

A Mathematical Akwete: Innovation, Technology and STEM Education

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A Mathematical Akwete: Innovation, Technology and STEM Education

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Introduction

- African people face the urgent need to foster world-wide education about their mathematics, science, technology, history and culture (Gerdes, 1998)
- The contributions of Africans other than those related to the early beginnings of Algebra and geometry in ancient Egypt, are still highly unacknowledged in the history of science and mathematics (Lumpkin, 1997)
- Becoming aware of career opportunities in STEM fields and the various pathways to success in these fields are helpful avenues for nurturing, grooming and mentoring African children and youth, particularly girls, into STEM related fields and teaching, as well as, showing them how they can make positive contributions to society (Agwu, 2010)

Mathematical Storytelling & The Ndebele People

- Mathematical story-telling is an innovative procedure I developed that uses mathematics tools, theories and concepts; indigenous knowledge systems; and cultural artifacts (African dolls, games, textiles, architecture, and so on) to tell stories about people and communities (Agwu, 2014)
- The Ndebele people are an ethnic group in the southern part of Africa whose life-style is highly rooted in mathematics, viz., geometry, number patterns, vertex-edge graphs, cryptology, and so on (Mosimege, 2004)
- The Ndebele people use dolls in highly symbolic ways and all members of the community (male and female of all age groups) create and use them in a variety of ways, for right of passage, engagement, fertility, intermediaries, and so on (Agwu, 2015)
- Many African ethnic groups (Gbari, Igede, Yoruba, Igbo, Hausa, Fulani and so on) have indigenous knowledge systems similar to the Ndebele people, that are being examined by this project (Agwu, 2015)

Carnegie African Diaspora 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 two African institutions
 - Federal University of Technology, Akure
 - National Mathematical Centre, Abuja
- Capacity building of African Children in STEM:
Uses the procedure of mathematical storytelling based on African Indigeneous Knowledge Systems & Ndebele Doll Sculpturing of Members of the Nigerian Women in Agricultural Research for Development (NiWARD)

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. 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

Activity I - Women Farmers of Ossomala in Anambra State, Nigeria, 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) are 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 – From the Wind Energy Work of Dr. Olayinka Ogunsuyi

Dr. Helen Olayinka Ogunsuyi is a Senior Lecturer and Researcher in the Department of Chemistry, Federal University of Technology, Akure (FUTA), Nigeria. Her areas of research interest are clean energy technology with a special focus on biofuel (biodiesel and bio-ethanol) and extractive metallurgy adopting different hydrometallurgical techniques to recover metals and minerals from heavy crude oil e.g Bitumen deposits. The following sample curricular activities were developed based on her research endeavors.

Activity: Efficiency in Extracting Wind Power ~ Ratios, Proportions, Percent and Equations

Betz Limit and Power Coefficient

Definition of Power Coefficient, C_p - This is the ratio of power extracted by the turbine to the total contained in the wind resource.

Therefore, $C_p = P_T/P_W$

Formula for turbine power output

$$P_T = \frac{1}{2} * \rho * A * v^3 * C_p$$

Definition of Betz Limit

This is the maximal possible $C_p = 16/27$

Questions:

1. Convert the maximal possible $C_p = 16/27$ from a fraction to a decimal to two places of accuracy. Answer: 0.59
2. Convert the maximal possible $C_p = 16/27$ from a fraction to a percent rounded as a whole number. Answer: 59%



Activity III – 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”
- The art of Ndebele people is very colorful. 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 of “Best Farmer” using the cypher you developed in #5.



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	

Capstone Activity: Creative Writing Coronation Hall of the Deji of Akure

My Mathematical Genome: A Tale of Vertex-edges Graphs and Number Patterns

I Nkechi (God's Own) am many times an *Equilateral Triangle*. This is a three-sided polygon with all sides equal and all angles equal to 60 degrees. It is a vertex edge graph with three sides known as a three sided odd cycle or complete graph. Both types of vertex-edge graphs have the number three as their Chromatic number since each vertex is connected to the other two. As an advocate and spokeswoman for equity, justice and recognition for Global African Women in Science, Technology, Engineering and Mathematics (STEM) and for nurturing the African girl child to consider STEM related careers, my three connected vertices are equity, justice and recognition. In my scholarship promoting gender, class and cultural equity for the African continent in the history of mathematics and its uses for teaching and learning mathematics, my three connected vertices are gender equity, class equity and cultural equity for Africa. These are two isomorphisms or similar triangles for my scholarship on the Nigerian Women in Agricultural Research and Development (NiWARD) are immersed one on top of the other (inner and outer concentric triangles). They remind me of the triangular symbols on the columns that serve as the cornerstone in the Coronation Hall at the Deji's Palace in Akure Kingdom, Ondo State, Nigeria.

From the NiWARD Biography of Dr. Nkechi Agwu

Significance and impact

- Brings recognition to the mathematical indigenous knowledge of African people
- Enhances the literature in the history of mathematics and science in an area of dearth
- Brings recognition to women in STEM who have or are making a difference.
- Promotes the use of culture and women's stories in the teaching and learning of mathematics.
- Fosters creativity, innovation and entrepreneurship skills
- Encourages more children and youth, particularly girls to consider STEM related careers



Recommendations

- Africa needs to use cultural, creative and innovative methods as illustrated above to profile women and girls for further empowerment and sustainability of agricultural processes and other areas of STEM
- Improve the teaching of mathematics in Africa through the use of curriculum based on our indigenous knowledge systems
- Transform agricultural researches so that the African agriculture sector can feed Africa and the rest of the world by supporting STEM that will empower women and youths in the sustainability of agriculture

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

~ Nkechi Madonna Agwu, Ph.D.
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