**RESOURCE BOOK ON ETHNO-MATHEMATICS, SERIES I**

**BY**

**NATIONAL MATHEMATICAL CENTRE (NMC), ABUJA, NIGERIA**

**AND**

**CARNEGIE AFRICAN DISPORA FELLOWSHIP PROGRAMME (CADFP), USA**

**2020**

***Nigerian Indigenous Mathematical Knowledge Systems From the Perspective of Agbari, Calabar, Abeokuta, Igede and Nsukka Cultural Groups***

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**FOREWORD BY DIRECTOR/CE, NMC**

The National Mathematical Centre (NMC), Abuja was established by decree No. 40 of 1989 with the mandate of improving the teaching and learning of mathematical sciences at all levels of education, among others. One of the methods of realizing this objective is by developing and implementing strategies and devices that would enhance the teaching and learning of mathematics. The formation of NMC Ethno-mathematics Research Group is one of the strategies, which the Centre has put in place to make the teaching and learning of mathematics more friendly and interesting by using our culture and the use of cultural materials including women stories.

This NMC Ethno-Mathematics textbook was written by the NMC Ethno-Mathematics Research Group including Professor Nkechi Madonna Agwu (a Carnegie African Diaspora Fellow) the international Leader of the Group. The book is designed to help both teachers and learners teach/learn mathematics more effectively, using local contents. It focuses on the Nigerian indigenous mathematical knowledge systems from the perspectives of Agbari, Calabar, Abeokuta, Igede and Nsukka Cultures. The book contains practical illustrations, activities and pictures that make it attractive and reader friendly to teachers and learners. There is no doubt that the book will help to improve the teaching and learning of mathematics.

I therefore recommend the textbook for teachers and learners of mathematics at various levels of our educational system.

Prof Stephen E. Onah (FIIA, FMAN)
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**ACKNOWLEDGEMENTS**

The contributing authors and members of the National Mathematical Centre (NMC), Abuja, Ethno-mathematics Research Group would like to first and foremost dedicate this book to the Almighty, The Absolute Infinite, and to whom we give thanks for everything and everyone that led to the successful accomplishment of this publication. Imela Okaka Onyekeruwa (Thank you Great and Mighty Creator of the World)!

We extend special thanks to the Carnegie African Diaspora Fellowship Programme (CADFP) for their support of Professor Nkechi Madonna Agwu as a Carnegie African Diaspora Fellow (CADF) for the project, "Culture, History and Women's Stories: A Framework for Capacity Building in Science, Technology, Engineering and Mathematics (STEM) Related Fields and for Fostering Entrepreneurship." This publication is a bi-product of this project.

We thank the NMC Board of Trustees and Leadership Administrators for providing us with the resources and opportunity to engage in this project. We thank them for their mentorship roles, administrative support, and review input for this and other publications based on this project. In particular, we extend special thanks to the past NMC Director, Professor Adewale Solarin and our research group member Dr. Smart Oloda, who opened the gates in bringing Professor Agwu to the NMC as a CADF, after her initial start of this project as a CADF at the Centre for Gender Issues in Science and Technology (CEGIST), Federal University of Technology, Akure (FUTA) where she partnered with the Nigerian Women in Agricultural Research for Development (NiWARD) as their Mathematical Story-teller. We also thank the current NMC Director, Professor Stephan Onah who embraced this CADFP project as something of value that is beneficial to the mathematics education community in Nigeria, and to the teaching and learning of mathematics in Nigeria and globally. We thank our ethno-mathematics research group technical resource members, state liaisons, project driver for ethno-mathematics research group visits to the states, NMC IMSA???? (SPELL IN FULL) school administrators and students, the Computer Science Department administrators and staff for technical assistance, use of their facilities and resources, and all other NMC staff and offices that were instrumental to moving forward this project, especially the Registrar, Malam Aliyu Biu and his staff, and the Bursar, Malam Mohammed Ibrahim and his staff, who ensured that all logistical and financial support were in place for our ethno-mathematics research group, particularly for Professor Agwu, the CADF. We give special thanks to our technical resource member, Mr. Bamidele Pelemo for opening the door that made the Agbari module a reality.

We extend special thanks to the traditional rulers, government offices and all resource persons in the various states in the country that we visited, for welcoming us with open arms, willingly sharing their cultural heritage items, norms and traditions with us that were necessary for the writing of this book. We also extend thanks to the following Women's Organizations and their Executive Board members for sharing their Women's stories in STEM, viz.: Nigerian Women in Agricultural Research for Development (NiWARD) and Nigerian Women in Mathematics (NWiM). These stories will be disseminated in a forthcoming series of this project.

We extend special thanks to Borough of Manhattan Community College (BMCC), City University of New York (CUNY), for releasing Professor Agwu for a one semester sabbatical to engage in this project. We also thank the Faculty Interest Group (FIG) on Culture, Women's Stories and Creativity in STEM of the Centre for Excellence in Teaching, Learning and Scholarship (CETLS), BMCC, CUNY, for their review input on various outcomes of this work; the Mathematics Teaching-Research Journal Online for giving us our first break at global dissemination of this project; L'Ecole Superieure Sainte Felicite, Cotonou, Benin

Republic, for providing Professor Agwu, the CADF, with a few seminar opportunities to share our work with their mathematics faculty members, students, and key administrators, as well as, other members of the mathematics community in Benin Republic; and the United People's Inclusive for providing Professor Agwu, the CADF, with seminar and workshop opportunities to share our work in communities in Brooklyn, New York, United States.

In addition, we thank the following institutions and organizations for helping with field-testing of and providing review input for various modules in this book, viz.: BMCC, CUNY, with courses in Discrete Mathematics, Foundations of Mathematics and Introduction to Statistics, was well as, with presentations at its Faculty Development Day Program and Women's History Month Program; Pan African Strategy and Policy Research Group (PANAFSTRAG) with professional development workshops for mathematics school teachers in Lagos State and its environs; Jacob Ukeje Agwu International Conference and Media Centre (JUAICMC) with their Waste to Wealth Program for primary school children from 13 public schools in Bende Local Government Area, Abia State, Nigeria; the Jacob Agwu Memorial Vocational Skills Acquisition and Entrepreneurship Centre (JAMVSEC) with their skills acquisition workshops for children, youth, women and the disabled at Agbakoli Alayi, Abia State, Nigeria; the Drammeh Centre with a program for middle school and high school girls in the Bronx County of New York City, New York State, United States; Black Women for Black Girls Giving Circle with partial funding for the Drammeh Centre program; New Covenant Christian School in the Bronx County of New York City, New York State, United States, with high school students in their mathematics club and mathematics classes; and the David's Builders' Children's Group founded by Professor Agwu, the CADF, at Vineyard International Christian Ministries in the Bronx County of New York City, New York State, United States with STEM enrichment workshops in collaboration with African Views Organization.

Special thanks go also to CHI STEM TOYS FOUNDATION (CSTF) and Worldwide Association of Small Churches (WASC) in US and Nigeria, and their Board of Trustees, for grant funding for the international and local travel of Professor Agwu to work with our ethno-mathematics research group during the period of absence of support from the CADFP. We thank these bodies also for grant funding to JAMVSEC and JUAICMC for field-testing of the modules in this book; and for grant funding to the Gbari Center of Research and Documentation, Abuja, for field-testing the Agbari module with local Agbari school children at their Centre. We thank JAMVSEC and JUAICMC for donating the initial cultural and other resource materials used by our ethno-mathematics research group at the onset of this project at NMC and FUTA. We also thank the Brooklyn Borough President, Mr. Eric Adams for the citation of Professor Agwu, the CADF, at the 400 Years of Fortitude Program, 6th November, 2019, for our project and other endeavors of hers in the area of uplifting and empowering people of African Heritage worldwide, thus making our project one of notable mention in the legislative annals of the United States.

Finally, thanks to Tetfund for publication support, to the publisher, and to all our readers in advance for your inquiries, comments, questions and encouragement as we continue our ongoing work on this project, documenting Indigenous Mathematical Knowledge Systems of diverse cultural groups in Nigeria and also of successful Nigerian women and rural women's work that have implications for the teaching and learning of a variety of mathematical and other STEM related concepts. We have barely scratched the surface with this ethno-mathematics resource book, series I, that covers only five cultural groups in the over 200 Nigerian cultural groups.

**THE GENESIS**

This book is an outcome of the National Mathematical Centre, Abuja, and Carnegie African Diaspora Fellowship Programme (CADFP) project, "Culture, History and Women's Stories: A Framework for Capacity Building in Science, Technology, Engineering and Mathematics (STEM) Related Fields and for Fostering Entrepreneurship. Like everything in life there is a starting point. The starting point for this project provides the framework for this book. The Genesis is a synopsis of the story behind this project – the motivation for it, where it started, how it got expanded and adopted as an NMC and CADFP, and where we are today in this journey of a thousand miles to document the Indigenous Mathematical Knowledge Systems of diverse Nigerian cultural groups and mathematical stories of successful Nigerian women and rural women's work that have implications for the teaching and learning of a variety of concepts in mathematics.

The journey to this project begins with Professor Agwu's certification training over the summer periods for seven years, from 1997-2003, by the Mathematical Association of America (MAA) Institute in the History of Mathematics and Its Uses in Teaching (IHMT) at American University and Catholic University in Washington D.C. There she received training as a Historian of Mathematics and as an Ethno-mathematician under the mentorship of Professors Victor Katz and Frederick Rickey, re-known Historians of Mathematics and Professor Ubiratan D'Ambrosio a re-known Ethno-mathematician. She also received motivation and inspiration to work in the area of African Indigenous Mathematical Knowledge Systems, an area of dearth in the literature. All groups of people have made significant contributions to the development of mathematics, yet the contributions of Africans other than those of Algebra and geometry in Ancient Egypt are still highly unacknowledged in the History of Mathematics (Lumpkin 1997). "This is partly due to our oral traditions, slavery, colonialism, neo-colonialism, globalization and the fact that our indigenous mathematics, scientific and technological knowledge as a people is often shrouded in our spirituality. This notwithstanding, efforts must be made to document the mathematical contributions of Africans to enrich the curriculum in a multicultural and interdisciplinary way by providing a wide repertoire of examples of mathematical concepts illustrated from the African context. (Agwu, 2015, p.13)"

At IHMT, Professor Agwu was reminded of the traditional strategy game called Okwe (popularly known worldwide as Mancala) commonly played in villages and cities in Ala Igbo (Igbo land). She was taught to play this game by her late paternal grandmother, Mrs. Virginia Omamma Agwu, who was an expert player, and saw the mathematical implications of the game when she had to engage in an ethno-mathematics research project as part of her MAA IHMT training. She chose Okwe as her ethno-mathematics research project to study topics in game theory and other mathematical topics related to the game with input from the MAA IHMT group of Historians of Mathematics. To her it was interesting that given her strong mathematical background she had never been able to win her grandmother, who never had even a primary school education, in this game. This was the genesis of her work as an ethno-mathematics researcher and the exodus to this project.

During the period while Professor Agwu was attending MAA IHMT and afterwards, she got several grants from her institution, City University of New York (CUNY), to further her ethno-mathematics research study on Okwe and conduct other ethnomathematics research on Igbo Indigenous Mathematical Knowledge Systems with integral input from a re-known Igbo Cultural Anthropologist and Catholic Priest, Reverend Father Dr. Jon Ukaegbu a native of Mbaise, Imo State, Nigeria, whose expertise is Igbo Symbolism, as well as, to develop curricular materials based on her research endeavors in this regard.

Professor Agwu's strong interest in Mathematical Story-telling and Curriculum Development on Women of African Heritage in STEM begun in 2005 when she was Chair of the Black History Committee of the American Association of University Women (AAUW), New York City (NYC) Branch, later to become the President of this branch in 2009, where she engaged in initiatives related to nurturing, grooming and mentoring school girls to consider STEM related careers as this was one of AAUW's major efforts to bridge the gap of under-representation of women in STEM in the United States. In the cover story or feature article of the Jul/Aug 2010 Network Journal, Black Business Professionals and Small Business Magazine (https://tnj.com/nkechi-madonna-adeleine-agwu-phd/), Professor Agwu articulates the AAUW NYC Branch and her STEM and economic agenda for women and girls so that all women can have a fair chance at climbing the ladder to success. She also provides policy recommendations for governments that want to facilitate pathways that break barriers for women in STEM.

In that same decade of 2001 – 2010, Professor Agwu's institution CUNY implemented a graduation requirement for each student to take at least one Writing Intensive (WI) course in any subject area of their choice. All departments at BMCC, her own CUNY campus, were now required to develop and implement some WI courses to help students meet this graduation requirement and faculty members were funded to develop and implement these WI courses. Professor Agwu saw this as an avenue to balance the mathematics curriculum at BMCC, CUNY, for race, gender, class and ethnicity as it pertains to the African context. She took advantage of this opportunity to develop WI courses in Discrete Mathematics and Introduction to Statistics for BMCC Mathematics Department that would feature African Indigenous Mathematical Knowledge Systems and African Women's Stories in STEM. This led to a number of presentations of her work in this regard at some United Nations Conferences on the Status of Women (UN CSW) where she connected with the Drammeh Centre, PANAFSTRAG, and with the Founders of the Nigerian Women in Agricultural Research for Development (NiWARD), Professor Stella Williams and the late Dr. Mojisola Olayinka Edema who was the then Director of the Centre for Gender Issues in Science and Technology (CEGIST) at the Federal University of Technology, Akure (FUTA). These connections resulted in the writing of the proposal for Professor Agwu to come to CEGIST, FUTA, as a CADF, to serve as a Mathematical Story-teller of NiWARD, in her partnership with PANASTRAG for professional development workshops on this project for mathematics teachers in Lagos State and its environs, and in her partnership with the Drammeh Centre Program for middle school and high school girls in STEM. It was at FUTA that Professor Agwu connected with our research group member Dr. Smart Oloda beginning the journey for the project to come to the NMC, Abuja, as a CADFP project under the past Director, Professor Adewale Solarin, who embraced this project at FUTA with a commitment of N200,000 towards resources. Professor Solarin also made a trip to Professor Agwu's host institution, BMCC, CUNY, to share the mission and vision of the NMC with top level administrators, mathematics department faculty members, and students at various campuses of CUNY, facilitating the sabbatical leave of Professor Agwu from BMCC to engage in this project as a CADF at the NMC. However, before the project actually took off at the NMC, Professor Stephan Onah was now the Director of the NMC. He recognized the value and benefits of the project and kept the door open for it to take off, endorsing it and giving it full support and approving financial resources for our travel to various states in Nigeria to engage in ethno-mathematics research on their Indigenous Mathematical Knowledge Systems and to present our work at the conferences of various professional groups, viz.: the Nigerian Mathematical Society (NMS), the Mathematical Association of Nigeria (MAN) and NiWARD.

It is not accidental that our first ethno-mathematics resource book begins with five modules. Five is the number of grace and favor. We have been favored in our search for funding to publish the modules we have completed. What we have here is just Series I of our Ethno-mathematics Resource Book for which we give thanks to the Almighty, The Absolute Infinite, who makes all things great and small. Amen.

## PRELUDE – STATEMENT OF THE PROBLEM AND PROPOSED SOLUTION

### Introduction

We are living in a world where Science and Technology have become an integral part of the world's culture and any country that overlooks this significant truism is unlikely to catch up with the rest of the world. Everyday human activities are driven by Science and Technology and undoubtedly, a sound Science, Technology, Engineering and Mathematics (STEM) education is the key to good health, development of industries, poverty alleviation, promotion of peace, conservation of environment, and good life for all and improved economic growth and development. It is an undisputable fact that many students in Nigerian Secondary Schools encounter multiple problems with the study of Mathematics. This problem has two main dimensions. While students on one hand have difficulties in understanding the topics taught, teachers on the other hand equally have difficulties in achieving effective teaching in our schools.

Another dimension of the problem is that in most societies in Nigeria the girl child education is not in the front burner. Women are left behind in most professions. In particular, the number of women in STEM education is low when compared with the male counterparts. It has been observed that among the factors that influence achievement of learners of school Mathematics, teachers' effectiveness as measured through the acquisition and use of good instructional skills and methodologies appear very prominent (Sobel, 1988). Studies have shown that high-quality teaching can make a significant difference in students learning and high-quality teaching requires a high-quality workforce. For instance, the National Mathematical Centre organized workshops in certain schools in some States under the Mathematics Improvement Programme (MIP): after the intervention by the Centre, the results of the Schools improved tremendously. The percentage credit pass in Mathematics of G.S.S Icheke-Ogene rose from 7.69% in 2010 to 55.56% in 2012, and that of St Peters' College Idah rose from 33.02% in 2010 to 70.86% in 2012. Also, in Kaduna State, the percentage credit pass in Mathematics of GSS Markarfi rose from 29.9% in 2013 to 99.2% in 2015 after the intervention by the Centre under the Mathematic Improvement Project.

Some of the problems of the teaching and learning of the core subjects in our educational system include lack of:

(a) Good quality teachers
(b) Good method of teaching
(c) Instructional materials
(d) Large class size
(e) Adequate training of teachers
(f) Good condition of service for teachers
(g) Good retraining of teachers
(h) Incentive for teachers
(i) Mathematics laboratory in our schools

(j) Regular workshops and seminar for teachers
(k) Reader friendly textbooks in schools.

Among all the stakeholders in the education process, the teacher is the most important one. It is true that no educational system can rise above its teachers because no nations rise above the standards of its schools. It is said that education is the key that unlocks the door to modernization, but it is the teacher who holds the key to the door.

One of the new and innovative ways of teaching Mathematics and the Sciences in schools is the use of Culture and Women Stories. This is designed for capacity building in Science, Technology, Engineering and Mathematics related fields and for fostering entrepreneurship and innovations. In Nigeria today, this innovative approach to teaching is not yet utilized by teachers while in many advanced countries this approach is used for teaching all subjects at all levels. The use of Cultural Artifacts and Women Stories to concretize educational concepts, arouse and sustain the interest of learners, and foster entrepreneurship and innovation among learners. With this innovative approach, the achievement of students in the study of STEM is improved.

Now the problem of the teacher in terms of quantity and quality has been fingered as the one of the most important factors affecting the performance of students in Mathematics. In particular, the approach to the teaching of the Mathematical Sciences is an important factor that determines the achievement of students in the Mathematical Sciences. This approach of using culture has not been used in Nigeria. Now the National Mathematical Centre and Professor Nkechi Agwu, Carnegie African Diaspora Fellow, have a joint project to introduce the Use of Culture and Women's Stories in the teaching of STEM in Nigeria. The problems confronting mathematics students resulting from the problems of approach of teachers deserve appropriate attention.

## CHAPTER ONE

## AGBARI CULTURE AND THE MATHEMATICAL IMPLICATIONS

In this chapter, we consider the mathematical implications of the Agbari Culture in the following areas, viz.: Pot Making, Significant Numbers, Stock-Pilling of Firewood, Building of Houses, and a woman's story.

### Agbari Culture and their Mathematical Implications

Agbari people are one of the ethnic groups that made up the Federal Capital Territory (FCT). They so much love or believe in circle or cycle that they live in circular houses that are arranged in circular form as can be seen in figures 1.1 below. They also bury the dead in circular graves. It is common belief that circle or cycle signifies unity; that many things in nature are cyclical; that even life revolves in a cycle and so they believe in reincarnation. The consequences of these beliefs, are the following: the adage that "if something happens to the eyes, it also happens to the nose", meaning that whatever affects an Agbari person affects others. What you sow is what you reap. Love is supposed to go around. Even their dances and musical instruments are in circular or cylindrical form and the dancers dance round the drummers (who stay in the middle) in anti-counter clockwise direction (see figure 1.2).

Figure1.1: Agbari Circular Storage Houses in Circular Form

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Figure 1.2: Agbari Musical Instrument in Cylindrical Form

**Pot Making and Mathematical Implications**

Pot making is a common occupation among Agbari women. These pots, which are made in different sizes, can be used for different purposes. Therefore they are of great economic value.

Figure 1.3: Agbari Pot

**Geometry**

A line drawn in such a way that every part of it is at equal distance from a fixed point outside the line is called a **circle**. The fixed point is the center and the distance between the line and this fixed point is called the **radius**. Any straight line joining two points on the circle and passes through the center is called the **diameter**. The length of the line that forms a circle is called the **circumference**. Circles with common center are called **concentric circles**. The space (region) between two concentric circles of different radii is called the **annulus**. A collection of many circles of the same radius carefully arranged on top of each other forms a **cylinder.** The shaded region in the concentric circles given in figure 1.4 is the annulus.

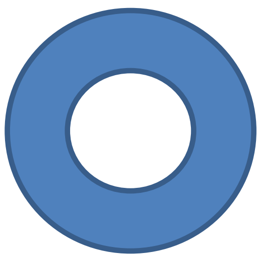


Figure 1.4: Concentric circles

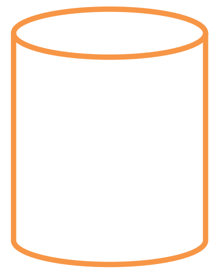


Figure 1.5: Cylinder

A Pot is a solid object. Therefore, it is of three-dimension. Every three-dimensional object occupies space known as **volume**. Volume can also be seen as the space that an object contains. The basic unit of volume is the **cubic meter ($m^3$)** which is derived from the lengths of the three dimensions. The maximum amount that the pot/object can contain is known as **capacity**. The basic unit of capacity is the **litre** which takes up the same space as $1000cm^3$. Something that is round and in three-dimension (like the pot) is said to be **spherical** in nature or shape, example the globe or the balloon.

**Activity 1.1**

1. Draw two circles having the same center to represent the top most part and the narrowest part of the mouth of the pot in figure 1.3.
2. Compare your drawing with figure 1.3. What can you say about the drawings?
3. What is the minimum diameter a circular grave must have for a coffin of length 6 feet to enter it?
4. What part of the pot has maximum **circumferences?** Determine the **radius** of the circle formed at the point.

5. Compare figures 1.2 and 1.5.  What can you say about them?

6. Can you make the following discoveries about the pot in figure 1.3?

a) The pot is made up of a collection of **circles** of different **radii**.

b) The collections put together make a **spherical** shaped object which is the pot.

c) The pot has a **capacity** and also a **volume**.

7. Suppose the top of the pot is sealed, can it still have **capacity** and **volume**?

8. How can you determine the capacity and volume of the pot?

9. State the difference between capacity and volume.

10. If a litre of cold water costs N50, what is the cost of the water in the pot if the capacity of the pot is 100 litres?

11. Each large pot costs N800 to make, you will like to start-up a business with at least 100 large pots to sell. How much minimum do you need as start-up funds to produce these 100 pots?

12. You lack the start-up funds to produce these 100 pots, so you get the funding from a micro finance company that is providing funds for women who are small business entrepreneurs at 5% simple interest over a period of three years. How much will you have to pay back at the end of the three years period?

**Significant Numbers in Agbari Tradition**

Agbari people attach significance to the following numbers: 1, 2, 4, 7, multiples of 7, 10, 50 and multiples of 50. Like many other traditions, one stand for unity, it is the beginning of counting. Any other number can be made from it. It is also believed that all Agbari people are one and peace-loving. As pointed out earlier the building of their houses and their dances are in circular form. This is because they believe in oneness, unity, and that whatever a man does (good or bad) comes back to the person (cycle).

Agbari market comes up every four days. Seven is seen as a perfect number.  A king that rules for seven years is said to have covered a mile-stone, 14 years, two mile-stones, 21 years, three mile-stones and so on.  Consequently, in their measurement of mile-stones for kingship, they have an intuitive understanding of the Arithmetic Sequence whose first term and common difference are both seven.

Agbari people are great farmers of yam. They count yams in heaps that contain 50 yams each or in multiples of 50. This is another area in which they have an intuitive understanding of the Arithmetic Sequence whose first term and common difference is 50.

**Activity 1.2**

Suppose there is only one market in each of the six area councils namely Abaji (A), Bwari (B), Gwagwalada (G), Kuje (J), Kwali (K) and Abuja Municipal (M).

| Sun | Mon | Tue | Wed | Thur | Fri | Sat |
|---|---|---|---|---|---|---|
| A | B | G | J | K | M | |
| | | | | | | |
| | | | | | | |
| | | | | | | |
| | | | | | | |
| | | | | | | |

If Abaji market comes up Sunday, Bwari on Monday, Gwagwalada on Tuesday, Kuje on Wednesday, Kwali on Thursday and Municipal on Friday:

1. How many markets will hold on Saturday of the first week? Name them.
2. Within the first two weeks, which of the market(s) will enjoy more patronage?
3. Within the first four weeks, which of these markets will enjoy more patronage?
4. Which day of the week will it be if we are to attend Abaji market at the third week?

**Activity 1.3**

Consider the following sequences of significant numbers in Agbari culture: 1, 2, 4, 7, 10, 50, 100, 200,

1. What is the sum of the sequence 1,2,4,7,10,50,100, 200?
2. Calculate the digital root reduction of the sequence.
3. Write out the associated series for this sequence.

**Answers to activity 1.2**

Modular arithmetic can be used to explain a phenomenon that occurs in cycle. Since the market days occur every four days (after the market has taken place) then we can use modulo 4. The counting we as follows: 0, 1,2,3, 0,1,2,3,0,…

| | | | | | | |
|---|---|---|---|---|---|---|
| Sun | Mon | Tue | Wed | Thurs | Fri | Sat |
| A | B | G | J | K, A | M, B | G |
| J | K, A | M, B | G | J | K,A | M,B |
| G | J | K, A | M, B | G | J | K,A |
| M, B | G | J | K, A | M, B | G | J |

Consider the table above:

1. Only one market comes on Saturday; Gwagwalada
2. Within the first two weeks, A (Abaji) enjoys more patronage since it comes up 4 times.
3. Within the first four weeks, A, B, G and J enjoy more patronage as each of them comes up 7 times.
4. At the third week, Abaji market holds on Tuesday and Saturday.

**Answers to activity 1.3**

1. 1+2+4+7+10+50+100+200 = 374
2. Digital Root Reduction:
   1+2+4+7+10+50+100+200 = 374
   3+ 7+ 4 = 14
   1+4 = 5
   The digital root reduction is 5.

   This implies persistent (#) number = 2

3. The associated series for 1,2,4,7,10,50,100,200
   i.e. 1+2 = 3
   1+2+4 = 7
   1+2+4+7 = 14
   1+2+4+7+10 = 24
   1+2+4+7+10+50 = 74
   1+2+4+7+10+50+100 = 174
   1+2+4+7+10+50+100+200 = 374

The associated series is: 3, 7, 14, 24, 74, 174, 374.

**Firewood, an Asset to Agbari People**

Another major occupation is stock piling of firewood. There is a direct relationship between wealth and firewood, it is a general believe among Agbari people that the more stock of firewood one has the richer the person. Piles of firewood can be used as collateral for obtaining loan.

**Activity 1.4**

**Financial Mathematics**

1. If a log of firewood costs N50.00, what will be the cost of a heap containing 100 logs?
2. If exactly 1000 logs are required to obtain a loan of N40,000, how many logs of the same size will be required to obtain a loan of N60?
3. If a heap of firewood bought for N15, 000 is sold for N18, 000 what is the percentage profit?
4. If the cost of stocking a containing 50 logs is N6000,

   a) how much must the owner sell each log in order to:

      i) Breakeven?

      ii) Make a profit of 45%?

   b) how much will it cost to stock pile a heap of 1000 logs, to be used to cook

   for orphanages at Christmas?

**A Woman's Story**

**Hadiza Ladi Kwali**

Hajiya (Dr) HadizaLadi Kwali (1925 - 1984), Officer of the Order of the Niger (OON) and a member of the Most Excellent Order of the British Empire (MBE), was an Agbari potter, born in the village of Kwali in the FCT. Her name Ladi means born on Sunday while her surname Kwali is the name of the village she was born. She learned pottery from her aunt before starting her own. She made pots of different sizes which were used for ornamental purposes in the residence of aristocrats, as decorations and for domestic use. She attended Michael Cardew's training Centre, Abuja. Ladi Kwali and her works are known in Europe and America. Her works were displayed during Nigeria independence in 1960. Although she could neither read nor write, she was a part-time lecturer/demonstrator at Ahmadu Bello University Zaria where she was awarded a doctorate degree in 1977. She is the only that appears on Nigeria currency (twenty naira note). She died on 12 August, 1984 in Minna Niger State.

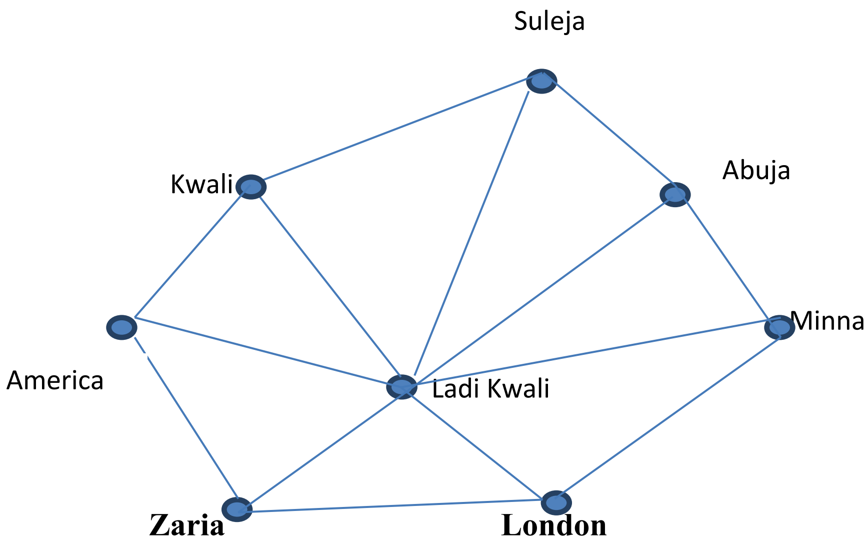



Figure 1.6: Some of the places Hajiya (Dr) Ladi Kwali Lived

**Activity 1.5**

1. What is the degree of the hub?

2. What is the degree of the vertices in the cycle around the wheel?

3. What is the chromatic number of the wheel?

4. What is the order of the graph?

5. Construct all the sub-graphs of the graph.

6. Why is the graph in figure 1.5 called a wheel?

7. Is the graph Hamiltonian?

8. Is the graph Eulerian?

## Digital Root Reduction of Names Using Pythagorean Cipher

The **digital root** or **repeated digital sum** of a non-negative integer is the (single digit) value obtained by the process of summing the digits. The process is repeated until a single-digit number is reached.

Example

Find the digital root of 576.

Solution

5 + 7 + 6 = 18 and 1 + 8 = 9.

Therefore the digital root of 576 is 9

The number of times the digits of a number is summed to get single digit is called the number's additive **persistence**. In the above example, the additive persistence of 576 is 2.

Digital root of a positive integer indicate the position of the number with respect to the largest multiple of 9 that is less than the number itself. For instance, the digital root of 15 is 6, this means that 15 is the sixth number after 9. Also the digital root of 3133 is 1, which means that 3133 − 1 is a multiple of 9. If the digital root of a number is exactly 9, then the number is a multiple of 9.

## The Pythagorean Cipher

| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|---|---|---|---|---|---|---|---|---|
| A | B | C | D | E | F | G | H | I |
| J | K | L | M | N | O | P | Q | R |
| S | T | U | V | W | X | Y | Z | |

Consider the name **HADIZA LADI KWALI**

$A_n$ =**HA D I Z A**

8 1 4 9 8 1 $\sum_{n=1}^{6} A_n = 31$; 3 + 1 = 4

Persistence = 1

$B_n$ = **L A D I**

**3 1 4 9** $\sum_{n=1}^{5} B_n = 17$; 1 + 7 = 8 Persistence = 1

$C_n =$ **K W A L I**

**2 5 1 3 9** $\sum_{n=1}^{4} C_n = 20$; $2 + 0 = 2$ Persistence $= 1$

$D_n =$ **H ADIZALADIKWALI**

81 4 9 81 3 1 4 9 25 1 3 9

$= A_n + B_n + C_n = \sum_{n=1}^{9} A_n + \sum_{n=1}^{5} B_n + \sum_{n=1}^{4} C_n = 31 + 17 + 20 = 68$; $6 + 8 = 14$; $1 + 4 =$ **5**

Persistence $= 2$

Her Expression number is 5

**CHAPTER TWO**

**CALABAR CULTURE AND THE MATHEMATICAL IMPLICATIONS**

# CALABAR CULTURE AND THE MATHEMATICAL IMPLICATIONS


## Introduction

The National Mathematical Centre (NMC), Abuja and Prof. Nkechi Madonna Agwu, a Carnegie African Diaspora Fellow, have a joint project to introduce the use of Culture, History and Women Stories in the teaching of Mathematics in Nigeria. The problems confronting Mathematics students resulting from the problems of approach of teachers deserve appropriate attention. Some members of the Ethno-Mathematics Research Group (see figure 2.1) visited Calabar on the 23rd of May, 2018 to see how their culture, history and women stories can be used to improve the teaching and learning of Mathematics.

**Figure 2.1: The Research Team of NMC and Professor Nkechi Madonna Agwu (A Carnegie African Diaspora Fellow)**

The following cultural practices of the Calabars can be used to teach Mathematics in our schools:

1) Manilas: This was the money used in Calabar before the coming of the white men. Money is an important topic in Mathematics. These Manilas could be used in addition to present Nigerian currency to teach money in Mathematics.

2) Structure of houses in Calabar: In the houses in Calabar, the shape of the doors and windows are rectangular and the upper part being semi-circles; the roof show triangular shapes and shape of trapezium; and other parts of the houses show some geometrical shapes. These could be used to teach geometry in the school.



Figure 2.2: Houses in Calabar

3) Gates: The gates are rectangular in shape and could be used to teach geometry in schools.

4) Flute: They have a traditional flute made of skin of animals. The skin is conical in shape. This could be used to concretize the concept of cone in the classroom.

5) Flower Ports: In most of the places visited, there were flower ports which are either in the shape of a frustum or a sphere. These could be used to teach mensuration in the Mathematics classroom.

Figure 2.3: Flower Pot in Calabar

6) Tables: Many of the tables in Calabar have rectangular or square tops. This could be used to teach shapes in the Mathematics class

7) Counting System: Calabar has its counting system. The major groupings are in 10s, 20s, 40s, 60s, and 80s. This could be used in teaching number bases in Mathematics.

8) Bangles: The traditional bangles of the Calabars are circular in shape. This can used to exemplify the concept of circle and its properties in the classroom.

9) Beads: The Calabar make beads. This can be used to teach profit and loss, simple interest, and other aspects of financial Mathematics.

10) Slave trade: The story of slave trade in Calabar remains ever fresh as one visits Calabar. Trade and commerce are aspects of Mathematics. The story of the slave trade could be used to teach many aspects of Mathematics in schools

Figure 2.4: Signpost at Slave Trade Museum

11) Story of trade with the Europeans: They used scale balance to measure goods for exchange which was trade by barter. The scale needed to be balanced for the exchange of the goods with the Europeans. This can be used to teach simple equations in the school.

12) Nsibidi Symbols: Before the coming of the Whites, the Calabars had their indigenous symbols or numerals. This is useful in the history of Mathematics in Calabar region.

Figure 2.5: Nsibidi

13) Grave of Mary Slessor: The grave is built in a conical shape. This can be used to teach cone in schools.

14) Hearse: There was a locally made Hearse for carrying corps in Calabar. This could be used to teach financial Mathematics in schools.

Figure 2.6: Hearse

15) Fishing in Calabar: This involves fishing in the river, preservation, buying and selling. These are all aspects of financial Mathematics

16) Dancing Styles: Their dancing styles are in curves, circles, semi-circles, straight lies etc. These are useful in the teaching of Mathematics

17) Market Days: The market days in Calabar could be used to teach number basis and modular Arithmetic. For instance, the market day in Ugep is every Tuesday called Koko.

18) Marriage in Ugep: For marriage to be completed, five things are required and shared as follows: Father 60%, Mother 20%and Daughter 20%. This can be used to teach ratio.

## Slave Trade in Calabar

Calabar, the capital city of Cross River State is made up of the Efik tribe. It is one of the towns used to export human labour during the Trans-Atlantic Slave Trade. The Slave History Museum that documented the activities of slave trade is located at Marine Resort, Calabar. During this period in history, human labour (slaves) were shipped from Africa to the Americas and the Caribbeans in exchange for manufactured goods usually luxurious and consumable items from Europe. The popular saying that human beings are priceless has an exception in the case of slavery. The price of these slaves were calculated in iron and copper bars in Niger Delta, cowry shells in Yoruba land and manilas in Efik, Ibibio and Igbo lands. Slave trade though dehumanizing was one of the first forms of globalization as it encouraged the building of social and economic relationships between the various continents involved (Europe, America, Africa, etc). Slavery and slave trade thrived in West Africa from 1440 to 1833 (that is 15th to 18th centuries). During this period, about 22,000 slaves were sold annually from ports in Nigeria.


Figure 2.7: Slave History Museum located at marine resort Calabar.

Below is the volume of English slave trade from Africa from 1690 to 1807:

141,300 Slaves was taken from Senegambia, 111,600 Slaves from Sierra Leon, 299,300 from Windward Coast, 473,800 from Gold Coast, 292,700 from Bight of Benin, 776,400 from Bight of Biafra, 468,300 from Angola and Mozambique and Others Unknown 16, 100.

**Fraction**

The teaching of fraction can be started by using the above story about slave trade, then the following:

The number of slaves taken from Senegambia (141,300) is part of the total number of English slave trade from Africa from 1690 to 1807 (2, 579, 500). This number 141, 300 is a fraction of the total number 2, 579, 500 and we can write 141, 300/2, 579, 500 to show that the number is part of the total. Fraction can therefore be defined as part of a whole. Fractions are normally written in their simplest reduced form. For instance, 141, 300/2, 579, 500 is better written as 1,413/25,795. This type of fraction is called proper fraction because the number on top called the numerator is smaller than the number below called the denominator.

Example: Find the fraction of slaves taken from each of the location given in the data.

| **Coastal Region** | **Fraction of Slaves** | **Reduced Form** |
|---|---|---|
| Senegambia | 141,300/2, 579, 500 | 1,413/25, 795 |
| Sierra Leon | 111,600/2, 579, 500 | 1,116/25, 795 |
| Windward Coast | 299,300/2, 579, 500 | 2,993/25, 795 |
| Gold Coast | 473,800/2, 579, 500 | 4,738/25, 795 |
| Bight of Benin | 292,700/2, 579, 500 | 2,927/25, 795 |
| Bight of Biafra | 776,400/2, 579, 500 | 7,764/25, 795 |
| Angola and Mozambique | 468,300/2, 579, 500 | 4,683/25, 795 |
| Others Unknown | 16,100/2, 579, 500 | 161/25, 795 |

The denominator of a fraction can be made to be 100 by multiplying the numerator by 100 and also the denominator by 100. When this is done, the resulting fraction is called percentage (per cent or 1/100). The fraction 1/100 is represented with special symbol %.

Example: Convert the above fractions to percentages.

| **Coastal Region** | **Fraction Of Slaves** | **Percentage Fractions** |
|---|---|---|
| Senegambia | 141,300/2, 579, 500 | 5.5/100 or 5.5% |
| Sierra Leon | 111,600/2, 579, 500 | 4.4/100 or 4.4% |
| Windward Coast | 299,300/2, 579, 500 | 11.6/100 or 11.6% |

| | | |
|---|---|---|
| Gold Coast | 473,800/2, 579, 500 | 18.4/100 or 18.4% |
| Bight of Benin | 292,700/2, 579, 500 | 11.3/100 or 11.3% |
| Bight of Biafra | 776,400/2, 579, 500 | 30.1/100 or 30.1% |
| Angola and Mozambique | 468,300/2, 579, 500 | 18.2/100 or 18.2% |
| Others Unknown | 16,100/2, 579, 500 | 0.5/100 or 0.5% |

Other aspect of fraction can be introduced and taught.

**Set**

Teaching of set can be started by using the above slave story, then the following:

The Coastal regions where the slaves were taken can be put in a curly bracket (braces) and separated with a coma. The number of slaves taken from the coastal regions also can put in a bracket and separated with a coma as shown below.

Coastal Regions = {Senegambia, Sierra Leon, Windward Coast, Gold Coast, Bight of Benin, Bight of Biafra, Angola and Mozambique, Others Unknown}

Number of Slaves = {141300, 111600, 299300, 473800, 292700, 776400, 468300, 16100}

Each of the above is called a set. Coastal Regions is a set of regions where the slaves were taken from while Number of Slaves is a set of numbers representing the quantity of slaves taken from each region. Each region or number in the bracket is called an element or simply a member of the set.

**Activity 2.1**

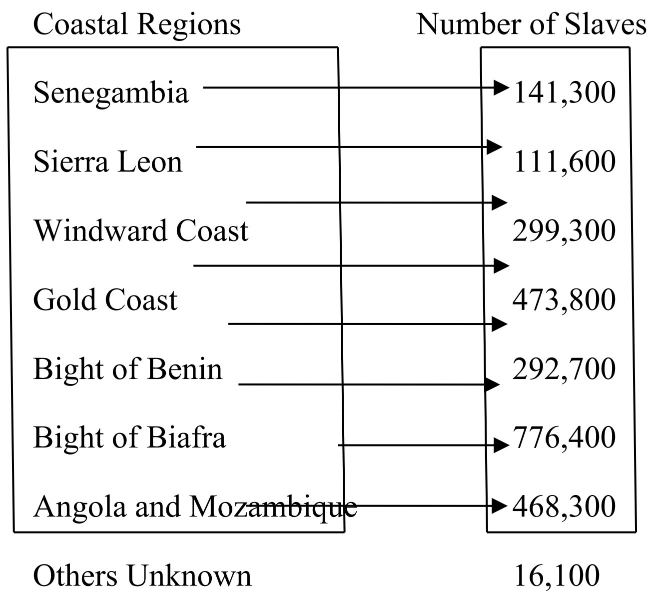
What is a set?

A set is a well defined collection of elements enclosed in a curly bracket.

With the above, the teaching of other aspect of set can follow.

**Assignment or Mapping**

Consider the assignments done below




To each coastal region, associate the number of slaves taken from there. Only one number of slaves is assigned to each coastal region. This type of assignment is called **Mapping** from a set of regions in the Coastal Regions (called the Domain of the mapping) to a set of Number of Slaves (called the Co-domain of the mapping). When the co-domain is a set of numbers as it is in this case, then the mapping is called a **Function**. Each number in the co-domain is called an image of the corresponding element in the domain. Every element in the domain must have an image for the mapping to be called a function. The set of images of all the elements in the domain is called the range of the mapping. The range is a subset of the co-domain.

No region/element in the Coastal Region is associated with more than one number of slaves. That is every region is assigned only one number. This type of mapping is called one-to-one or onto mapping

**Activity 2.2**

Give an example of (a) mapping that is unto (b) function

**Statistics**

**Raw Data:** The number of slaves taken from Senegambia during the Trans-Atlantic Trade is 141,300; 111,600 from Sierra Leon; 299,300 from Windward Coast; 473,800 from Gold Coast; 292,700 from Bight of Benin; 776,400 from Bight of Biafra; 468,300 from Angola and Mozambique and Others Unknown 16, 100.

The figures given above are known as data. Data is simply recorded observation. These can be processed to get information. This type of data is called secondary data because they are taken from records kept by another person. Data taken directly by those who witnessed the event is called primary data (That is first-hand information).

The above data can be put in a table so that at a glance one can get better picture and easily extract information from it.

| COASTAL REGION | NUMBER OF SLAVES |
|---|---|
| Senegambia | 141,300 |
| Sierra Leon | 111,600 |
| Windward Coast | 299,300 |
| Gold Coast | 473,800 |
| Bight of Benin | 292,700 |
| Bight of Biafra | 776,400 |
| Angola and Mozambique | 468,300 |
| Others Unknown | 16,100 |
| Total | 2, 579, 500 |

The way the first data is presented is called Raw Data Presentation. The table above is one of the ways in which the data can be presented and it is called Tabular Presentation of Data.

If the number of slaves taken from each Coastal region is written as a fraction of the total taken from Africa and converted to percentage, we have

| Coastal Region | Number of Slaves | Percentage |
|---|---|---|
| Senegambia | 141,300 | 5.5 |
| Sierra Leon | 111,600 | 4.4 |
| Windward Coast | 299,300 | 11.6 |
| Gold Coast | 473,800 | 18.4 |
| Bight of Benin | 292,700 | 11.3 |
| Bight of Biafra | 776,400 | 30.1 |
| Angola and Mozambique | 468,300 | 18.2 |
| Others Unknown | 16,100 | 0.5 |
| **Total** | **2, 579, 500** | **100** |

The above information can be presented in a circular chart called the pie –chart as given below

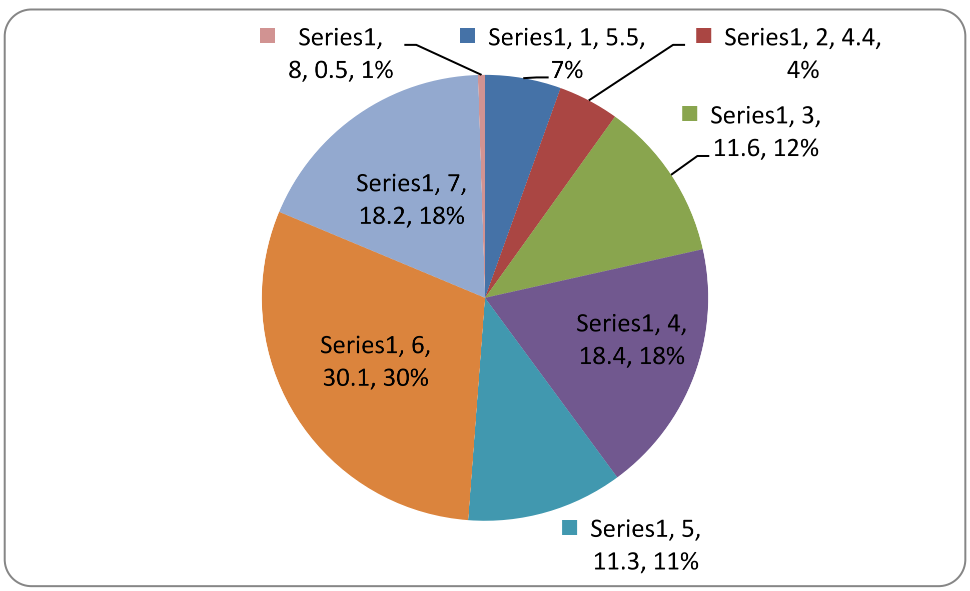



Figure 2.8: Pie Chart for all the categories

The percentage of slaves taken from Windward Coast and Gold Coast is 30%. The percentage from Bight of Benin and Bight of Biafra is 41.4%. Percentage from Angola and Mozambique is

18.2%. Percentage from Senegambia, Sierra Leon and other unknown areas is 10.4%. This information can be presented in a chart as

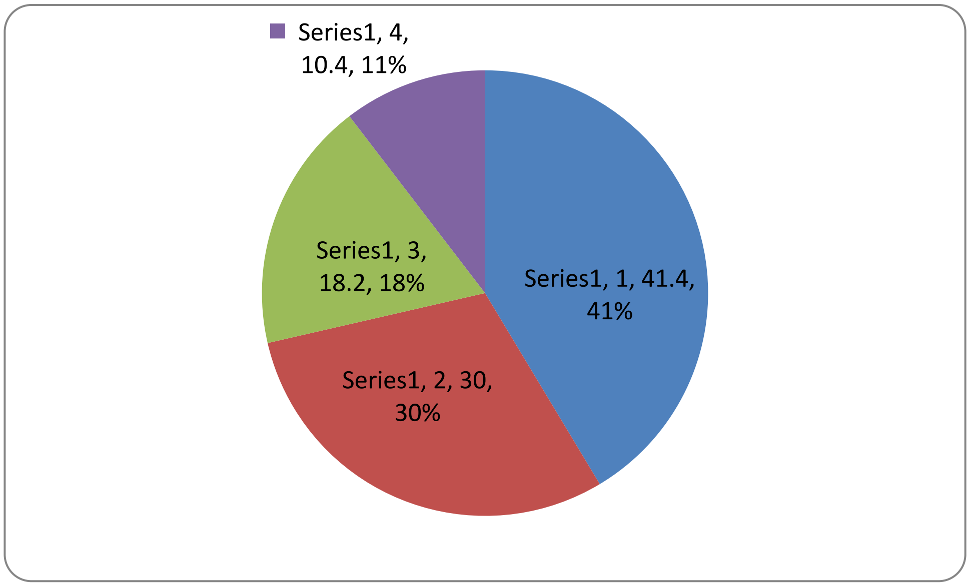



Figure 2.9: Pie chart for the groupings

Another way of presenting the above information is what is called the bar chart. The number of slaves taken from each region is represented with a rectangular bar as shown below

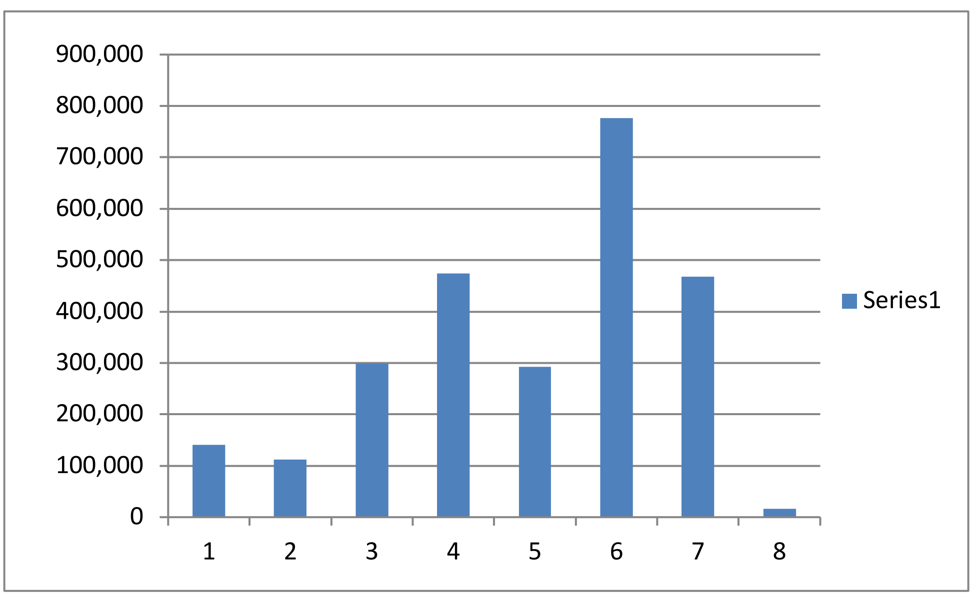



Figure 2.10: Bar Chart

**The Hearse in Calabar**

At the early years in Calabar, there was no motor ambulance for the conveyance of corpse to church and to burial grounds. Locally made Hearse were used for carrying corpses. A man called Ekikan manufactured the hearse shown below. The Hearse was rented by families of any deseased to convey corps for burial services in Calabar. The Hearse was made of circular wheels and tyres, rectangular iron bars and slabs

Implications for Teaching Mathematics

**1. Geometry**

In the figure below, the tyres are circular in shape. This can be used to teach circles and its properties such as radius, diameter, circumference, and area.

The iron shape on top of the tyres is a cuboid. This can be used to teach the properties and measurements of cuboids.

The floor and sides of the cuboids are different shapes of rectangles. From here, the properties and measurements of rectangles can be explained using the hearse.

**2. Commercial Arithmetic**

The production and hiring of the hearse showed that the Calabar people had knowledge of commercial Mathematics. The production cost could be calculated and used to determine the cost of a given number of Hearse.

The cost of hiring the hearse could be determined and used to calculate the cost of hiring it for a given number of times.

**Activity 2.3**

1. Identify the circumference, radius and diameter of the circular tyre

2. If the radius of the tyre is 30cm, calculate the diameter and the circumference of the tyre

3. Measure the length, width and height of the cuboid formed by the iron bars on top of the wheels

4. If it costs N60,000.00 to construct a hearse, how much will cost to construct 8 Hearses?

5. If the cost of hiring a hearse (see Figure 2.6) for a day is N12,000.00, how much will it cost to hire the Hearse for two weeks?

**Nsibidi and the Universal Language (Numbers)**

Cultural systems can be translated to Mathematics concepts.

The terra cottas of Calabar are striking for their elaborate decorations:

- Geometric Motifs
- Concentric Circles
- Spirals
- Cruciforms
- Stars

Nsibidi or Nsibiri is the system of recording, hiding and conveying knowledge used by members of various Men's and Women's associations. One's knowledge of Nsibidi is influenced by several factors, including age, gender and membership status within an association that uses it.

Nsibidi, unlike alphabetic scripts, is not standardized. Some signs, on the other hand, have acquired a popular connotation and are widely understood. Conjoined arcs, for example signify love or marriage and this motif remain popular till date. Nsibidi motifs include multitude of abstract linear and curvilinear shapes and representations of people, animals, mythical creatures and things.

The terra cottas of Calabar provide evidence that body decoration is indeed an ancient practice in the region. Geometric motifs visible on anthropomorphic vessels are similar to women's body painting as documented during the colonial period. None members are usually not provided a full knowledge of meanings for particular signs in Nsibidi.

Nsibidi could convey information in narrative form. Nsibidi is as dynamic as the people who invented it. We take numbers for granted and use them every day. Numbers are universal: all cultures have them. It took humanity thousands of years to advance from literal quantities to the concept of numbers.

How do we add things up?

By seeing each object simply and exclusively as a unit, by seeing things as entities while rejecting their specific differences.

From the point view of the number, all objects are the same but not identical.

The idea of number is based on a division of the world into two levels: ***The same and the different.*** The things we enumerate are the same essentially but not numerically – that is, they have the same value but are not one-and-the-same. If they were not different, there would be only one object in the world. To note their equal existence and nothing more is to say ***how many*** they are. Where the eye is weak, the finger is strong. Because we are incapable of grasping quantity directly by sight, numbers have been invented; and with their counting.

To keep track of quantity, we make marks; then we name the marks and memorize the names. Nsibidi of Calabar Culture uses this concept. The most ancient numerical marks occur in the first human civilizations, those of the Paleolithic era. Take a group of things – animals, people, or objects. How can we remember how many they are, without any idea of their number? by making a mark, often a notch, for each thing, on a sort of document. In early culture, the idea of ***many*** preceded the idea of ***one***. For example, in religion, polytheism before monotheism; in marriage, polygamy before monogamy.

Besides bone, wood, and stone recording devices, people used their own bodies as a tool to remember quantity. Many civilizations developed highly complex corporal numerical maps, accompanied by a grammar of gesture expressed principally by the fingers placed in different positions – extended, bent, or curved. This dance like use of the fingers is called ***digital calculation.***

In 16$^{th}$ Century China, Accountants developed a system employing two hands that allowed them to count beyond a billion. This counting method aids the memory, making it possible to keep in mind the particular place on the body where a number of objects belongs. While number is intimately connected to objects, whose quantity it represents, the idea of ***natural sequence*** is purely conceptual, having no relation to the concrete natural world. For example, two is related to an eagle's wings, four to the legs of a dog, and one to a human being's head. Two, four and one have no connection with one another. Since they do not, why place them in a certain order? Why place two before four?

The abstract idea of number itself must exist, divorced from specific quantities of things, before we can conceive of the sequence of numbers.

What do we know about this sequence?

i. Numbers follow one another marching in single file.
ii. Another number always tags on after the last.
iii. If we know a number we know the one that follows it, which is always obtained by adding one.
iv. Numbers get bigger and bigger
v. They follow one another endlessly
vi. There is no last number, although there is a first
vii. They are in order
viii. They create, in fact, the very archetype of order.

To put a series of objects in order is to assign to them a standard order: first, second, third, and so on. The source for the idea of sequence may be the ancient act of ticking off the fingers of the hand, because it depends on a morphology that implies a natural order.

Number is the product of abstract thinking. Number has two faces: ***cardinal*** and ***ordinal.*** In order for the Paleolithic hunter to record the killing of four beats, for example, he had to count - that is inspect them: first, second, third and fourth. This counting action gives us both ***quantity*** and ***sequence.*** The two roles are inseparable.

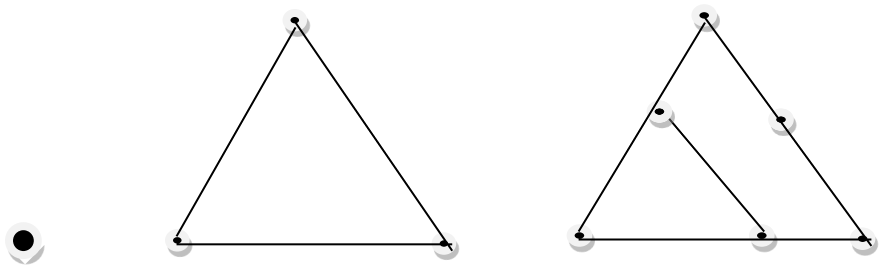
When quantity is assessed, the numbers are called cardinal; when the sequence is assessed, the numbers are ordinal. An ordinal number is seen as the link of a chain; a cardinal is seen as pure quantity. The cardinal measures; the ordinal orders.

Figure 2.11: Nsibidi

Activity 2.4

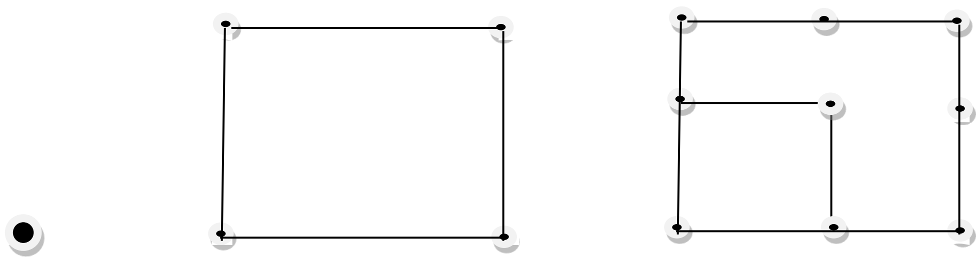
(1) How many faces has a number? What are they?
(2) Indicate the next two terms in the figurate numbers:

(a) Triangular numbers:



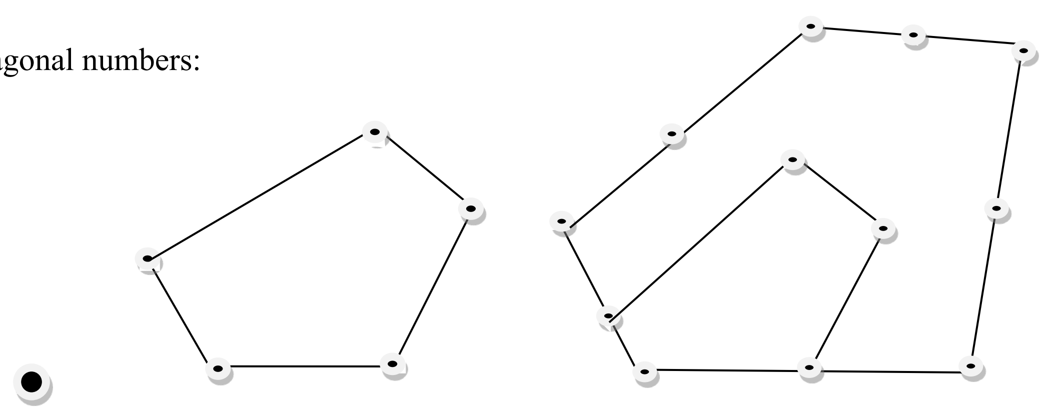
1 3 6

(b) Square numbers:



1 4 9

(c) Pentagonal numbers:



1 5 12

(3) What relationship can you get from the patterns of figurate numbers in activity 2 above?

(4) Let $T_n$ represent the triangular number in the $n^{th}$ position. Let $S_n$ and $P_n$ be the $n^{th}$ square and pentagonal numbers respectively. Then

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

$$S_n = n^2$$

$$P_n = \frac{n(3n-1)}{2}$$

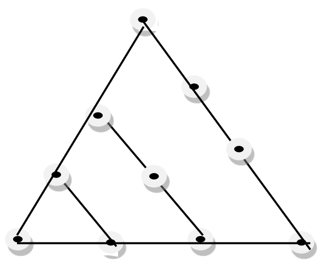
Find, with the use of the above:

(a) The 7th triangular number.
(b) The 12th square number.
(c) The 6th Pentagonal number.

**Solutions**

(1) A number has two faces. They are cardinal-when quantity is assessed, and ordinal when sequence is assessed.

(2) (a)



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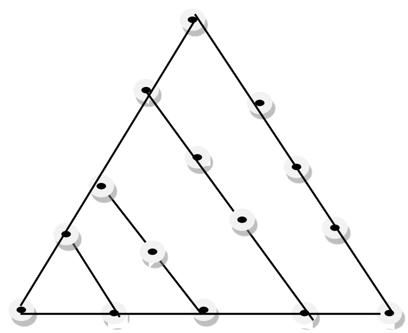

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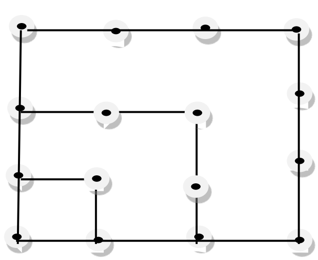
(b)



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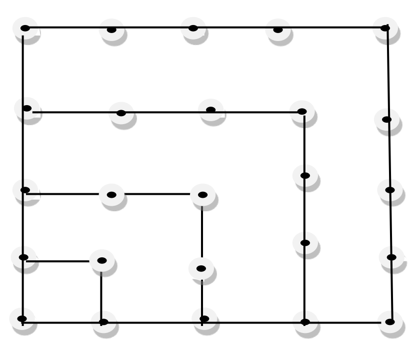

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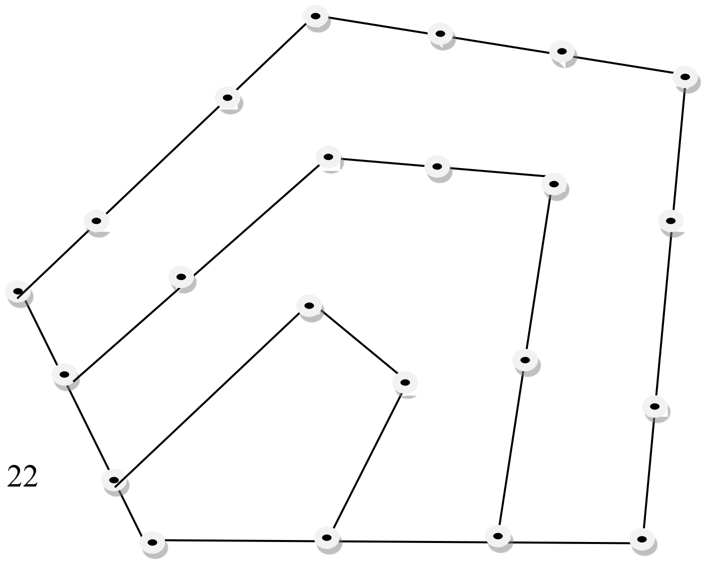
(c)



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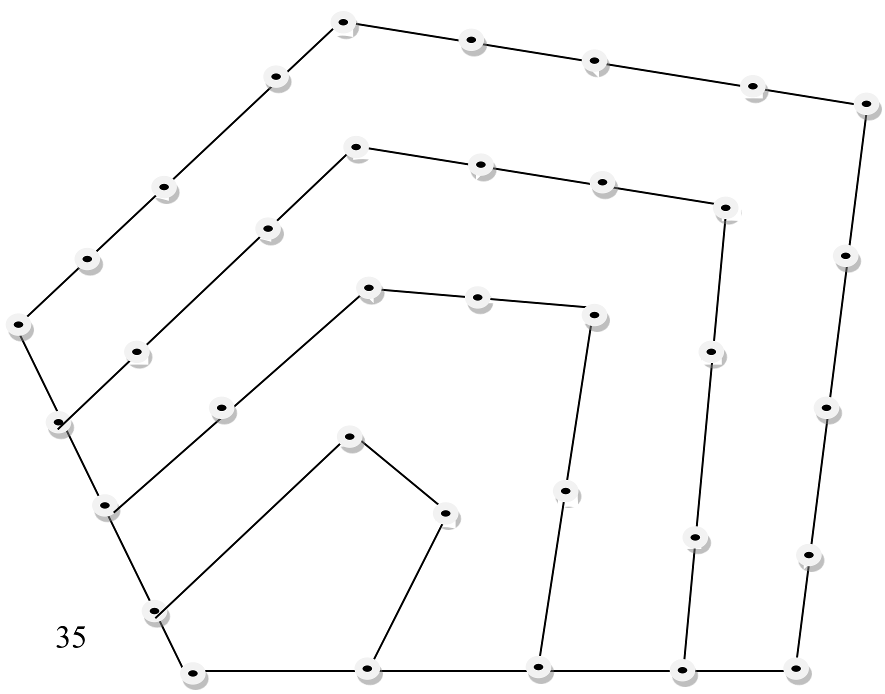

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(3) Every square number greater than 1 is the sum of two consecutive triangular numbers. Examples:
$9 = 3 + 6,\ \ 16 = 6 + 10,\ \ 25 = 10 + 15$

Every pentagonal number can be represented as the sum of a square number and a triangular.

Examples:

$$5 = 4+1,\ 12 = 9+3,\ 22 = 16+6.$$

(4) (a) $T_n = \dfrac{n(n+1)}{2}$

7th term implie$n$ = 7.

$$T_7 = \frac{7(7+1)}{2} = 28.$$

(b) $S_n = n^2$

The 12th square number:

$$S_{12} = 12^2 = 144.$$

(c) $P_n = \dfrac{n(3n-1)}{2}$

The 6th pentagonal number:

$$P_6 = \frac{6((3\times 6)-1)}{2}$$
$$= \frac{6(18-1)}{2} = 3(17) = 51$$

**Sequence**

An interesting unsolved problem in Mathematics concerns the 'hailstone sequence', which is defined as follows:

Start with any positive integer. If that number is odd, then multiply it by three and add one. If it is even, divide it by two. Then repeat. For example, starting with the number 10 we get hailstone sequence 10, 5, 16, 8, 4, 2, 1, 4, 2, 1, …

Some mathematicians have conjectured (guessed) that no matter what number you start with, you will always reach 1.

Real number sequences are strings of numbers. They play an important role in our everyday lives. Real number sequences may follow an easily recognizable pattern or they may not. Recently a great deal of mathematical work has concentrated on deciding whether certain number sequences follow a pattern (that is, we can predict consecutive terms) or whether they are random (that is, we cannot predict consecutive terms). This work forms the basis of chaos theory, speech recognition, weather prediction and financial management, which are just a few examples of an almost endless list.

**Activity 2.5**

The rate of population growth is expected to increase by 200 people per year, what will be the expected total population growth between 2004 and 2019 inclusive, if the population of Calabar increased by 42000 in the year 2004?

**Activity 2.6**

How many ancestors from parents through great-great-great grandparents do three unrelated Ibibio people have?

**Answers to activities on Calabar (Ibibio) people**

1. $a = 42000$ (the population growth in the first year that is to be included in the total)

$d = 200$( the difference between the population growth for consecutive years)

$S_{16}$ = ? ( the total population growth in sixteen years from 2004 to 2019 inclusive)

$S_n = \frac{n}{2}[2a + (n-1)d]$

$S_{16} = \frac{16}{2}[2(42000) + (16-1)200]$

$S_{16} = 8(84000 + 3000)$

= 696,000

So the expected population growth in Calabar is 696,000.

2. Each person has two parents, a mother and a father, and these people are distinct because the people in the problem are unrelated. These parents are the closest generation to the original people; we call them the first generation. Now, each person in the first generation has two different parents, which we call the second generation. If we continue like this, we can see that there are five generations, and each generation contains twice the number of people of the previous generation. This is a geometric sequence, and we can write

$a = 6$ (total number of parents of the three unrelated people)

$r = 2$ ( $the\ ratio\ between\ the\ number\ of\ people\ in\ successive\ generations$)

$S_5$ = ? (the total number of ancestors in five generations)

Using the sum formula

$S_n = \frac{a(1-r^n)}{1-r}$ or $\frac{a(r^n-1)}{r-1}$

$$S_5 = \frac{6(2^5-1)}{2-1}$$

= 6 (31) = 186

So the three unrelated people will have 186 ancestors from parents through great-great-great grandparents.

**Structure of houses in Calabar:**

In the houses in Calabar, the shape of the doors and windows are rectangular and the upper part being semi-circles; the roofs show triangular shapes and shape of trapezium; and other parts of the houses show some geometrical shapes. These could be used to teach geometry in the school. The shape of the walls of some local houses are cylindrical with conical tops. This could be used to exemplify cones and cylinders in the class. The doors and windows show a combination of rectangles and semi-circles.

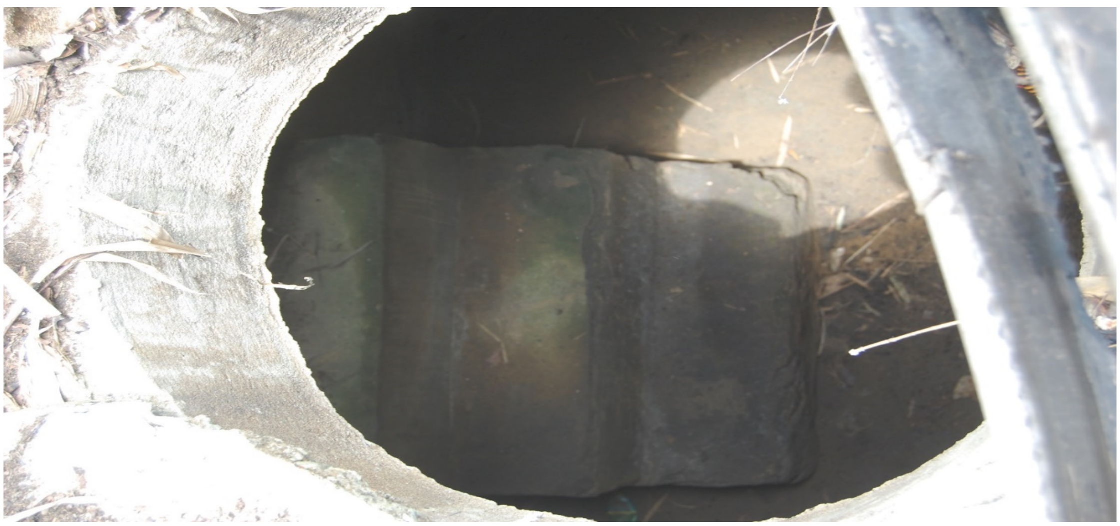
**Activity 2.7**

Develop activities based on the structure of Calabar houses

**The Biafran Bunker**

The Biafran Bunker is located by the river side in old Calabar. It was dug during the Civil war by the Biafran soldiers. It was designed to protect the soldiers from bullets and bomb attacks from the Nigerian army. Also, from there they could fire bombs to attack the enemies. The outer shape is a cuboid with rectangular entrance and circular top.

This could be used to teach the properties and measurement of plane and solid shapes such as rectangles, Circles, and cubiods.



**Activity 2.8**

Develop activities based on the Biafran Bunker.

**CHAPTER THREE**

**ABEOKUTA CULTURE AND THE MATHEMATICAL IMPLICATIONS**


# ABEOKUTA MODULE AS DEVELOPED BY NATIONAL MATHEMATICAL CENTRE ETHNO-MATHEMATICS RESEARCH GROUP

## Introduction

The Egba people migrated from Orile Egba in old Oyo Empire to settle in Abeokuta in the year 1830 due to the war ravaging the Yoruba land and they found solace under a rock so as to be shielded from any external aggression. They were of the opinion that "Oluwa lo moo: literarily meaning God built the rock" hence the name Olumo Rock was established i.e. Oke Olumo in Yoruba language. On the rock there are shrines, caves, and there is an Iroko tree which is 250 years old as at the time of visit. There is a shrine on the rock where only the Chief priest and the king, Alake of Egba land, could enter to pray for an individual, the town and the world in general. Also, whatever anyone is looking for could be prayed for and with faith such request would be answered, such as the fruit of the womb and other notable challenges in the world. There are four rulers in Egba land but the paramount ruler is the Alake of Egba land.

On the rock, there is a tomb of Chief Sanni who was the Osi of Itoko i.e the third in command to the paramount ruler, he died at the age of 125 years in January 1956. The Egbas got to the rock in year 1830 with a population of a little above one hundred people and they met Atagba. In 1833 there was war between Egba and Dahomey and after the war they were in the state of dilemma whether to go back to Oyo or stay. Hence, they consulted the oracle which asked them to settle at the location of the rock. After the Dahomey war, they appreciated God and the rock that gave them the opportunity for an escape. The rock was named Olumo rock (Oluwa lo moo) meaning God moulded the rock. The Yorubas in the old Oyo Empire asked the Egbas where they were during Dahomey war and they said they were under the rock hence the name Abeokuta.

**Olumo Rock Tourist Site at Abeokuta**

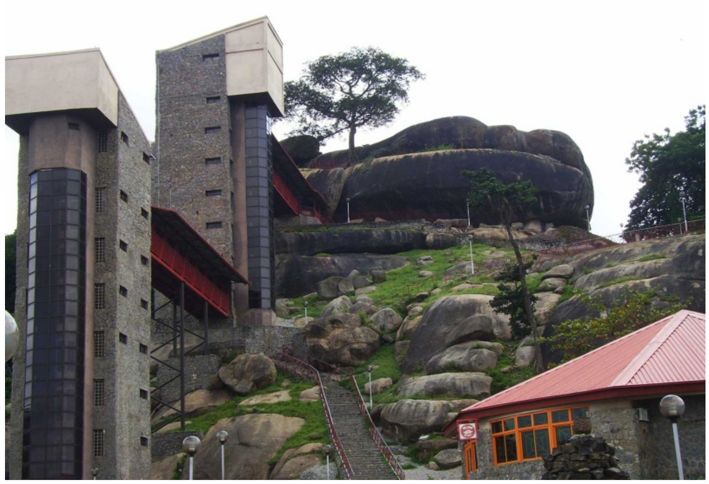


Figure 3.1: The Elevator at Olumo Rock

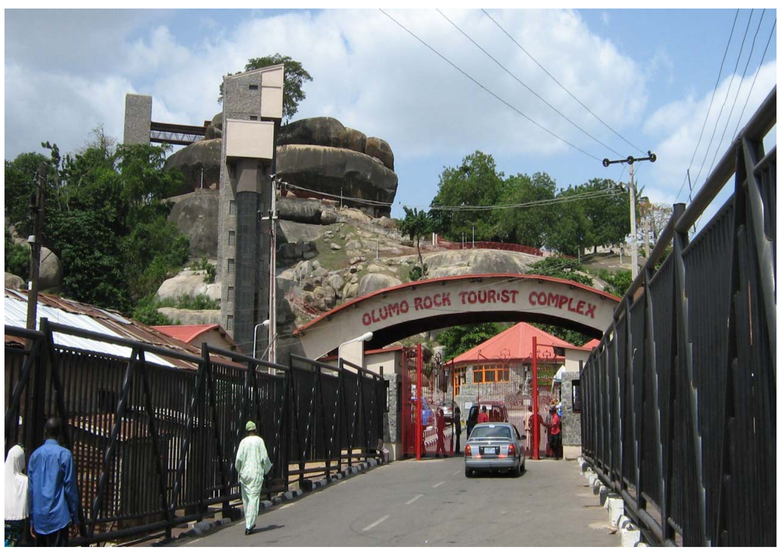



Figure 3.2: Olumo Rock Main Entrance


Figure 3.3: A Section of Olumo Rock

Figure 3.4: Water fountain at Olumo Rock

Olumo rock (figures 3.1 – 3.4) is located between Ikija and Ikereku, Abeokuta, the capital city of Ogun State. The name Olumo means "troubles and sufferings are all over". It is a massive outcrop of granite rock of primitive formation from which Abeokuta, the capital of the state derived its name, under the rock. The rock is an historical monument which served as shelter and fortress for the Egbas who settled under the rock during the intercity wars in 1830. It is a monument of faith, unity, source of strength and unfailing protection for Egba people. The highest point of the rock is

187 meters above sea level with existence of a tree growing for over 200 years and surrounding caves.

Olumo rock tourist site has modern infrastructures of a heavy duty glass elevator running through the different levels of the rock as shown in figure 1, with a well constructed stair case for aged, physically challenged persons and visitors with phobia for climbing the mountain. It is also a great destination for lovers of paintings and sculptures. The view from the top of the mountain is spectacular with a rich historical significance. Also found in the tourist site are eatery/restaurant, a museum, conference hall, multipurpose hall, garden, parking space, waterfalls and heavy duty generators. For a visitor who wants to tour the site, an amount is paid for entrance, climbing the stairs and using the elevator. Tourists who visit Olumo Rock have several interesting activities they can engage themselves in. They also need a tour guide, who is versed in the history of the site and culture of the people to take them round the interesting places at the tourist location.

A number of commercial activities such as sales of palm wine and pepper meat take place on the rock. Items such as already made Kampala clothes, neck laces and beads, portraits, text books, pens with the Olumo Rock inscriptions, "Ayo" accessories, etc are available at the museum.

**Activity 3.1**

1. If every visitor entering Olumo Rock tourist site pays an entrance fee of N700 for a day, how much will the management of the tourist site make given that a population of 200 visitors is recorded per day?
2. Suppose each of the lightening system around Olumo Rock costs N12,000, how much would have been spent to set up 103 of such lightening system?
3. Suppose a heavy duty generator at the tourist site consumes 75 litres of diesel in a day, how much would be needed to run the generator if a litre of diesel costs N250.50?
4. How many rectangular windows can you cite on the two elevators from figure 1?
5. If it cost Ogun State Government N10, 000 to construct each of the windows on the elevators in figure 1, how much would have been spent by the state government to fix the windows?

6. Trace the number of rocks you can cite from figures 1 – 3?
7. If it takes a visitor one hour to get to the top of the mountain non-stop, would you say it will take the same visitor less than or more than an hour to descend non-stop?
8. Twelve (12) already made pieces of Kampala clothes are displayed at the Olumo rock museum for sale. If the cost of producing a piece is N3500, what is the total profit made if each of them is sold for N7000?
9. Given that a bottle of palm wine sold on the rock costs N200 per bottle, how much would be needed to consume 18 bottles of same palm wine by a group of visitors?
10. The Accounting Officer of Olumo Rock wants to know the amount of money generated from the tourist park haven been told that 30 vehicles gained entrance to the tourist site. What would be his financial expectation if it costs N200 to park a vehicle?
11. A tour guide took 30 visitors to the peak of Olumo Rock by an elevator and 45 visitors by traditional staircases in a particular week, how much would have been generated for the said period if the cost of using the elevator is N150 and that of using the traditional staircase is N50?
12. How many set of concentric circles can you find from the waterfalls in figure 4?
13. If it took Olumo Rock management N250,000 to build the waterfalls in figure 4, how much would it cost to build 15 of the same waterfalls at the same unit cost?

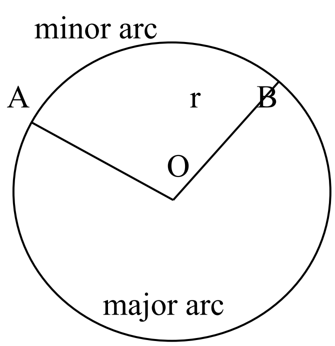
## THE ART WORKS DISPLAYED AT OLUMO ROCK

Some of the art works at Olumo Rock are shown in the figure 5

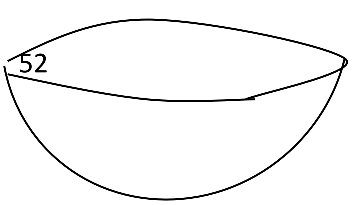
Figure 3.5: Some of the art works of the Egbas

The above picture shows water pots with top circular face on a circular iron stand. The pots are collection of circles with different radii, there are calabashes in form of hemisphere and sectors which are used as plates and food servers respectively.

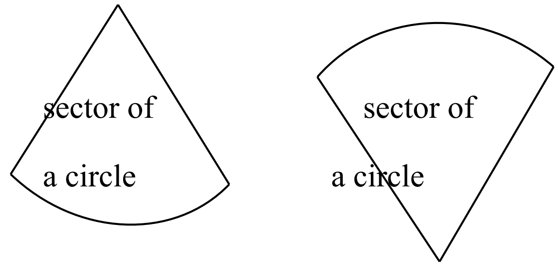
**Circle**




The figure above shows a circle of center O, radius R units. The points A and B divide the circumference into two arcs. The smaller and the larger arcs are called minor arc and major arc respectively.



Hemisphere




A calabash that is cut into two, the lower half gives a shape of a hemisphere and they are used to dish food in homes

Figure 3.6: Kegs at Olumo Rock

The picture above shows kegs that are used for palm wine and water in those days.

**Nature of Houses in Abeokuta**

The picture below shows the view of Abeokuta town from the top of Olumo Rock. The roof of the houses are in various shapes such as conical, curvilinear and so on.

Figure 3.7: Arial View of Abeokuta from the Top of Olumo Rock

**Activity 3.2**

1. From the picture in figure (), draw the shape of the roof that is
   a) conical  b) curvilinear
2. Copy and complete the table below

| Radius of a circle | Diameter | π | Circumference |
|---|---|---|---|
| 7 | | 3.142 | |
| | 12 | | 37.704 |
| 14 | | 22/7 | |

3. Find correct to 2 decimal places, the length of an arc of a circle, radius 25cm, which subtends an angle of $60^0$ at the centre. Take $\pi = 22/7$
4. Find the radius of the circle in which an arc 22cm long subtends an angle of $70^0$ at the center. Take $\pi = 22/7$
5. Find the area of a sector of a circle of radius 45cm which encloses on angle of $155^0$. Take $\pi = 22/7$

**June 12 Cultural Centre at Abeokuta**

Figure 3.8: The Main Building in the June 12 Cultural Centre

The cultural centre in figure 3.8 located in the heart of Abeokuta was renamed June 12 cultural centre in commemoration of the June 12 presidential election, won by Chief M.K.O. Abiola. The result was annulled by General Ibrahim Babangida led military administration in 1993. The centre is an impressive architectural piece. There are three types of halls in the centre: The Hubert Ogunde theatre, where various events hold, Cinema hall and Ogun State hall of fame.

The hall of fame is a section of the cultural centre that contains sculptures of great and illustrious sons and daughters of the people of Ogun state (both alive and dead) who have brought great fame to the people of Ogun state and by extension, the whole of Nigeria. These great men and woman contributed immensely to the benefits and recognition of Ogun state. Some of the sculptures in the hall of fame include: Chief Mrs Olufunmilayo Ransome Kuti (Born 1900), Dr Tai Solarin (Born 1922), Fela Anikulapo-Kuti (Born 1938), Chief Hubert Adedeji Ogunde (Born 1916), Professor Akinwande Oluwole Soyinka (Born 1934), Chief Obafemi Awolowo (Born 1904), Chief Dr Matthew Olusegun Obasanjo **GCFR** (Born 1935), Professor Olikoye Ransome Kuti (Born 1927), Chief Victor Olabisi Onabanjo (Born 1917), Chief Mashood Kasimawo Olawale (MKO) Abiola (Born 1937), Chief Olaseinde Earnest Shonekan (?), Bishop Peter Jasper Akinola **CON** (Born 1944), Prince Adesumbo Bola Ajibola **CFR** (Born 1934), Justice Adetokunbo Ademola **KBE** (Born 1906).

**Activity 3.3**

1. Suppose Hubert Ogunde Hall is a 500-Seater hall and filled up to the capacity during a stage
   (a) how much would the organizer of the film make if an entry fee is N2000?
   (b) if the bill for the rentage of the hall is N100,000 per night, how much profit would be made by the organizer after three nights?
2. If it costs Ogun state government N55,000 to construct a male sculpture in the hall of fame at the cultural centre, what is the total amount spent by the state government for 21 male sculptures in the hall?
3. What would be the cost of building the sculptures of those who have been previous Heads of State in Nigeria?
4. Identify the geometrical shapes from the above picture.

Figure 3.9: Chief Mrs Olufunmilayo Ransome  Kuti ( 1900 - 1978)

Olufunmilayo Ransome  Kuti (the only woman in the hall of Fame) was born on the 25th of October, 1900 into the family of a returned slave from Sierra Leone, Mr Daniel Olumeyuwa Thomas and Mrs Lucretia Phyllis Omoyeni Adesolu Thomas. She attended Abeokuta Grammar School for her Secondary Education and later went to England to study.

She was the first Nigerian lady to drive a car in Nigeria, the first woman in politics in Nigeria and probably in Africa. She was a woman right activist in the early twentieth century.

Olufunmilayo Ransome  Kuti in 1944 formed the Abeokuta Women Union which later became a National Women Union. It was a Union of 20, 000 financial members. Their achievements includes: Objections against the Sole Native Authority of Abeokuta. Due to her stern resistance to payment of tax by women, the then Alake, Oba Ademola II had to abdicate the throne in 1949.

She was the administrator of Rev. Kuti Memorial Grammar School in Abeokuta. Her children include: Fela Anikulapo-Kuti, Professor Olikoye Ransome-Kuti and Dr Beko Anikulapo-Kuti. She fought the military against the unjust arrest of her son, Fela Anikulapo-Kuti and sustained an injury on her leg of which the resultant complications allegedly led to her death in April, 1978.

The above history or story of Mrs Olufunmilayo Ransome Kuti can be used to introduce the teaching of the following topics in Mathematics: Sets, Inequality, and Functions as shown below.

**Activity 3.4**

**Set**

**A**

Write out observations you can make  in the following list of names:  Chief Mrs Olufunmilayo Ransome  Kuti, Dr Tai Solarin, Fela Anikulapo-Kuti, Chief Hubert Adedeji Ogunde, Professor Akinwande Oluwole Soyinka, Chief Obafemi Awolowo, Chief Dr Matthew Olusegun Obasanjo, Professor Olikoye Ransome Kuti, Chief Victor Olabisi Onabanjo, Chief Moshood Kasimawo Olawale (MKO) Abiola, Chief Olaseinde Earnest Shonekan, Bishop Peter Jasper Akinola, Prince Adesumbo Bola Ajibola, Justice Adetokunbo Ademola and Dr Nnamdi Azikiwe .

Though many observations can be made but these three stood out:

1. With the exception of Chief Mrs Olufunmilayo Ransome  Kuti all the others are males.
2. With the exception of Dr Nnamdi Azikiwe, all others are indigenes of Ogun State.
3. Some of the people listed are dead while some are still alive.

**B**

1. With the exception of Chief Mrs Olufunmilayo Ransome  Kuti, put the other names inside  curly brackets {}. Make sure the names are separated with comas.
2. With the exception of Dr Nnamdi Azikiwe, put the other names inside curly brackets {}.
3. Put the people listed that are dead inside curly brackets {}.
4. Put the people listed that are still alive inside curly brackets {}.

Each activity in B is called a Set. That is:

1. {Dr Tai Solarin, Fela Anikulapo-Kuti, Chief Hubert Adedeji Ogunde, Professor Akinwande Oluwole Soyinka, Chief Obafemi Awolowo, Chief Dr Matthew Olusegun Obasanjo, Professor Olikoye Ransome Kuti, Chief Victor Olabisi Onabanjo, Chief Moshood Kasimawo Olawale (MKO) Abiola, Chief Olaseinde Earnest Shonekan, Bishop Peter Jasper Akinola, Prince Adesumbo Bola Ajibola, Justice Adetokunbo Ademola, Dr Nnamdi Azikiwe} is a set of males in the above list.

2. {Chief Mrs Olufunmilayo Ransome  Kuti, Dr Tai Solarin, Fela Anikulapo-Kuti, Chief Hubert Adedeji Ogunde, Professor Akinwande Oluwole Soyinka, Chief Obafemi Awolowo, Chief Dr Matthew Olusegun Obasanjo, Professor Olikoye Ransome Kuti, Chief Victor Olabisi Onabanjo, Chief Moshood Kasimawo Olawale (MKO) Abiola, Chief Olaseinde Earnest Shonekan, Bishop Peter Jasper Akinola, Prince Adesumbo Bola Ajibola, Justice Adetokunbo Ademola} is a set of prominent indigenes of Ogun State.

3. {Chief Mrs Olufunmilayo Ransome  Kuti, Dr Tai Solarin, Fela Anikulapo-Kuti, Chief Hubert Adedeji Ogunde, Chief Obafemi Awolowo, Chief Moshood Kasimawo Olawale (MKO) Abiola, Justice Adetokumbo Ademola, Dr Nnamdi Azikiwe} is a set of Nigerian prominent persons that have died.

Each of the sets above can be represented by a capital letter. For instance

**A** = {Chief Mrs Olufunmilayo Ransome  Kuti, Dr Tai Solarin, Fela Anikulapo-Kuti, Chief Hubert Adedeji Ogunde, Chief Obafemi Awolowo, Chief Moshood Kasimawo Olawale (MKO) Abiola, Justice Adetokunbo Ademola, Dr Nnamdi Azikiwe}

Each name in the list above is called an element. For example, Dr Tai Solarin is an element in the set **A.**

**C**

What do you understand by the word set?

A set can easily be described as a well-defined collection of things separated by comas and enclosed in curly brackets. That is, things with similar characteristics.

With this introduction, students will not only be learning Mathematics with local contents but also be learning a little bit of history.

**Inequalities:**

Consider the list in the Ogun State Hall of Fame, if $X$ is the age of Chief Dr Matthew Olusegun Obasanjo **GCFR** (Born 1935), $Y$ the age of Professor Akinwande Oluwole Soyinka (Born 1934) and $Z$ that of Bishop Peter Jasper Akinola **CON** (Born 1944)

**Activity 3.5**

1. Place $X, Y, Z$ at the appropriate place in $0 < \ldots\ldots < \ldots\ldots\ldots < \ldots\ldots\ldots < 90$
2. Let $x_i$ be the age of Chief Dr Matthew Olusegun Obasanjo performed activity $i$( where activity *i* means anything he has done in life), then which of the following is true?

   (a) $x_i \geq X$ (b) $x_i > X$ (c) $x_i \leq X$ (d) $x_i < X$
3. Represent the answer to question 2 of activity IV on a number line.
4. If $x_i$ represents the age $X$ of Chief Mrs Olufunmilayo Ransome Kuti when Fela Anikulapo-Kuti was born, which of the following is false?

   (a) $x_i > 10$ (b) $x_i < 70$ (c) $x_i \in (10, 70)$ (d) $x_i < X$ (f) $0 < x_i < 78$

**Fractions**

Professor Olikoye Ransome-Kuti was born on 30th December 1927 to the family of Rev and Chief Mrs Ransome-Kuti.

**Activity 3.6**

1. What was the age of Chief Mrs Olufunmilayo Ransome-Kuti when Olikoye was born?
2. What fraction of her age was she when Olikoye, was delivered?

**The Palace of Alake of Egbaland**

Figure 3.10: A Section of Alake's Palace

Figure 3.11: Some Art Works at Alake's Palace

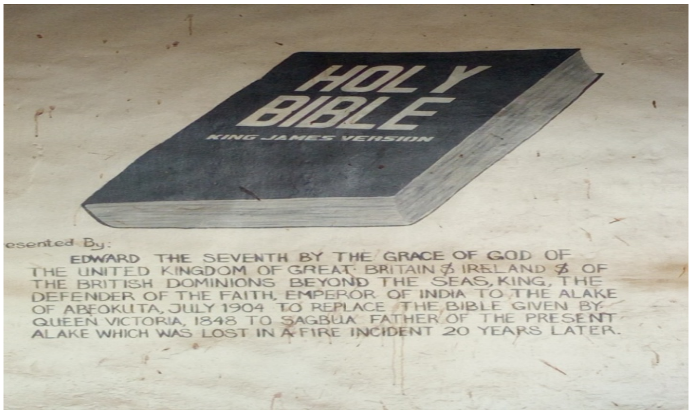



Figure 3.12: Picture of a Bible in Alake's Palace

*The figures 3.10 – 3.12 are pictures taken at the Palace of Alake* of Egbaland located at Ake Road, Abeokuta, Ogun State. When the palace is viewed, the things you notice first are two magnificent pillars that anchor the gate. They are decorated with Alake's emblem and a bar that connects them together. Inscribed on the bar are the Yoruba words, "Aafin Alake Ti Ile Egba" which translates to "The Palace of Alake of Egbaland ". The palace is made up of two sections, the old and the new. The old palace precedes the new and they are well maintained. There are statutes, busts and figurines adorning the compound, each telling its own tale.  We can use the above description to introduce *angles of elevation and depression.*

***Angles of Elevation and Depression in Alake palace***

Suppose a man standing on the level ground in Alake's Palace wants to see the top of the magnificent pillars that anchor the gate decides to look upward to see a point where the decorated emblem connects each other. Then an angle of elevation will be formed.

Suppose the same man wants to sight a lizard on the ground close to the gate, he will turn his eyes downwards in order to sight the lizard. The angle formed by turning his eyes downwards is referred to as angle of depression.

**Activity 3.7**

1. A man 1.7m tall is 10m from the foot of the magnificent pillar in Alake's Palace. He observed that the angle of elevation of the top of the gate is $45^o$. Find the height of the magnificent pillar.
2. A man standing 25m away from the pillar observes that the angle of elevation of the top of the pillar and the angle of depression of the bottom of the pillar are $55^0$ and $20^0$ respectively.

Find

i. The height of the man
ii. The of height of the pillar

**Mensuration with respect to Alake's Palace**

The Palace is rich in art, culture, history and tradition of the Egbas. Everything about it, boastfully displays the pride of the Egbas. There are Palace staff who will take you on a tour of the Palace but unless you have a royal appointment, you may neither be allowed to enter the Palace chambers nor see the Alake. However, there are a lot of intriguing sights to grip your fancy, as shown in the figures below:

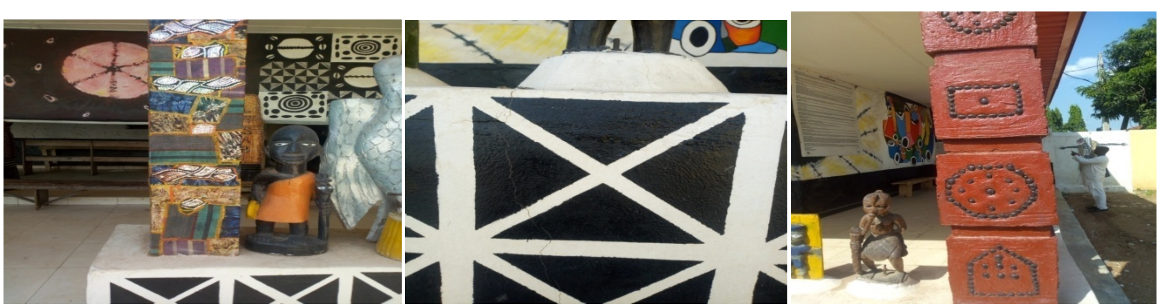


Figure 3.13: Painting and Sculptures at Alake's Palace

The pillar in the frontage of the Alake palace has some geometrical features like plane and solid shapes such as circles, rectangles, and triangles.

**Activity 3.8**

Identify and draw the various plane shapes on the pillar.

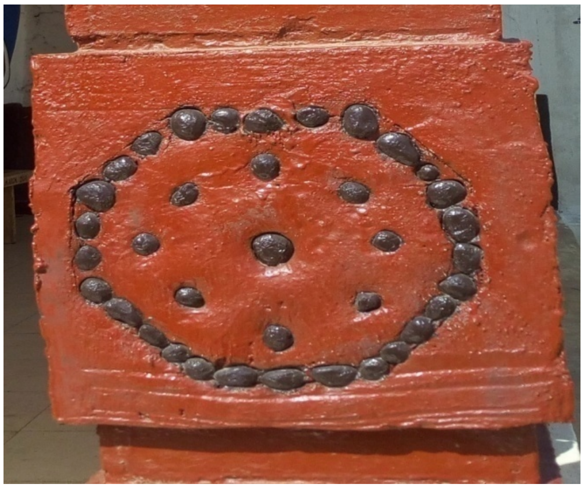


Figure 3.14: Circular Pattern on a Pillar at Alake's Palace

Consider the shape formed by the above pattern. There is a stone at the center. The distances between the stone at the center and outer most ones are equal. The pattern formed by these outer-most stones is called a circle. A circle therefore is a collection of points that are of equal distance from a fixed point called the center. It can equally be defined as a locus of points equidistant from a fixed point. The equal distance from the center is called the radius.

**Parts of A Circle**

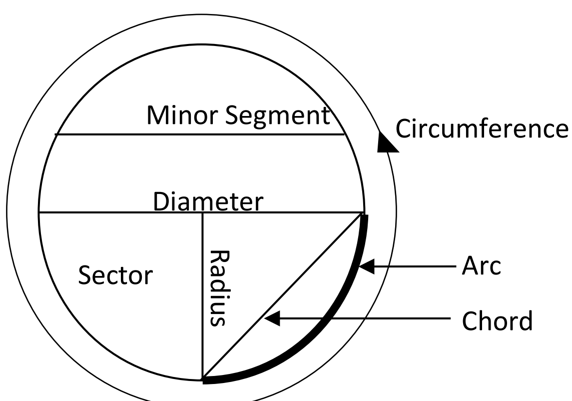



Figure 3.15: Parts of a Circle

**Circumference of a circle**

**It is good to determine the value of pi ($\pi$)** before delving into the formula of circumference of a circle. Let C = circumference and D = diameter, $\frac{C}{D}$ is constant no matter the size of the circle. This constant is called pi ($\pi$). Since 2 radii make up the diameter, we have from

$$\frac{C}{D} = \pi \Rightarrow C = \pi D.$$

That is

$C = 2\pi r$ since $D$ = 2r.

**Area of a Circle**

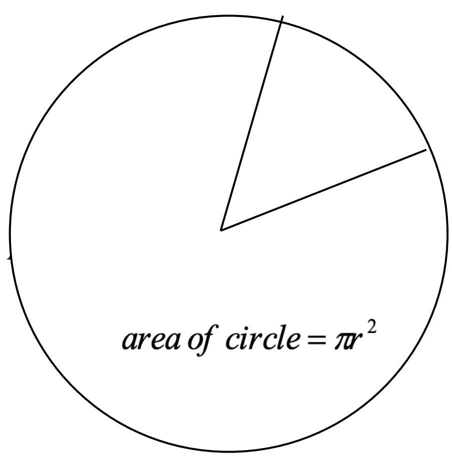



Figure 3.16: A Circle

**Area of circle:** If a circle is cut into even number of equal sectors and arranged alternately as shown below

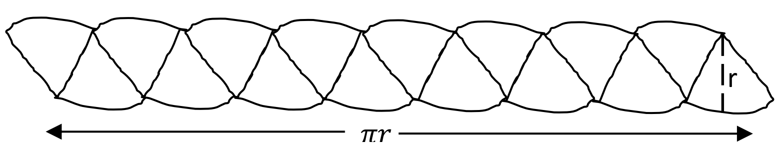


Figure 3.17: Sectors of a Circle

then Area of the circle = $\pi r$ x $r$ = $\pi r^2$

**Activity 3.9**

1. Find the area and the circumference of a circle with radius 5cm (take $\pi = \frac{22}{7}$ ).

**Rectangle:**

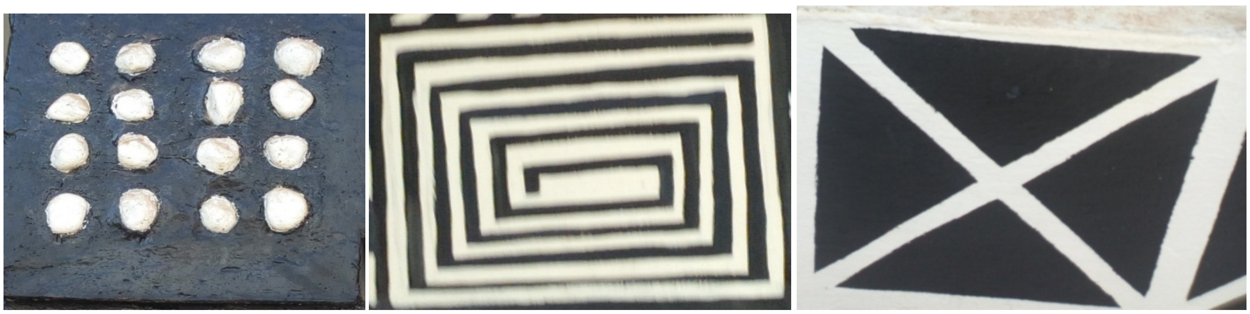


Figure 3.18: Some rectangular Patterns in Alake's Palace

A rectangle is a plane shape, whose opposite sides are equal and diagonals are equal.

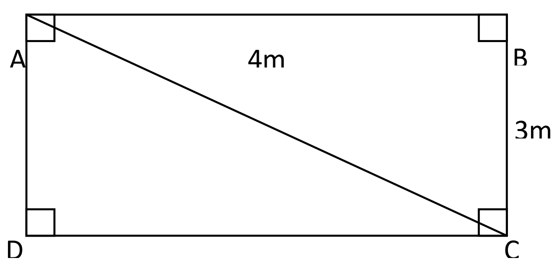



Figure 3.19: A Rectangle

**Properties of a Rectangle**

1. Looking at the above figure we see the opposite sides are parallel and equal.
2. This means AD and BC are parallel to one another and AB and DC are also parallel to each other. This means the opposite sides are parallel.
3. The sides AD and BC have the same length, so it is clear that they are congruent. Also,

4. side DC and AB are congruent to one another. Here in this figure, we have four angles. All the angles in a rectangle are 90°.

5. That is 90° + 90° = 180°. The sum of all the interior angles is 90° + 90°+ 90° + 90° = 360°

6. The diagonals of the rectangle are also congruent to each other and they bisect each other at their point of intersection.

7. A rectangle can also be called as a quadrilateral as it has 4 sides.

Area of rectangle = length × breadth.

**Activity 3.10**

1. Find the perimeter, area, diagonal of the rectangle whose length is 4m and breadth 3m.
2. The length of a room exceeds the breadth by 2 m. If both the length and the breadth are increased by 1 meter, then the area of the room is increased by 11 sq. m. Find the length and the breadth of the room.

**Alake's Bible**

This Bible in figure 3.12 was presented by king Edward the seventh by the Grace of God of the United Kingdom of Great Britain and Ireland and of the British Dominions beyond the seas, the defender of the faith, emperor of India to the Alake of Abeokuta, in July, 1904 to replace the Bible given by Queen Victoria in 1848 to Sagbua, father of the then Alake which was lost in a fire incident, 20 years later.

The Bible in Alake Palace is cuboidal in shape. Volume of a cuboid is the product of length, breadth and height. From the above, we can say that volume of Alake's Bible is $l \times b \times h$. A cube is a special case of a cuboids', where $l = b = h$. Hence, volume of cube = $l \times l \times l = l^3$. The total surface area is $2(h \times l + b \times h + b \times l) = 2(lb + bh + hl)$ where h, l and b are the height, length and width of the cuboids' respectively.

Volume of Cuboids': Amount of space occupied by a three dimensional object is called its volume. To find the volume of a solid we need to divide it into cubical units. We can say that the volume of a solid is measured by counting the number of unit cubes it contains. Cubic units which we generally use to measure volume are 1 cubic cm = 1 cm × 1 cm × 1 cm = 1 $cm^3$ = 10 mm × 10 mm × 10 mm =1000$mm^3$ can be assumed as the pages in Alake bible.

**Activity 3.11**

1. Suppose the height, length and width of the Alake's Bible shown in figure 3.13 are 20 cm, 15 cm and 10 cm respectively. Find the total surface area of the Bible.
2. **Suppose** the Bible in Alake's Palace have these dimensions length 25cm, width 20cm, and height 10 cm. Find

   i) Total surface area of the Alake bible

   ii) Volume of Alake bible

**Adire Factory**

One of the occupations of the people of Abeokuta is the production of local fabrics called Adire and Kampala. Both men and women are involved in the production of the fabrics. The designs on these fabrics (Adire and Kampala) have many mathematical concepts. Different types of plane shapes are found on the fabrics. Many of these mathematical concepts could be used as instructional materials in the teaching and learning of mathematics.

There are a lot of mathematical concepts that are involved in the production of these fabrics materials. There are different stages and duration in the production processes. On the fabrics materials, are found different mathematical shapes, models and patterns. Examples of mathematical concepts that can be learnt here are: concept of time, plane shapes and arithmetic of finance.


Figure 3.20: Adire Shopping Mall Built by Ogun State Government

**Concept of time**

Time is one of the concepts taught at the middle and upper basic education. This important mathematics concept is noticed in the production of Abeokuta local fabrics of adire and kampala.

**Activity 3.12**

There are 6 stages involved in the production of a set of adire and kampala. Suppose that an adire and kampala industry can produce 20 pieces of 6 yards of the cloths at once in 2 hours.

1. Find the average time spent per stage.
2. What is the average time spent per 6 yards of cloths?
3. A customer wants 80 pieces of 6 yards of adire. At what time will his consignment be ready if production starts at 8.00 am of a particular day?
4. Supposing, of the 2 hours of production, it takes 30 minutes to complete the first stage and the remaining 5 stages take equal time, find a suitable formula to illustrate this.
5. Use the formula to answer question 3 above.

**Plane shapes**

Many geometric plane shapes and figures can be identified in Abeokuta local fabrics designs.

Figure 3.21: Kampala with Concentric Circles and Polygons

Figure 3.22: Rectangular Array of Concentric Circles on Adire

Figure 3.23: Triangular Shapes and Concentric Circles on Kampala

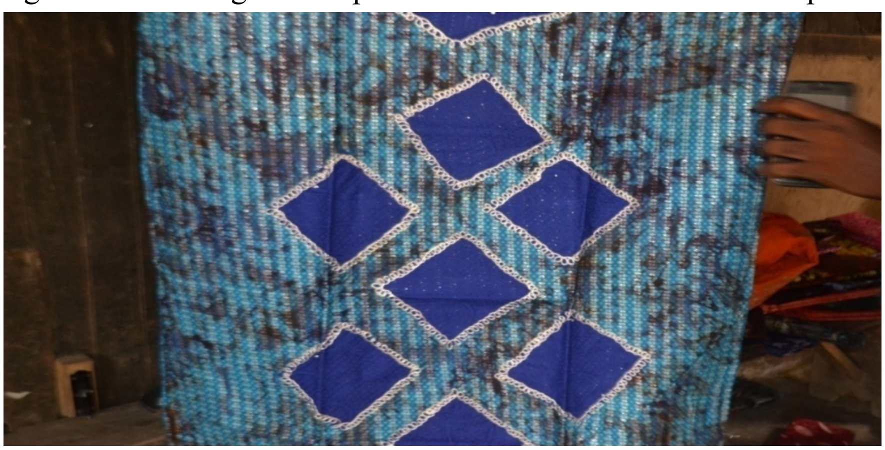


Figure 3.24: Rhombi in a Group of 7 and Concentric Circles on Kampala

Figure 3.25: Rectangular Strips on Adire

**Activity 3.13**

1. What are concentric circles?
2. If a yard of kampala contains 8 concentric circles, how many concentric circles are the in a 6 yards kampala?
3. On an adire material, a rectangle contains 9 smaller trapezia. If there are 38 of such triangles on a yard of an adire material
   a. How many trapezia are there on one yard of adire?
   b. How many rectangles are there on 6 yards of adire?
   c. How many trapezia are there on 6 yards of adire?
   d. How many yards of adire will contain 1, 025 trapezia?
   e. How many yards of adire will contain 152 rectangles?
4. A piece of adire measures 250cm by 100cm
   a. Find the area of the piece of adire can cover.
   b. Find the area of one rectangular strip if the area is covered by 20 rectangular strips.
   c. How many triangular strips are there if the area of one strip is 200 $cm^2$.
5 Six yards of a kampala cloth has 216 triangles.
   a. How many triangles are there in a yard of kampala?
   b. If the area of one triangle is 54 $cm^2$, find the total area of the triangles in one yard of the kampala.
   c. If the total area of the triangles is one-third of the area of one yard of a kampala, find the area of one yard of a kampala.
   d. The length of the base of one triangle on the kampala is 12cm. Find the height of the triangle.

**Arithmetic of Finance**

The primary aim of production is to be in business and make profit.

1. It costs N1, 600.00 to produce 6 yards of adire.
   a. How much would it cost to produce 12 sets of 6 yards?
   b. N14, 400.00 will produce how many sets of 6 yards?
   c. If a set of 6 yards is sold for N1, 900.00, find the profit and percentage profit.
   d. How much would a set of six yards be sold to make a profit of 20%?

**CHAPTER FOUR**

**IGEDE CULTURE AND THE MATHEMATICAL IMPLICATIONS**

Figure 4.1: His Royal Highness OgaEro C.P (Rtd) ,Adirahi NY 1 Igede, the King of Igede land

Figure 4.2: Some Ethno-Mathematics Research Team Members with the Adirahi NY 1 Igede, Wife and High Chiefs of Igede Land


Figure 4.3: Some Research Team Members at Arts and Culture Office Makurdi

**History of Igede Kingdom**

Igede tribe is found in Benue State and Cross River State of Nigeria. They are found in the following Local Government Areas (LGAs): Oju, Obi, Konshisha and Gwer LGAs of Benue State. Others are found in Yalla LGA of Cross River State. Agba, the father (Progenitor) of Igede people was the 11$^{th}$ son of Oraekpen in Ora land, Ovwian West LGA of Edo State. Oraekpen's bloodline is traced to Oba Evwuare, a former monarch of the Benin Empire. His brothers include: Umale, Ahiedu, Akhuaize, Obe, Ivbiare, Eghonmi, Owato, Uguanroba, Odu, Ohela and Ofebe. Agba's first abode was Ohia in Ora land (Sabongida Ora) in Edo State. Agba migrated from there in the 15$^{th}$ Century and settled in Igede land. His last son was Oju.

The origin of the Igede people although well documented, is shrouded in myth and legends. The Igede people migrated from Ora in Edo State in the 15$^{th}$ Century. They were led by Iyeche through Enugu until they settled in a forest, which is the present day Igede land.

The name "Igede" was coined from "Ogede", a musical instrument that Agba himself carved. The progenitor of Igede, Agba, was a traveller and a native doctor.

Agba's first abode was Ohia in Ora land. Agba's forceful migration took place in during the reign of Oba Evwuare (about 1440 – 1473). During this period, one of the Oba's grandsons (Okpame) was exiled because of his bad behavior. He left the kingdom to settle at a place called Odorere. Agba, the Igede people ancestor was able to trace his bloodline to prince Okpame at Odorere where he stayed until the unfortunate incident that forced him to leave Ovwian.

History has it, that an Ora woman borrowed a pot from an Igede woman but the Ora woman accidentally broke the pot, while the Igede woman insisted that the broken pot must be mended. As this could not be done, a conflict ensued.

The Ora people took advantage of the presence of the Fulani jihadists who had superior weapons, to help them drive the Igedes from the land.

The Igedes were thus said to have fled and sojourned at Odorere, Edumoga, Uke, Idah, Ogwudehi, Okwetumwu and the Oyongo River. The people moved from Oyongo River to Ipinu Igede (Igede Forest) where they made their original settlement. As a result of internal conflicts and population pressure, the original settlement at Ipinu Igede was abandoned and all the Igede groups, with the exception of Oyinyi (which stayed behind to guard the sacred shrine – Ota Amwo), went to settle in other areas of the present Igede land.

Settlement in Igede land is made up of 15 clans: Ada, Anchim, Oye, Ukpa, Oboru, Owo, Ibilla, Uwokwu, Ainu, Ito, Itakpa, Anyaboga, Igabwu, Idelle, and Oju. Each clan settled close to one another at Ipinu Igede.

Integrity and good family name is the hallmark of the Igede people. Family name is highly guided and respected. Igede was part of the Kwararafa Empire with the Jukuns, Idomas, Igalas and Ebiras. On the issue of kingship, it was said that the Igalas insisted in dominating others. Therefore the Idomas and Igedes moved with some Iyala people. The nuclear family system thrives among the Igedes. This system fosters solidarity from compound to clan, to lineage and village.

There are five market days in Igede land: Ihigile, Ihio, Ihiobla, Ihiegbo and Ihioko. Key decisions are made in Ihigile, while Ihioko is regarded as a bad day, and nothing major is always done on that day.

At Alegu festivals, societal vices are tackled and no appeal is granted on decisions made here. A clan is subdivided into villages, while a village or lineage is further subdivided into kin heads or sub lineages, comprising families that have a common parentage.

**Mathematical Implications of The History of Igede People**

Like every other tribe the Igede people have origin (Ora).

In Mathematics, positional notation uses zero as the origin. The necessity of zero and the power of zero is discussed.

**The Necessity of Zero**

In most positional numeration systems the places are written horizontally, like letters in a word. Each place corresponds to a power of the base. The principle of position was originally used in figure/numerations and was later adopted in written numerations.

There is only one element that an abacus has that the written representation of symbols lacks: the rod with no beads on it, indicating an empty column. Positional numeration system are the ones that require zero. For example, the tens place must stand even if the column that represents it has no occupant. A symbol must be put in that column to tell us both that it has no digits in it and that the digits in the next column are in the hundreds place (Guedj, 2010).

In number 1001, the tens and hundreds do not count i.e. they have no content. Although, the other two digits are identical in form, we can identify their differing values by their positions

**The Power of Zero**

In positional notation of numbers, all places are permitted to all numbers including zero. A unique exception is starting a number with zero, for example 0213, in which the zero is not necessary. Another advantage of this numeration system is the link it establishes between the length of the name and the size of the number; the longer the name the longer the number. Such a link between the length of the name and its value makes comparison extremely simple. For example, as 1001 has more digits than 888, it follows that 1001 is longer than 888 (Guedj, 2010). This is not true especially for Roman numerals, where 1001 is written as MI with two digits, while 888, the smaller number is written DCCCLXXXVIII with twelve digits. There is therefore the need to search for exceptions while generalizing.

**Activity 4.1**

The Igede nation originated from Ora land in Edo State. The bearing of an object from a point is always measured with reference to the North pole of the point, and then through a clockwise direction towards the object.

(1). A group of Igede people moved 224km from Ohia on a bearing of $27^0$ and then 150km on a bearing of $109^0$ to Ipinu Igede. Find the distance and bearing of Ipinu from Ohia.

**Topology**

In the history of Igede nation, the borrowed pot that was broken by an Ora woman was definitely deformed. The Plane and solid figures studied in Euclidean geometry are carefully distinguished by differences in size, shape, regularity and so on. For a given figure such properties are permanent and thus we can ask sensitive questions about congruence and similarity. Suppose we studied "figures" made of rubber bands as it were, figures that could be stretched bent or otherwise distorted without tearing or scattering. Topological questions concern the basic structure of objects rather than size or arrangement.

**Occupation**

Igede people are farmers with some going into fishing, hunting, weaving, shoe making, beads making, hunting, pot making, baskets making etc. They are honest seekers for greener pastures, in healthy conditions.

**Igede Beads**

One of the cultural identities of the Igedes is their cultural beads. The beads are made of three colours which are the cultural colours of the Igede nation. The colours are white, black and blue.

**W**hite colour symbolizes purity of the Igede people. Every Igede person is pure in heart in all relationships, endeavours and transactions in life. Fellow human beings are treated with love and purity of heart. An Igede person does not quarrel nor keep malice with fellow human beings irrespective of the tribe and location where they meet. By this quality, there are no rooms to suspect an Igede person of evil plans against one another rather trust of one another is an integral part of their way of life. For instance, when an Igede woman provides food for a visitor, she is expected to taste the food before the visitor eats the food. This is to show purity of her heart in the provision of the food. An Igede person values integrity so much and no person wants to soil the name of his by his/her actions in life

Black colour symbolizes Unity among the Igede people. They work together to protect and assist one another. In this culture, injury to one is an injury to all. They have strong family and cultural ties that bind them together. For instance, each family builds their hurts in circular locations near one another to ensure unity, assistance and protection of one another. This bond of unity is extended to the village and Igede nation

Blue colour symbolizes hospitality among the Igede people. They welcome and show hospitality among themselves and to visitors in terms of food and protection. One cannot visit an Igede family and go hungry. Every effort is made by your host to make you feel welcome and comfortable

The beads making provides job opportunity in the production and sale of the beads Many people are engaged in this business of beads making.

Figure 4.4: A high Chief wearing the Igede Beads

Figure 4.5: Some designs of Igede Beads

**Mathematics Applications**

1. An Igede woman can produce a set of beads in three days. How many days will it take her to produce twelve sets of beads?
2. The cost of producing a set of beads is N1200. How much will it cost to produce 50 sets of beads?
3. A trader bought 50 sets of beads at N2500 each and sells them at the rate of N3000 each. Calculate his profit.

4. A man borrows the sum of N20,000 from a bank at the rate of 5% simple interest to start beads making business at Oju town. The loan lasted for six years. Calculate the simple interest and the amount to be paid back to the bank?
5. A woman made a necklace beads with 120 beads. How many beads are black beads if the ratio of white: black: blue is 3:2:1?
6. A circular set of beads has radius of 8cm. Calculate the circumference of the circular beads.
7. A piece of beads is cylindrical in shape. The base diameter is 6cm and height is 4cm. Calculate the volume of the bead.

**Farming**

Igede people are farmers. The major farm produce include yams, Okro, Okpono, Fish, Melon, Vegetables, Groundnut, Beniseeds, Garden Eggs, Calabash etc. The major farm implements include hoes, diggers, cutlass etc

Figure 4.6: Some of the Farm Produce of Igede People

**Basket Weaving and Carving of Mortars and Pestles**

The people of Igede weave different sizes of baskets for carrying their farm produce and for carrying them to the market. They also carve mortals and pestles for pounding of yams and other food items eaten by the people.

Figure 4.7: Some of the woven baskets and carved mortar and pestle

**Weaving of Traditional Clothes**

Igede women weave clothes as shown below

Figure 4.8: Clothe weaving by Igede woman

Figure 4.9: Clothes weaved by Igede women

**Applications**

The farming activities and the farm produce could be used to teach shapes, commercial mathematics, proportion, volume, capacity and other relevant topics in the classroom.

**Traditional Igede Houses**

The traditional Igede houses are huts. The huts are circular based with conical roofs. The windows and doors are rectangular in shape. The walls are made with mud blocks that are cuboids in shape without hollows in them. Each family lives in a hut and families build their huts in circles with one hut at the center to form a compound. The father of the family lives in the hut at the center. All the children in a nuclear family live in the same compound and eat food together. This form of building in circles is for security reasons to prevent attacks from enemies. It also enables them to work jointly in their farms helping one another. The Igedes have the technology of making the blocks, building the walls and making the conical roofs with long grasses. In Igede, nuclear families form a compound. Compounds form a lineage and lineages form a village. These ensure solidarity in their existence as a nation of people

Figure 4.10: Traditional huts in Igede land

Figure 4.11: Traditional Settlements in Igede land

Figure 4.12: House in Igede Land

Figure 4.13: The Palace of the King of Igede Kingdom

**Applications to Mathematics Teaching**

1. A cylindrical wall of an Igede hut has radius of 5 meters and height of 3 meters. The conical roof is 4 meters high with base radius 6 meters. Calculate the volume of the hut.

2. A man can make 60 mud blocks in a day. How many days will it take two men to make 600 blocks at the same rate?
3. A mud block has length 15cm, width 10cm and height 8cm. Calculate the total surface area and the volume of the block.
4. The area of the circular floor of a hut is 14 meter square. Calculate the radius of the floor.
5. If the cost of building a hut is N25,000 and a family can save N5000 in a year, how many years will it take to save the money to build a hut.

**Traditional Games**

The Igedes have many traditional games with which they socialize and enjoy their leisure times. The games help in developing counting ability and numeracy skills. Some of them include:

**Echie.** It has six holes on each of the two sides. A hole contains four stones or any spherical seeds. It is usually played by two persons at a time. Like other games it has strategy of winning and losing. At the end of the game the player with the highest number of seeds is the winner

Figure 4.14: Echie Game Board and accessories

**Epe**. This is played with four game seeds which are spherical in shape. It could be played by two or more players at a time. The four seeds are put in a palm and thrown up. The player tries to allow the seeds to land on the back of the fingers. The number of seeds that are on the back of the fingers are recorded for the player. At the end of the game, the player with the highest number of seeds is the winner. The game involves counting, recording, addition and comparison of numbers

**Eru**. In this game, players hold hands together and form a circle. They then dance round in a circular form singing songs.

**Applications**

The games can be used to teach counting, addition and comparison of numbers.

1. A hole of Echie game contains four seeds. How many seeds are in the 12 holes?

2. A player of Echie game collected his opponent's seeds as follows: 4, 6, 2, 8, 5 to win the game. How many seeds has he altogether? How many seeds are with his opponent?

3. In a five rounds of Epe game, John had 4, 3, 4, 1 and 4 seeds while Peter had 4, 3, 0, 4 and 2 seeds. Who won the game?

**Pot Making**

The Igede people make various types and sizes of Pots for serving food, fetching water, flower pots, musical instruments, plates, cups, and for other domestic uses from clay. Both males and females are engaged in pot making and it serves as a profession to many families. Some people are also involved in the trading on pots.

Figure 4.15: Local Pots in Igede Kingdom

Figure 4.16: Ceramics made in Igede land

**Applications to the Teaching of Mathematics**

**Geometry**

These objects and pots made by the Igedes could be used to teach geometrical shapes, volume and capacity in the classroom. The properties of the shapes and concepts such as area, volume and capacity could be practicalized in the classroom.

**Activity 4.2**

1. A spherical object has radius 8cm. Calculate the total surface area and the volume of the object

2. A cup made by an Igede woman is in a form of a frustum of a cone. The lower radius is 5cm, the upper radius is 8cm and the height is 7cm. Calculate the total surface area, the volume and capacity of the cup.

3. A circular plate for serving kola-nuts in Igede land has radius of 9cm. Calculate the area of the plate.

4. An Igede woman produces 3 pots in a day. How many days will it take her to produce 42 pots of the same size, working at the same rate.

5. A trader bought 50 pots at the rate of N1500 each and sold them at the rate of N1800 each. Calculate his profit.

6. Ada produces 4 pots in a day, Ochu produces 6 pots in a day while Iyange produces 5 pots in a day. Calculate the mean of the number of pots produced in a day by three of them.

**Inheritance in Igede Kingdom**

Inheritance in Igede kingdom of Benue state of Nigeria is patriarchal. The properties of a deceased are shared out among the relations and the children of the deceased but not wife (unless a will is left for them to follow). The male children are given portions of their father's properties based on the position according to birth. This does not mean that a female child does not benefit from her father's properties. But this is done indirectly. Suppose a man dies without given birth to a male child, the relations of the deceased automatically inherit the properties. In Igede kingdom, the benefactors can then give part to female children of the deceased. However, the female child must not take such inheritance to her husband's house.

**Significant Symbols**

Everybody needs clothes for various reasons. However, the traditional Igede cloth is more than an ordinary cloth. It is significant to the people. Its three colours of black, white and blue give brilliant cultural radiance that many non-Igedes sincerely admire. The symbolic nature of the cloth goes thus:

(a) Black (Onyobiri tai tai): This means that the heart of an Igede man cannot be understood easily. It gives the feeling of perspective and depth of the Igede mind. By this, he can be trusted, confided in and relied upon (Agogo, 2018).
(b) Blue (Onyobiri): This signifies honesty, loyalty, sincerity and calmness. It means an Igede man is full of wisdom, royalty and composed confidence. Whenever he speaks, the audience listens (Agogo, 2018).
(c) White (Onyoru): It means purity, faith, transparency and safety. It portrays trustworthiness and faithfulness in an Igede man. These truthful combinations give a total Igede man, who he truthfully is, honest and hardworking (Agogo,2018).

Figure 4.17: Igede Symbols

**Circular Hut:**

An Igede man lives in a round hut so as to know what goes on among his kindred. They take turn to work in each other's farm until it goes round (circular). The huts are clustered together for security reasons; what affects one affects the others. Children of the same father sit round a plate of food to eat. This implies that the circular figure holds a big importance in Igede kingdom.

**Rectangular/Squared faced blocks:** The circular hut is gradually giving way to the huts built with rectangular or squared faced blocks.

Figure 4.18: Blocks for Building Houses

**Conical Roofing**

The circular huts are covered by conical thatched roofs. This gives the hut the cool atmosphere experienced under it. This gives a structure of a solid with a circular base surmounted by a conical top.

Figure 4.19: Conical Roofs of Igede Houses

**Applications**

The cylindrical walls and the conical roofs could be used to introduce the concepts of cylinders and cones in geometry

**Activity 4.3**

1. The cylindrical wall of an Igede House has radius of 2m and height 3m. Calculate the area of the wall

2. A conical roof of a house has base radius of 3m and height 2m. Calculate the volume of the roof.

3. A bag of cement is used to mold 45 blocks in Igede land. If a man buys 50 bags of cement, how many blocks will he get?

**Leaf (Okootu)**

This leaf signifies peace. In time of crisis, once the leaf (of okootu) is raised up, this means the person is for peace, not for trouble hence the person is left unhurt.

**Even Number of Items**

In Igede kingdom, two or four or even number of items (e.g. kolanuts) must not be presented to a guest; rather, one or three or odd number is preferred. Even number of items signifies slavery.

**Counting in Igede and Idoma Lands**

Throughout the history of mankind, people needed to count. In every ancient time, a farmer carried pebbles or stones to help him count his heaps or tubers of yam. In a bag, a pebble represents a tuber of yam. By matching each pebble to a tuber, the farmer could see if any of his yams were missing. However, a farmer could not say how many tubers of yam he had because there were no words for numbers.

Later on, people began to use words instead of things to answer the question 'how many?'. For example, some people used the word for 'hand' to mean five things. Every primitive civilization had a set of words like this, but the idea was the same. People recognized that there was something similar, for example, five tubers of yam or cassava, five pebbles and a hand. This was the beginning of numbers.

Finally, people began to put the names of the numbers in order so that they could count things. Instead of using pebbles, a farmer could say the word for 'one, (at least in his mother's tongue), followed by the word for 'two', then the word for 'three', and so on. This was the beginning of counting systems, also called number systems. Over time, different people in different parts of Benue state developed different counting systems.

Today, we call the system of counting in Igede kingdom a decimal system, because it is based on the number ten. This system is interesting because it is similar to the modern system we use today.

In Igede kingdom, counting from one through ten is as follows:

| | |
|---|---|
| One | Opopo |
| Two | Imiye |
| Three | Ita |

| | |
|---|---|
| Four | Ine |
| Five | Eho |
| Six | Erogen |
| Seven | Iruye |
| Eight | Ineku |
| Nine | Ihikiku |
| Ten | Inio |

In Idoma land, counting from one through ten is as follows:

| | |
|---|---|
| One | Eye |
| Two | Epa |
| Three | Eta |
| Four | Ene |
| Five | Eho |
| Six | Ehili |
| Seven | Ahapa |
| Eight | Ahata |
| Nine | Ahane |
| Ten | Igwo |

We live in a world of numbers. We use numbers in many different ways, but the simplest use is for counting. When we count the number of items in a group, we begin with the number 1 and continue with 2, 3, 4 and so on. For this reason, we call the numbers 1,2,3,4,etc. counting numbers. The set of counting numbers is called the set of natural numbers (denoted by $\mathbb{N}$).

**Application**

Igede counting system could be used for number and numeration in the classroom. It could also be used to teach number bases especially base five.

**Activity 4.4**

1. Convert the following to base 5: 4, 5, 7, 10, 14, 15
2. The sum of four consecutive natural numbers is 38. Find the numbers.

**Solution**

Let the first number be n. The next three will be n+1, n+2, and n+3.

So $n + n + 1 + n + 2 + n + 3 = 38,$ this means $4n + 6 = 38\ , i.e. n = 8.$

Therefore, the numbers are 8,9,10, and 11.

3. A two-digit natural number is equal to twice the sum of its digits. Find the number.

**Solution**

Let ab be the two-digit number, where a and b are digits.

$$ab = 2.(a + b)$$

$$10a + b = 2a + 2b$$

$$8a = b$$

Since a and b can only have a value between 0 and 9 inclusive, we get $a = 1\ and\ b = 8.$

So ab = 18.

In this activity, note that ab stands for a two-digit number, not the product a.b .

4. Prove the statements

a. The sum of two even numbers is even.

b. The sum of two odd numbers is even.

**Solution**

a. Let $n_1\ \ and\ n_2$ be two even numbers.
   Then $n_1 = 2k_1\ and\ n_2 = 2k_2(n_1, n_2\ \epsilon\mathbb{N}).$
   Hence $n_1 + n_2 =\ 2k_1 + 2k_2 = 2(k_1 + k_2)$
   We can now write $k_3 = k_1 + k_2\ \epsilon\mathbb{N}\ so\ \ n_1 + n_2 =\ 2k_3.$
   This is an even number, which proves the statement.

b. Let $\ m_1\ \ and\ \ m_2$ be two odd numbers.
   Then $m_1 = 2k_1 - 1\ and\ m_2 = 2k_2 - 1\ \ (k_1, k_2\ \epsilon\mathbb{N}).$
   Hence $m_1 + m_2 =\ 2k_1 - 1 + 2k_2 - 1 = 2(k_1 + k_2 - 1\ ), and\ \ k_1 + k_2 - 1 = k_3\epsilon\mathbb{N}.$
   Therefore the sum $m_1 + m_2 =\ 2k_3$ is an even number.

5. How many digits do the number $616.2^{21}.5^{22}$ have?

**Solution**

To find the number of digits, we need to express the number as a power of 10.

$616.2^{21}.5^{22} = 308.2.2^{21}.5^{22} = 308..2^{22}.5^{22} = 308.(2.5)^{22} = 308.10^{22}$

$308.10^{22}$ means 308 followed by 22 zeros. So the number has 25 digits.

**Igede – Women**

Igede women are home builders and binding force in the community. In a communal settlement of Igede families, women look after children while the men go to farms and hunting. Women help to preach morality to the children. The Igedes live in polygamous homes and the women live in harmony with their fellow wives. Polygamy is welcomed because of enormous farming activities by the men. More wives and children help in farming activities. The Igede land is very fertile.

Women are the rallying points of Igede families. They go to market to sell the farm produce for their families.

Women form groups to help themselves in their farming activities. They form dancing groups to entertain people during any ceremony and also entertain themselves in the evening hours.


Figure 4.20: Some Igede Women During a New Yam Festival

The Igede women have the challenge of their girls being taken to cities as house helps without good education

Generally, the Igede people are known for the respect of their cultural practices such as honest, hardworking and purity.

The above mentioned attributes are also the attributes of their women and are known for their togetherness, eat together and live in oneness. They have Nuclear family system, they built their houses in huts which are spherical and cone shapes.

They settle in round forms so that it foster unity and security; and for agricultural reasons.

Women are not allowed in their traditional kingdom to hold any title conclusively, the Igede women are honest, trustworthy with integrity and sincerity.

Conclusively, the Igede women are honest, trustworthy with sincerity and integrity.

**Applications**

This could be used to teach operations on numbers, commercial arithmetic and Proportion in the mathematics classroom.

**Activity 4.5**

1. An Igede man married three wives and each of the wives has five children. How many people are in the man's nuclear family?

2. An Igede woman took 40 tubers of yam to market and sold each tuber for N500. She spent N2000 for transportation. How much money would she take back home for her husband if there were no other expenses.

3. A group of 5 Igede woman can harvest the maize in a farm in one day. How many days would it take an Igede woman to harvest the maize in the farm at the same rate?

4. An Igede woman bought 20 tubers of yam for N15,000.00 and sold them for N21,000. Calculate her percentage gain.

**Market Days**

Igede women are very industrious in farming and selling their produce on market days. In the olden days they carry out their selling in "trade by barter". This is a system whereby one exchanges her farm produce with another farm produce from another woman which does not involve money. ie. give items in exchange for another items. As civilization advances, they started using cowries.

The Igede people have five (5) market days meaning having five days in a week. The market days are Ihigile, Ihio, Ihiobula, Ihijwo and Ihiokwu. The most popular market is Ihigile and the least popular is Ihiokwu. Igede people honour these markets as found in all the clans of Igede. Justice on any offence committed is done on market day, called Alegwu and only men operate on that day. Hence their market days are in modulo 5 mathematically; ie, 0, 1,2,3,4. Day "0" is the market day. Their women also involve in weaving of cloths, beads, shoes and caps which they carry to the market for sales.

Igede people are into professions such as Farming, fishing, trading, palm wine tapping, craft making, Blacksmithing, weaving of Igede traditional clothes, hunting etc. The products of these professionals are taken to market for sales.

**Activity 4.6**

**Modular Arithmetic**

The teaching of modular arithmetic can be taught using the market days, gestation periods and menstrual cycles.

- The market days in modulo 5 or mod (5).
- The gestation period in pregnancy is nine months which is in mod (9)
- The menstrual cycle has 28 days ie. in mod (28).

If the market day in Igede land is held on Tuesday when will it be the next market day?

Solution

Draw a table of the days in a week

| DAYS | SUN | MON | TUE | WED | THUR | FRI | SAT |
|---|---|---|---|---|---|---|---|
| | | | 0 | 1 | 2 | 3 | 4 |
| | 1 | 2 | 3 | 4 | 0 | | |

The next market day will be on Thursday i.e. 5/5 = 1 Remainder 0

(1) The zero day is the Market day. In Modular Arithmetic, we are always interested in the remainder as the answer.

(2) Gestation period in any mammal is the period between the conception and Delivery of their new born babies. In human beings it is normally nine (9) Months i.e. 9/9= 1Remainder 0, Zero as the answer, is the date of delivery of the baby
(3) Menstruation is the biological process in every matured women whereby, the unfertilized eggs in the ovaries are released as blood every 28 days; called Menstrual Cycle

Example

If a lady saw her period on 5th of the Month when will she see her next period if there are 28 days in a menstrual circle?

**Solution**

There are 28 days in the menstrual circle. Draw a table of the days in a month.

| DAYS | SUN | MON | TUE | WED | THUR | FRI | SAT |
|---|---|---|---|---|---|---|---|
| | 5(0)DAY 0 | 6 | 7 | 8 | 9 | 10 | 11 |
| | 12 | 13 | 14 | 15 | 16 | 17 | 18 |
| | 19 | 20 | 21 | 22 | 23 | 24 | 25 |
| | 26 | 27 | 28 | 29 | 30 | 31 | 1 |
| | 2 | 3(DAY 0) | | | | | |

The next period would be on 3rd of the Month. Therefore, 28/28= 1Remainder 0

**Activity 4.7**

1) If today Tuesday is Ihigile market, which day of the week will be the next Ihigile Market day
2) If today is Friday, which day of the week will be 26 days' time?
3) A pregnant woman has 32 days more to deliver her baby. If today is Monday, which day of the week will she deliver her baby?
4) What will be next day of the menstrual period of a lady that saw her period on the 10th of August in September if there are 28 days in a menstrual circle?

**Marriage Tradition**

Literally, marriage is the union between a matured man and a woman to become husband and wife.

In Igede land, the matured man and lady both accept kolanut in odd numbers ie 1,3,5,7, a jar of palmwine or Burukutu. This would be followed with the payment of dowry. The men, women and youths are given certain amounts. The amount paid to the family is shared between father and mother in the ratio of 2:1 between the father and mother of the girl.

In the olden days marriage was contracted when a man saw a lady and shoots gun three times in the public and uses the gun powder to rob the chest of the girl.

**Applications**

1. Teaching of Odd Numbers: The practice of presenting Kolanuts in odd quantities could be used to teach odd numbers in Mathematics and the progression of odd numbers

2. Teaching of Ratio: The sharing of dowry between father and mother in ratio of 2: 1 could be used to teach ratios in the classroom

**Activity 4.8**

1. Identify odd numbers among the following 5, 8, 7, 6, 12, 17

2. A man paid N60,000 as dowry to a family. How much will the father receive and how much will the mother receive?

3. Share 30 oranges between John and Peter in ratio of 1:2.

**Cultural Dances in Igede Land**

The people of Igede respect and value their cultural practices. At various practices they have several dancing groups which they use to entertain people. Some of their dancing groups include Aita, Ogirinye, Omeme, Obume, Akatanka, Ogbete, Onyanfu, Ihi and Adiya. The dance staps are performed vigorously in tone with the beating from the drums, flutes or the Gong. The Instruments used for most of the dances are Ogirigho (Gong), Icheche (Shakers), Uba(Eba) Talking drums, Oko (Flute) and Ekwure (Trumpet).

Figure 4.21: Drums in Igede Land

The women entertainment dance is called “Ihi” dance in Igede language. It is carried out in the evenings. It involves only young and old women. They only use their hands by clapping, called “Adiya” dance, and dancing without drums, dancing in circular form ie. in circle.

Figure 4.22: Dancing Groups in Igede Land

Their women also have “Agba” dance. This is a venue where the ladies pick their husbands, however, their women are educationally disadvantaged.

**Applications**

1.The dance style in circles could be used to teach the concept of circles I the class and is properties such as circumference, radius, arc etc

2. The upper surface of the drums are circular in shape and some drums have cylindrical shapes. These could be used to teach geometry in the classroom

3. Hiring of the dance groups could be used to teach commercial arithmetic

**Activity 4.9**

1. A dance group formed a circle with radius of 5m. Calculate:

a. the area of the circle

b. the circumference of the circle

2. If it costs N25,000 to hire an Igede Dance group to perform at a ceremony in a day, how much would it cost to hire for sic ceremonies on six different days

3. The cost of musical instruments in Igede land are as follows: Ogirigho (Gong) = N5,000, Icheche (Shakers) = N3,500, Uba(Eba) Talking drums = N4,500 Oko (Flute) = N7,000 and Ekwure (Trumpet) =N12,500. A Philanthropic in the community wants to buy the instruments for five Dance groups. Calculate the total cost.

**New Yam Festival in Igede Land**

The people of Igede observe their new yam festival annually according to their tradition. The activities include traditional dances, cooking competition, exhibition of farm produce and farm implements, cultural displays, lectures and other activities.

Figure 4.23: The King, Queen and some Dignitaries at a New Yam Festival


Figure 4.24: Cooking Competition Banner at the New Yam Festival


Figure 4.24: Cooking Competition at the New Yam Festival

Figure 4.24: Some Masquerades at a New Yam Festival

Figure 4.25: A Traditional Group at a New Yam Festival

CHAPTER FIVE

# NSUKKA CULTURE AND THE MATHEMATICAL IMPLICATIONS

## Introduction

Nsukka people are found in the Northern part of Enugu State. The Local Governments that make up Nsukka are Nsukka, Uzouwani, Ugbo-Eze, Ude-Enu, Igbo Eze North and Igbo Eze South. The people of Nsukka have their peculiar culture and Language. History has it that the people migrated from Idah in Igala land due to war.

Figure 5.1: Interview with an Nsukka man at Aku

Figure 5.2: Interview with some Teachers at Aku


Figure 5.3: Sign Post at Aku

**Nsukka Counting System**

In the past, the Nsukka people counted using sticks, stones and cowries. They counted in base ten arithmetic and sometimes in base five. The Counting system is as follows;

| | |
|---|---|
| Otu | 1 |
| Abua | 2 |
| Ato | 3 |
| Enuo | 4 |
| Ise | 5 |
| Ishi | 6 |
| Asa | 7 |
| Asato | 8 |
| Itenin | 9 |
| Iri | 10 |
| Iri le otu | 11 |
| Iri-abua | 20 |

**Applications**

The counting system is relevant in the teaching of number and numeration in the classroom. It could also be used to teach number bases.

**Activity 5.1**

1. Convert the following numbers to base five: 4, 5, 7 , 12, 16, 20

2. Convert the following in base five to base ten arithmetic: 11, 24, 32, 40, 43

**Nsukka Market Days**

Nsukka has four market days namely: Eke, Orie, Afor, and Nkwo

**Applications:**

This could be used to teach Modular Arithmetic in schools.

**Activity 5.2**

1. If today is Monday and is Afor market day, which market day will it be in 23 days time?

2. A man discovers that his birth day is 30 days time from today being Nkwo market day. Which market day will be his birth day?

**Occupation**

The main occupation of the people of Nsukka is farming. They produce cash crops and other crops including palm trees, kolanuts, plantain, cassava, cocoyam, banana, pear, vegetables etc . The men tap palm wine and harvest palm nuts while the women produce and sell the palm oil. Some other occupations of Nsukka people are trading, pot making, blacksmith, mortar making.

Figure 5.4: Nsukka Mortar and its Pestle

Figure 5.5: Pots made in Nsukka

**Applications**

The occupation of Nsukka people could be used to teach Commercial arithmetic, ratio and proportion in schools:

**Activity 5.3**

1. If an Nsukka family produced 45 gallons of 20 litres of oil in a year and each gallon of oil is sold for N9,500, how much will the family get after selling all the 45 gallons?

2. If it takes an Nsukka man two days to produce a mortar, how many mortars will he produce in 30 days?

3. A bunch of plantain is sold for N1,500. If a family produces 75 bunches in a farm, how much would the family get?

## Marriage

The first stage of marriage between a girl and a man is agreement between them and between the two families. This is followed by marriage ceremonies. Some of the items required for marriage include: 50 Kolanuts, Jars of palm wine, Cartons of beer, N20,000 for the Parents, N5,000 for Umunna (Male Relations), N5,000 for Umuada ( Female Relations) and Female youths N2,000.

After the payment of the bride price, a day is set aside to take the bride to the groom's house. On that that day the people accompanying her to the house and the family are entertained. The bride's family is presented with one leg and neck of a pig, nine tubers of yam, clothe and N2000.00. Out of these, the mother takes the neck of the pig, one clothe and three tubers of yam. The rest are shared to other members of the extended family. When a bride returns to the groom's house, she is given broom to sweep the compound and she would be given some money in return.

To regulate the bride price, some communities fix the bride price for all marriages. For example the Aku General Assembly makes laws on marriage and is binding on all the people of Aku town. In a family the junior female siblings must wait for their senior sisters to marry before getting married.

## Activity 5.4

1. For any bride price paid at Nsukka, the parents get N20,000 while the youths get N2000. Calculate the ratio of the share of the parents to the youths.

2. If the amount paid to parents is raised to N50,000 (based on the ratio in question 1), how much would the youths receive?

**Inheritance**

The first son inherits the main house but he can share it with other brothers. Women are not allowed to inherit any property. In a situation where there is no male child, the first daughter must stay behind in the family to have a male child before marriage.

**Festivals**

Some of the annual festivals include New yam festival held in August, Orie-Ogba festival where big masquerades perform and Akatakpa festival.

**Houses**

The houses are rectangular in shape with thatched roofs or Zinc.

Figure 5.6: Nsukka Houses

Figure 5.7: Thatches for Nsukka Houses

**Dressing**

The chiefs wear red cap while others wear any other colour. Men wear Agbada and the women wear George.

**Traditional Worship**

Some Shrines like Ohe and Adoro make people in the society to be upright, not to kill, tell lies, take bribe, commit adultery etc.

**Dances**

The various dances in Nsukka include:

**Atiliogwu Dance** - By young males and females.

**Ikorodo Dance** - This is for elders and they dance in circular pattern. They use elephant tails, flutes and drums.

**Akunecheinyi** - This is for youths.

**Ogene** - for youths.

Figure 5.8: Iron gong (Ogene) made in Nsukka

The instruments for dance include Gong, Ududu, Osha, Igba or Abia. The people dance forming parallel lines or in circles

# Concluding Remarks

## Discussion of Results

The results of our field-testing of the Agbari module both at IMSA?? and with local Agbari children at the Gbari Centre for Research and Documentation showed that the use of cultural materials and women stories improve the academic achievement of both male and female students in Geometry. This supports the finding by Kurumeh (2004) that the use of Ethno-mathematics improves the achievement and interest of students in Geometry and Measurement (Kurumeh, 2004). It also lends support to Aprebo's (2016) recommendation that the use of teaching aids in our environment for Mathematics teaching and the use of African objects as examples in the teaching of Mathematics make the learner to bring out the mathematical bit in any subject that he/she handles and make him/her to see the mathematical composition in any object he or she sights. Also, it supports Ugwuanyi (2014) who opined that the use of instructional materials in Mathematics reduces to a large extent the abstract nature of many mathematical concepts. When the Mathematics topics are made less abstract, the understanding and retention of students are improved upon and this leads to higher academic achievement.

The results of our field-testing of the Agbari module at IMSA??? also shows the mean score of students in Geometry is higher than that of the female students but there is no significant difference in the mean post-test mean achievement scores in Geometry between the male and female students taught with the use of cultural materials and women stories. This finding supports some researchers (Atovigba, Vershima, O'kwu&Ijenkeli, 2012; Ali, Bhagawati&Sarmah, 2014) who found out that male students perform better than female students in Mathematics, and Timayi, Ibrahim and Sirajo (2016) who in their study found out that there was difference in the mean and standard deviation scores of male and female students in favour of the males students in geometry test but the observed difference was not statistically significant with regard to achievement and gender interaction. However, these results does not support some other researchers (Linderberg, Hyde, Perersen&Lin (2010) who reported that gender differentials among males and females is converging; hence, they perform similarly.

## Conclusion

From the results of our field-testing of the Agbari module at IMSA, the use of cultural materials and women stories in teaching Geometry improves the academic achievement of students in general, irrespective of the gender of the students. Also, although the post-test mean score of students in Geometry is higher than that of the female students, there is no significant difference in the post-test mean achievement scores in Geometry between the male and female students taught with the use of cultural materials and women stories.

**Recommendations:**

It is hereby recommended that:

a) all Mathematics teachers should adopt the use of cultural materials and women stories in the teaching of Geometry in secondary schools.

b) all Mathematics teachers should be made to undergo a capacity building workshop on the use of cultural materials and women stories in the teaching of geometry in secondary schools.

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