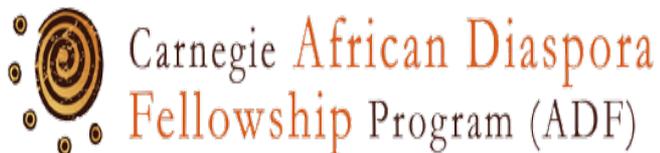


Mathematical Storytelling: Fostering Creativity, Innovation, Gender Equity, Cultural Awareness and Entrepreneurship

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2020 British Joint Mathematics Meetings

Black Heroes of Mathematics Conference

Keynote Presentation

- Mathematical Storytelling – My brand
- My Mathematical Story & Related Activities
- Carnegie African Diaspora Fellowship Project
- Mathematical Story-Telling of NiWARD Women by High School Girls and BMCC Students
- Project Curricular Activities Based on NiWARD
- Acknowledgements & Books
- Thank you: Africa ~ The Silent Curriculum



Mathematical Storytelling – My Brand

Mathematical Storytelling is an innovative procedure that uses mathematical tools, concepts and theories, indigenous knowledge systems, and cultural artifacts (dolls, games, textiles, architecture, and so on) to tell stories about people and communities in a manner that fosters creativity, innovation, cultural awareness, gender equity and entrepreneurship (Agwu, 2014).



My Mathematical Story & Related Activities



“I am Nkechi (an Igbo name meaning God’s Own), represented spiritually as the feminine form of the Trinity, three in one. I am personified mathematically as an infinite number of concentric similar equilateral triangles and the infinite triangular sequence. Interestingly you will find patterns of concentric similar triangles in threesome on the columns in the Coronation Hall of the Deji’s Palace in Akure Kingdom, Nigeria. To know me you need to understand the properties of this three sided regular polygon and of this infinite sequence that is the third diagonal on the Pascal’s Triangle. Like Georg Cantor, Father of Set Theory, I am interested in how Mathematics reveals the existence of God as The Absolute Infinite. The Absolute Infinite inspires my creative mind, the mind of Nma (Beautiful in Igbo) Jacob, the author of *God’s Own: The Genesis of Mathematical Story-Telling*” and Founder of CHI STEM TOYS Foundation where we plant seeds of creativity, innovation and entrepreneurship in children, youth, women and vulnerable groups of people in rural communities.

Three curricular activities derived from this story line.

1. Construct three concentric similar equilateral triangles on a column to represent three generations of Nkechi (vertices of the triangle) – Jacob (her father), Nma (Beautiful) Jacob (Nkechi) and Jacob (her son)?
2. Prove by induction that the sum of the first n terms in the triangular sequence is the tetrahedral number given by $[n(n+1)(n+2)]/6$.
3. Create the sequence of sums in #2 for the powers of 10, viz., $n = 1, 10, 100, 1000, 10000$ and so on? Try using powers of 2 or powers of 3 instead?



My Mathematical Story & Related Activities



“I am a Black Madonna represented as an Ndebele Doll of Our Lady of Africa. The Ndebele people from Southern Africa have a highly mathematical lifestyle. Traditionally, both men and women of all ages create Ndebele Dolls for different purposes, such as rite of passage, engagement and so on. The High Priest of Akure Kingdom told me I wear “The Garment of Africa” when he interviewed me to grant access to the Kingdom for my Carnegie Ethnomathematics Project. My Ndebele Doll representation is crowned with fertility yams tied with five strings of five cowrie shells to represent my wealth and my Hidden Passion Number five, the spiritual number of grace and favor. In the tradition of my ancestors who were farmers, as a 10th generation farmer, I am planting seeds in an uncharted creative realm with faith in The Absolute Infinite (God) to birth a great harvest. My Ndebele Doll representation is beautifully dressed in the traditional Igbo Akwete cloth normally woven by women, filled with symmetrical and asymmetrical patterns of equilateral triangles, cycles, wheels, trees and complete graphs, sequenced periodically.” (Adapted from *God’s Own: The Genesis of Mathematical Story-Telling*)

Three curricular activities from this story line

1. Construct my Ndebele Doll representation of Our Lady of Africa as described.
2. Draft a cost spreadsheet for creating 12 disciples of Ndebele Doll representations of Our Lady of Africa, include labor costs as Slavery has been abolished.
3. Using the Pythagorean Cipher, prove that five (the modal number) is my Hidden Passion number based on my birth name – Nkechinyere Madonna Adeline Agwu.



Carnegie African Diaspora Fellowship Project

- Carnegie African Diaspora Fellowship 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 Education (2014-present)

- A collaboration between an African diaspora mathematician and an African institution

Centre for Gender Issues in Science and Technology, Federal University of Technology, Akure (2014) and National Mathematical Centre, Abuja (2015 – present)

- Capacity building of African women in STEM:

Began with Mathematical Storytelling of the Nigerian Women in Agricultural Research for Development (NiWARD) and has extended to other successful women in STEM and the traditional work of rural women in Africa that is STEM related.

- Development of Gender based and Cultural Heritage curricular activities in Mathematics

This presentation will focus on NiWARD curricular activities



Outcomes: Ndebele Doll Exhibits, Women's Stories & Curricular Activities



Dr. Agwu with seven Ndebele Dolls

Seven Ndebele doll sculptures created by BMCC students in a Discrete Mathematics class. Illustrated on these dolls are various types of vertex-edge graphs and number patterns based on the students' analysis of biographies of the women that these dolls represent. These seven dolls represent the following subset of NiWARD: Dr. Mojisola Edema, Dr. Joy Odigmegwu, Dr. Omobolanle Temitope Ogunlolu, Dr. Olayinka Ogunsuyi, Dr. Nusirat Aderinsola Sadiku, Ms. Olabukunola Williams and Dr. Stella Williams. **Why seven?** The number seven in this picture is significant in the African context. It is the number of completion or perfection. For the Gbari people it is the number of a kingship cycle. It also represents the seven weeks in a month in the Igbo Calendar.

Illustrating Vertex-Edge Graphs and Number Patterns in the Lives of NiWARD Women



Mathematical Story-Telling of NiWARD Women by High School Girls



Activity I – Graph Theory Based on Women Farmers of Ossomala with NiWARD Woman and AWARD Fellow Dr. Joy Odimegwu



Vertex-edge Graphs, Coloring, Counting Principles and Ndebele Dolls Questions:

1. How many women are in this picture?
2. How many vertices and edges are there in the longest horizontal path(s) in this picture?
3. Create an Ndebele doll collection representing all the women in this picture, so that each woman can receive her Ndebele doll to keep on her farm as a source of good harvest?
4. Convert this picture of women into its associated vertex-edge graph and color the graph for its Chromatic number?

“My AWARD role modeling event took me to a village in Anambra state where they never had access to improved varieties of cassava and yams, their main produce. So in collaboration with Dr. Okechukwu of IITA, I took several varieties of improved cassava stems and distributed to the women farmers in the village” – (adapted from *Innovating the Rural Space in Nigeria Agricultural Development*, 2013).



Activity II – Cryptology Using the Life of Dr. Nusirat Aderinola Sadiku

Using the Pythagorean Cypher given below, answer the following questions:

- Write the name of the AWARD/NiWARD woman, Dr. Nusirat Aderinola Sadiku.
- Write the phrase “Best Farmer of the Year”, an award she received
- Decode the sequence “595194”
- Find the modal (Hidden Passion Number) of Dr. Nusirat Aderinola Sadiku
- The art of Ndebele people is very colorful and the people are known traditionally to send color coded messages. Now you have some basic knowledge of cryptology, develop a cypher based on color coding.
- Construct an Ndebele doll sculpture of Dr. Nusirat Aderinola Sadiku that will carry a coded message on her hijab of “Best Farmer” using the color cypher you developed.



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	



Activity III – Yoruba Conversion Rate for the Cowrie Based on Olabukunola Williams and Dr. Binta Iliyasu



Ms. Olabukunola Williams is the Coordinator of the Nigerian Women in Agricultural Research for Development (NiWARD). Prior to that, she was the Darfur Dream Team Sister Schools Program Manager at Enough Project, a project of the Center for American Progress to end genocide and crimes against humanity.



Binta Iliyasu grew up in northern Nigeria, where she was among the third primary class to ever be established in Bari, Rogo local government area in Kano State. “Education was delayed in getting to our region,” she says. “But my parents were enlightened by the missionaries about its importance, and they risked sending me and other girls to school.” At age 9, as she prepared to write primary boarding school entry exams, the women from her village pressured Iliyasu to give poor answers to the questions. “They tried to brainwash girls against education, but I went ahead and wrote the exams and passed,” she recalls. “I am thankful that my parents’ hearts were turned toward education. They were undaunted.”



Yoruba Conversion Rate for the Cowrie (African Traditional Currency)

Commerce is the activity of buying and selling, especially on a large scale. In the past, cowrie shells were the basic unit of currency in Africa. Cowries were either counted in groups of five or pierced and threaded in strings of 40, according to the traditional Yoruba system for counting cowries.

40 cowries = 1 string;

2000 cowries = 1 head or 50 strings;

20,000 cowries = 1 bag or 10 heads.



Activity III – Yoruba Conversion Rate for the Cowrie Based on Olubukunola Williams and Dr. Binta Iiyasu

- Dr. Binta Iiyasu has 18 cowrie heads and 9 times more cowries than Ms. Olubukunola Williams. Using the Yoruba Conversion Rate for the cowries given above, where applicable, answer the following questions.
- How many cowries does Ms. Olubukunola Williams have?
- How many cowries in total do both Dr. Binta Iiyasu and Ms. Olubukunola Williams have?
- If Ms. Olubukunola Williams donates 10% of the strings of her own cowries to buy bags of garri to feed orphaned girls at Jacob's House of Dr. Agwu at Agbakoli Alayi in Abia State, Nigeria, how many strings of cowries is she left with?
- If Dr. Binta Iiyasu uses 20% of her cowries to purchase supplies for rural women in Bari, Rogo local government area in Kano State to produce Hijabs, how many cowries is she left with?
- If a plot of farm land in Ota costs two strings, how many plots of farm land can Dr. Binta Iiyasu buy with 50% of her cowries? How many plots of farm land can Ms. Olubukunola Williams buy with the remaining 90% of her cowries?
- What percentage of cowries does Dr. Binta Iiyasu have remaining after the purchase of Hijabs and farm land?
- If Dr. Agwu is selling an Ndebele doll sculpture of Ms. Olubukunola Williams for a string, how many Ndebele doll sculptures of Ms. Olubukunola Williams can Dr. Binta Iiyasu buy to donate as birthday presents for the orphan girls at Jacob's House of Dr. Agwu at Agbakoli Alayi in Abia State, Nigeria, with the remaining percentage of her cowries after the purchase of Hijab supplies and farmland?



Acknowledgements & Books

- Amsterdam News, September 22, 2016 (<http://amsterdamnews.com/news/2016/sep/22/stem-program-focuses-mathematical-storytelling/>), WHCR Harlem 411, October 7, 2016 and Co-op City Times, April 8, 2017
- Bende Analyst Newspaper, October 11, 2016 (<http://www.bendeanalystnewspaper.com>)
- Borough of Manhattan Community College, City University of New York, New York, USA
- Carnegie Foundation and Institute of International Education, USA
- Centre for Gender Issues in Science and Technology, Federal University of Technology, Akure, Nigeria
- Drammeh Institute, New York, USA
- Graceland Primary and Secondary Schools of the Anglican Diocese of Gusau, Zamfara State, Nigeria
- Jacob Agwu Memorial Vocational Education and Entrepreneurship Center
- National Mathematics Centre, Abuja, Nigeria
- New Covenant Dominion Ministries High School
- Nigeria Masterweb, USA
- Nigerian Women in Agricultural Research for Development, Nigeria
- Nigerian Women on the Move Magazine, Lagos and Abuja, Nigeria
- Palace of the Deji of Akure Kingdom, Akure, Nigeria
- Pan-African Strategy and Policy Research Group, Lagos, Nigeria
- RUFORUM Conference and Higher Education Week
- Worldwide Association of Small Churches

Books

- ***God's Own: The Genesis of Mathematical Story-telling***, ISBN 9781523678129
- ***The Grace of Dr. Mrs. Mojisola Edema: A Visionary and a Reformer***, ISBN 978153001148



THANK YOU

Africa ~ The Silent Curriculum

The silence is a myth
My mathematical tradition is in my everyday life
Everywhere you look, you will find it
It is in my clothing – ceremonial and everyday
It is in my spirituality
It is in my architecture
It is in my warfare
It is in my art
It is in my music
It is in my food
It is in my healing traditions
It is in the work of my grandmothers, mothers and daughters
It is in my identity, who I am
You have got to understand me
To understand the nature of my mathematics
Look deeply and you will see I am the cornerstone
~ Rev. Nkechi Madonna Agwu, Ph.D.

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