degree of accuracy.
- Select and apply indirect methods of measurement including formulae (e.g. the Pythagorean theorem).
- Identify and create examples of line symmetry.
- Understand that the sum of the angles of any triangle 180° and the sum of the angles of any quadrilateral is 360° and use this information to solve problems.
- Collect data by using the following procedures: observing, measuring, counting and analysing information to solve relevant and realistic scenarios.

ANNEX VI. THE BASIC FORMULAE TO CALCULATE THE CIRCUMFERENCE /PERIMETER AND AREA OF DIFFERENT GEOMETRICAL FIGURES

FIGURE	CIRCUMFERENCE/PERIMETER [m]	AREA [m²]
1. Square 	P = a + a + a + a	A = a × a = a²
2. Rectangle 	P = 2l + 2b	A = l ×b
3. Circle 	C = 2πr or C = πD D = 2r	$A = \frac{\pi D^2}{4}$ OR A = πr²
4. Triangle 	P = b + c + h	$A = \frac{1}{2} b \times h$
5. Parallelogram 	P = 2a + 2b	A = b×h
6. Trapezium 	P = a + 2 + 2c	$A = \frac{a+b}{2} \times h$
7. Ring (Annulus) 	C_d = 2πr or C = πd d = 2r C_D = 2πR or C = πD D = 2R	$A = \frac{\pi(D^2 - d^2)}{4}$ OR A = π(R² - r²)

ANNEX VII. THE BASIC FORMULAE TO CALCULATE THE VOLUME OF DIFFERENT GEOMETRICAL FUGURES

FIGURE	VOLUME [m^3]
1. Cube 	$V = l^3$
2. Prism 	$V = l \times b \times h$
3. Cylinder 	$V = \pi r^2 \times h$
4. Cone 	$V = \frac{1}{3}(\pi r^2 \times h)$
5. Right Pyramid 	$V = \frac{1}{3}(l \times b \times h)$

ANNEX VIII. LESSON PLAN – DAY 1

Name of the Teacher:	M. B. Hara-Gaes
Name of the School (s):	Cornelius Goreseb Senior Secondary School
	Welwitchia Junior Secondary School
Grade:	10
Duration 0f the lesson:	45 Minutes
Date:	15/09/2003
Class size:	CGSSS - 20/WJSSS A - 13/WJSS B - 12
Subject:	Ethnomathematics
Topic:	Geometry in the Damara traditional patterns
	(traditional dresses and bedspreads)

LESSON OBJECTIVES:

Upon completion of this topic, the learners will be able to:

- identify different geometrical shapes within the Damara traditional activities/products/items.
- describe symmetry underlying the Damara traditional shapes.
- investigate mathematical concepts and principles hidden in such cultural practices.

PRE-REQUISITE OBJECTIVE:

The learners should already be able to:

- measure length, width, and breadth of an object.
- distinguish between basic metric units and carryout conversions of units according to requirements.

INTRODUCTION

Namibia is a multicultural country whereby each culture has numerous unique cultural practices. Culture cannot be dealt with in isolation. Each society should be very proud of its culture. A nation without culture is a lost nation, because we are all guided by our cultural norms, beliefs and values.

Aim of the lesson:

(1) Size of the material required for a Damara traditional dress, made up of small pieces of different

colours needs to be determined.

LESSON DEVELOPMENT

Aunt #Nîtago needs a traditional dress for her daughter's engagement party. She decides to design a rectangular pattern made up of 10cm material pieces that are enough for the whole dress (seams included). One square piece is made up of triangular pairs of brown and orange coulor pieces that are to be attached to each other symmetrically. The length of the material required for the dress is 2m, and the height 0.5m.

Compute the following:

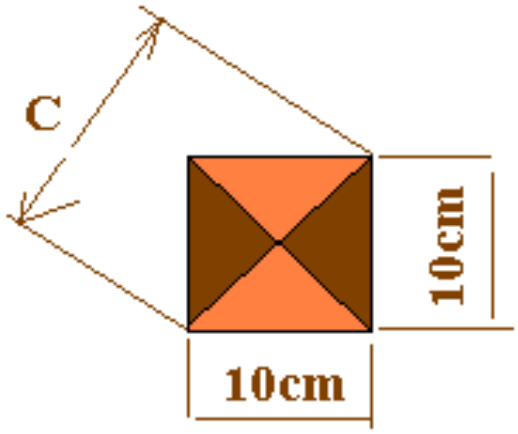
(a) Area of one (1) square piece to be cut out.

(b) The value of side "C" as shown in the figure.

(c) Number of square pieces required for the length of the material.

(d) Number of square pieces required for the height of the material.

(e) Number of square pieces required for the whole material.



(a) Area of one (1) square piece to be cut out.

$A = a^2$

$A = (10cm)^2$

$\underline{A = 100cm^2 = 0.01m^2}$

(b) The value of side "C" as shown in the figure.

$C^2 = (10cm)^2 + (10cm)^2$

$C^2 = (100cm^2 + 100cm^2) = 200cm^2$

$\therefore$

$C = \sqrt{200cm^2} = \underline{\mathbf{14.14cm = 0.1414m}}$

(c) Number of square pieces required for the length of the material.

$$n = \frac{2m}{0.1m}$$

$\underline{\mathbf{n = 20}}$

(d) Number of square pieces required for the height of the material.

$$n = \frac{0.5m}{0.1m}$$

$\underline{\mathbf{n = 5}}$

(e) Number of square pieces required for the whole material.

$n_T = 20 \times 5$

$\underline{\mathbf{n_T = 100}}$

SUMMARY

- Role and importance of mathematics in our lives must be recognized and the subject to be viewed as an integrated whole rather than as a series of disconnected topics and rules.

- Formulae: Area, circumference, volume of basic shapes.

LESSON EVALUATION

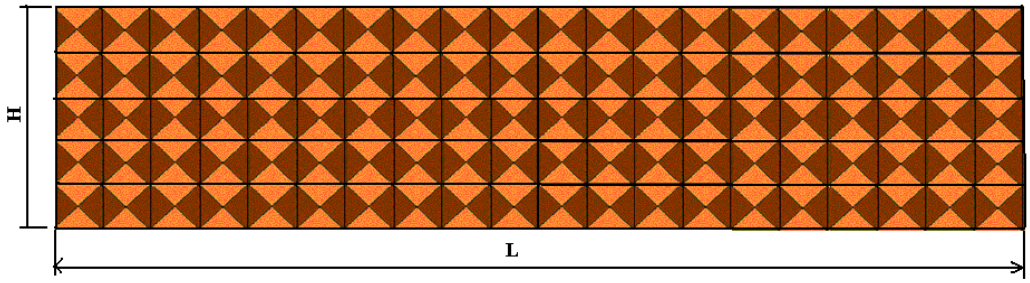
1. What type of geometrical figures did you find in the Damara traditional sewing?
2. What mathematical laws/ principles were hidden in the Damara traditional sewing?
3. How are the following being calculated: circumference, area, and volume of the figures found in the Damara traditional sewing?

HOMEWORK

(a) In your immediate cultural environment, identify a traditional object that you think entails mathematical concepts, bring it to the next lesson and be prepared to explain the type of mathematics underlying it and to solve problems.

(b) Calculate the following by using the same material piece that was discussed in the lesson today.

(i) Draw a figure representing the whole area of the required material and calculate its total area.



A = L × H

A = 2m × 0.5m

A = 1m²

(ii) Number of pairs of brown and orange colour pieces required for the material and their sum.

Brown pair pieces = 20 ×5 = **100**

Orange pair pieces = 20 × 5 = **100**

Sum of brown and orange pair pieces = 100 + 100 = **200**

ANNEX IX. LESSON PLAN – DAY 2

Name of the Teacher:	M. B. Hara-Gaes
Name of the School (s):	Cornelius Goreseb Senior Secondary School
	Welwitchia Junior Secondary School
Grade:	10
Duration of the lesson:	45 Minutes
Date:	16/09/2003
Class size:	CGSSS - 20/WJSSS A - 13/WJSS B - 12
Subject:	Ethnomathematics
Topic:	Geometry in the Damara traditional patterns
	(traditional objects)

LESSON OBJECTIVES:

Upon completion of this topic, the learners will be able to:

- Explain the type of mathematics underlying the Damara traditional objects they brought to the classroom.
- Use mathematical principles to compute values, quantities, (circumferences, areas, and volumes of different geometrical shapes) by using objects found within their immediate cultural environments.
- Compare real life problems with what is being taught in the classroom.

PRE-REQUISITE OBJECTIVE:

The learners should already be able to:

- Calculate circumferences, areas, and volumes, of different shapes/figures.
- Use trigonometric ratios to compute the unknown values and angles.

INTRODUCTION

Mathematics and culture cannot be dealt with in isolation because they are interlinked in the real life situations.

LESSON DEVELOPMENT

Based on the cultural objects brought to the classroom by the learners.

SUMMARY

- Reasonable predictions, estimations, or solutions should be made when working with quantities, measurement, computations, and problem solving.

- Important formulae: Area, circumference, and volume of basic shapes.

EVALUATION

1. What type of geometrical figures did you identify from your objects?
2. What mathematical laws/ principles were hidden in these objects?
3. Which formulae did you used to solve problems underlying the traditional objects you brought to the classroom?

HOMEWORK

(a) Explain in your own words what you understand by the term ‘Ethnomathematics’.
(b) Identify two (2) items arising from mathematical situations within your cultural environment.
(c) Investigate type of mathematics underlying these items;
(d) Compute the necessary values/quantities by using these items.
(e) Bring the items to the classroom for further exploration.

ANNEX X. LESSON PLAN – DAY 3

Name of the Teacher:	M. B. Hara-Gaes
Name of the School (s):	Cornelius Goreseb Senior Secondary School Welwitchia Junior Secondary School
Grade:	10
Duration of the lesson:	45 Minutes
Date:	17/09/2003
Class size:	CGSSS - 20/WJSSS A - 13/WJSS B – 12
Subject:	Ethnomathematics
Topic:	Geometry in the Damara traditional patterns (traditional house construction)

LESSON OBJECTIVES:

Upon completion of this topic, the learners will be able to:

- use mathematical principles to compute values, quantities, (circumferences, areas, volumes of different geometrical shapes) by using objects found within their immediate cultural environments.

- compare real life problems with what is being taught in the classroom.

PRE-REQUISITE OBJECTIVE:

The learners should already be able to:

- Calculate circumferences, areas, and volumes, of different shapes/figures.

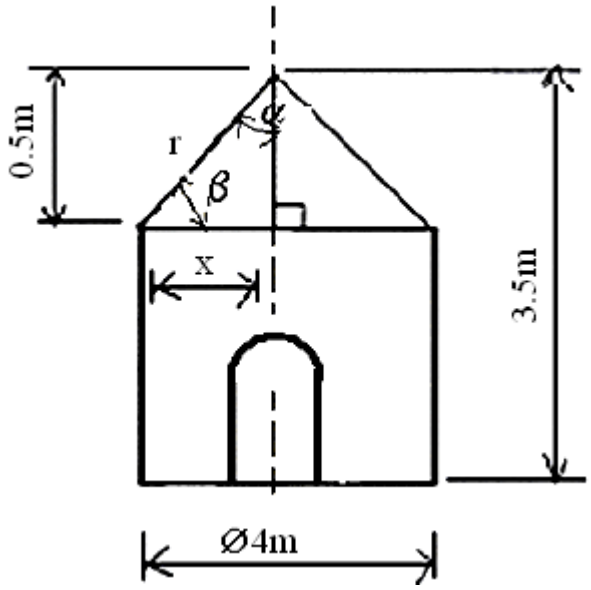
- Use trigonometric ratios to compute the unknown values and angles.

INTRODUCTION

The traditional houses of the Damara people are constructed with square shapes by using small pieces of sheet metal. A window and two doors, of which one is placed in front, and the other at the back, are made for each room for good air circulation. Floors are laid with mixer of cow-dung, sand, and clay. It will be very interesting to find out about the geometry as well as the other calculations and ratios that are applied by the illiterate or semiliterate builders during house construction.

LESSON DEVELOPMENT

Uncle /An-/an wants to build a round traditional shelter for his family. He started to layout a plan that is 4m in diameter, around which edges 3m long poles, that are apart from each other at an arch length of 0.5m, are to be placed. A standard door of 0.80m × 2m is to be placed in the middle at the front side. The total height of the hose must be 3.5m Uncle /An-/an will require 0.025m³ of mud for plastering 1m² of the hut.



Calculate the following:

(a) Circumference of the floor plan.

(b) Area of the floor plan.

(c) Area of the roof trust.

(d) Hypotenuse "r" by using the Pythagorean Theorem.

(a) Circumference of the floor plan.

$C = \pi.D$

$C = 3.142 \times 4m$

C = 12.57m

(b) Area of the floor (base) plan.

$$A = \frac{\pi d^2}{4}$$

$$A = \frac{3.142 \times 4m}{4}$$

A = 3.142m²

(c) Area of the roof trust.

$$A = \frac{\pi d^2}{4}$$

$$A = \frac{3.142 \times 4m}{4}$$

$$\mathbf{A = 3.142m^2}$$

$$A = \frac{1}{2} h \times d$$

$$A = 2 \times \left(\frac{1 \times 0.5m \times 4m}{2}\right)$$

$$\mathbf{A = 2m^2}$$

(d) Hypotenuse "r" by using the Pythagorean Theory.

$$r^2 = (0.5m)^2 + x^2$$

$$r^2 = (0.5m)^2 + (2m)^2 = 4.25m^2$$

$$\therefore$$

$$r = \sqrt{4.25m^2} = \mathbf{2.06m}$$

HOMEWORK

(a) Draw a simple plan of a rectangular traditional shelter with a triangular roof.

(b) Determine the mathematical principles hidden in your drawing.

(c) Compute the necessary values found within your drawings.

(d) Make comments about your findings.

ANNEX XI. LESSON PLAN – DAY 4

Name of the Teacher:	M. B. Hara-Gaes
Name of the School (s):	Cornelius Goreseb Senior Secondary School
	Welwitchia Junior Secondary School
Grade:	10
Duration of the lesson:	45 Minutes
Date:	17/09/2003
Class size:	CGSSS - 20/WJSSS A - 13/WJSS B - 12
Subject:	Ethnomathematics
Topic:	Geometry in the Damara traditional patterns
	(traditional house construction)

LESSON OBJECTIVES:

Upon completion of this topic, the learners will be able to:

- Investigate the mathematics hidden in different types of cultural objects and use appropriate formulae to solve problems.

PRE-REQUISITE OBJECTIVE:

The learners should already be able to:

- Calculate circumferences, areas, and volumes, of different shapes/figures.
- Use trigonometric ratios to compute the unknown values and angles.

INTRODUCTION

The neglect of nature, experience, and reality has been a major underlying reason for many of the problems we encounter in the teaching and learning mathematics.

LESSON DEVELOPMENT

Continuation of solving problems from the previous lesson.

(a) Angles α, and β.

(b) Volume of the cylindrical shape of the hut.

(c) Volume of the roof trust.

(d) Number of poles required for the whole hut.

(e) Amount of mud required for plastering the exterior part of the hut.

(a) Angles α, and β.

$$\sin\alpha = \frac{x}{r} = \frac{2m}{2.06m} = 0.97$$

$\therefore$

$$\underline{\boldsymbol{\alpha = 76^\circ}}$$

$$\sin\beta = \frac{0.5m}{r} = \frac{0.5m}{2.06m} = 0.24$$

$\therefore$

$$\underline{\boldsymbol{\beta = 14^\circ}}$$

Note:

$90° + \alpha + \beta = 180°$

$90° + 76° + 14° = 180°$

(b) Volume of the cylindrical shape of the hut.

$$V = \frac{\pi d^2}{4} \times h$$

$$V = \frac{3.142 \times (4m)^2}{4} \times 3m$$

$$\underline{\mathbf{V = 37.7 m^3}}$$

(c) Volume of the roof trust.

$$V = \frac{\pi d^2}{4} \times \frac{h}{3}$$

$$V = \frac{3.142 \times (4m)^2}{4} \times \frac{0.5m}{3}$$

$$\underline{\mathbf{V = 2.094 m^3}}$$

(d) Number of poles required for the whole hut.

$$n = \frac{C}{0.5} = \frac{12.57m}{0.5m}$$

n = 25

(e) Amount of mud required to plaster the exterior part of the hut.

0.025m³ of mud ……. 1m² of the hut

Xm³ of mud …… 3.142m² of the hut

$$\frac{X}{0.025m^3} = \frac{3.142m^2}{1m^2}$$

$\therefore$

$$X = \frac{3.142m^2 \times 0.025m^3}{1m^2}$$

X = 0.07855m³

LESSON EVALUATION

1. What type of geometrical figures are found in the Damara traditional activities and practices?
2. What mathematical laws/ principles have you been using to solve problems?
3. Give the formulae used for the calculations carried out.

HOMEWORK

(a) Draw a simple sketch of a wired toy car.

(b) Determine the mathematical principles hidden in your drawing.

(c) Compute the necessary values found within your drawings.

(d) Make comments about your findings and discuss these in group of three.

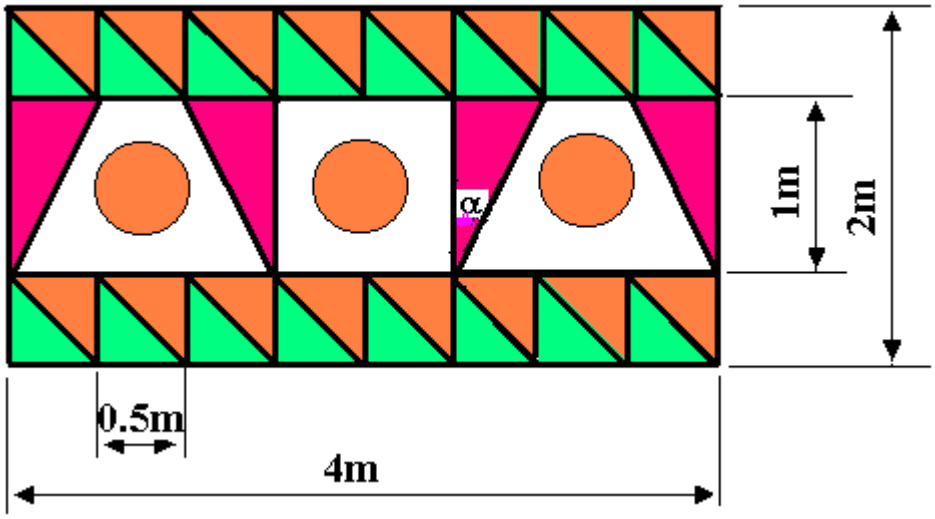
(e) Study for the ethnomathematics test tomorrow.

ANNEX XII. TEST ON ETHNOMATHEMATICS – MEMORANDUM

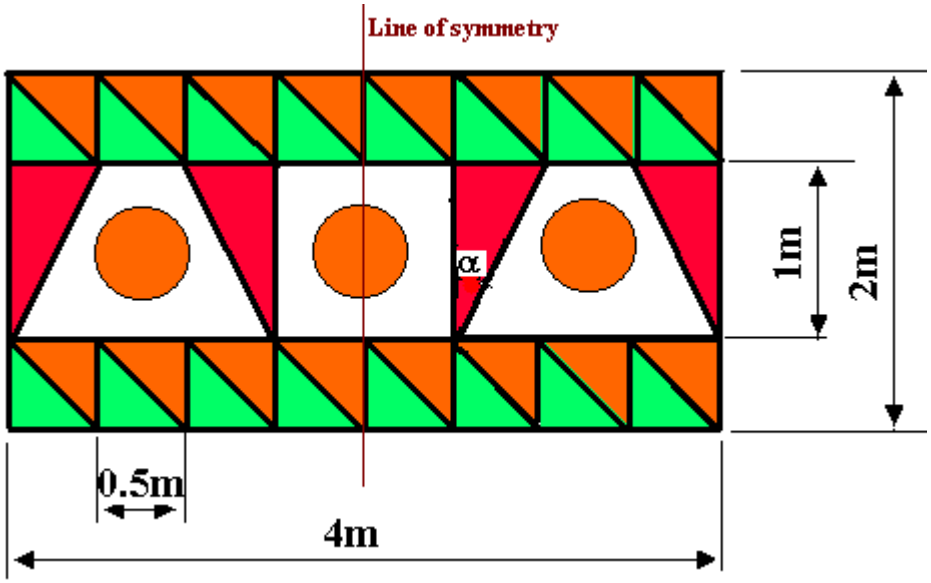
TOTAL: 30 Marks

Solve the following by using the figure representing a Damara traditional bedspread below:

The diameter of all the circles is 0.5m. *Use π = 3.142 to calculate the required quantities to three digits after the comma.*



(a) Draw the line of symmetry on the drawing of the bedspread.



(2)

(b) Calculate the whole area of the bedspread.

A = L × W

A = 4m × 2m

A = 8m (2)

(c) Calculate:

(i) The radius of a circle.

$$r = \frac{d}{2}$$

$$r = \frac{0.5m}{2}$$

r = 0.25m

(2)

(ii) Calculate the circumference of a circle.

C = π.d

C = 3.142 × 0.5m

C = 1.571m

(2)

(d) Calculate:

(i) the area of a circle.

$$A = \pi r^2$$

$$A = 3.142 \times (0.25m)^2$$

A = 0.196m²

OR

$$A = \frac{\pi d^2}{4}$$

$$A = \frac{3.142 \times (0.5m)^2}{4}$$

A = 0.196m²

(2)

(ii) the total area of all the circles.

A_T = Area of one circle × number of circles

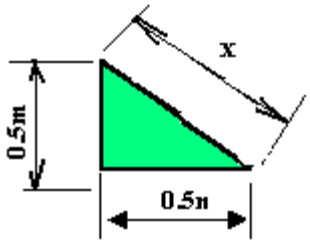
A_T = 0.196m² ×3

A_T = 0.588m²

(2)

(e)Calculate:

(i) the hypotenuse of a small triangle.



$x^2 = (0.5m)^2 + (0.5m)^2$

$x^2 = 0.5m^2$

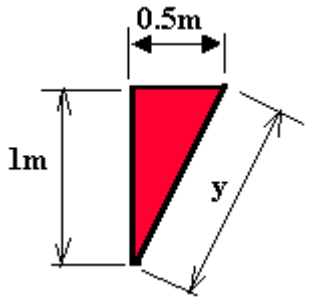
$\therefore$

$x = \sqrt{0.5m^2}$

x = 0.707m

(2)

(ii) the hypotenuse of a big triangle.



$y^2 = (0.5m)^2 + (1m)^2$

$y^2 = 1.25m$

$\therefore$

$y = \sqrt{1.25m^2}$

y = 1.118m

(2)

(f) Calculate:

(i) the area of a small triangle.

$$A = \frac{1}{2} base \times height$$

$$A = \frac{1}{2} 0.5m \times 0.5m$$

A = 0.125m²

(2)

(ii) the area of a big triangle.

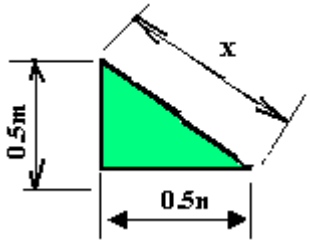
$$A = \frac{1}{2} base \times height$$

$$A = \frac{1}{2} 0.5m \times 1m$$

A = 0.25m²

(2)

(ii) the perimeter of a small triangle.



P = Opposite + Adjacent + Hypotenuse

P = 0.5m + 0.5m + 0.707m

P = 1.707m

(2)

(iv) the perimeter of a big triangle.

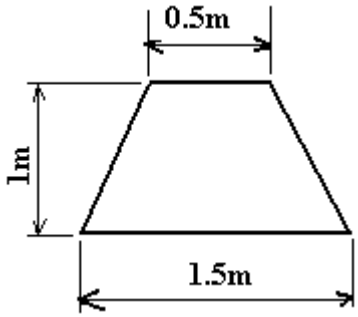
P = Opposite + Adjacent + Hypotenuse

P = 0.5m + 1m + 1.118m

P = 3.236m

(2)

(g) Determine the area of a trapezium by disregarding the circles within it.



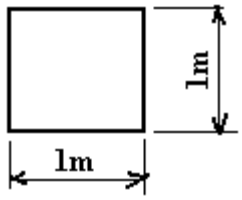
$$A = \frac{b_1 + b_2}{2} \times h$$

$$A = \frac{0.5m + 1.5m}{2} \times 1m$$

A = 0.375m²

(2)

(h) Calculate the area of the big square in the middle of the bedspread by disregarding the circles within it.



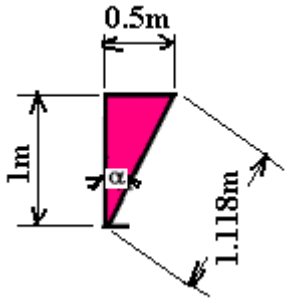
A =l × b

A = 1m × 1m

A = 1m

(2)

(i) Use the geometric ratios to calculate angle α.



$\sin\alpha = \frac{0.5m}{1.118m}$

$\sin\alpha = 0.447$

$\therefore$

α = 26.565°

OR

$\cos\alpha = \frac{1m}{1.118m}$

$\cos\alpha = 0.894$

$\therefore$

α = 26.565°

OR

$\tan\alpha = \frac{0.5m}{1m}$

$\tan\alpha = 0.5$

$\therefore$

α = 26.565°

OR

$\cot\alpha = \frac{1m}{0.5m}$

$\cot\alpha = 2$

$\therefore$

α = 26.565°

(2)

ANNEX XIII: THE MALE AND FEMALE LEARNERS' SCORES IN THE ETHNOMATHEMATICS TEST

Males		**Females**	
Test Scores %	**Frequencies**	**Test Scores**	**Frequencies**
0	1	0	2
10	3	7	2
13	1	10	3
20	3	17	3
23	3	20	2
27	1	23	1
30	1	27	2
43	2	30	1
50	2	33	2
53	1	37	1
-	-	40	1
Total:	**18**	**Total:**	**20**