Using Indigenous Mathematical Knowledge and Innovations to Solve Community Challenges: A Case Study of the Shona in the Shurugwi County of Zimbabwe

by

Silvanos Chirume
skchirume@gmail.com
Department of Mathematics and Statistics
Zimbabwe Open University, Midlands Region

Abstract

Using the researcher's personal experiences, ethnographic interviews, observations and literature search, this paper investigates whether the rural elderly Shona people in Zimbabwe believe they possess mathematical knowledge. Second, it investigates and critically analyses how the Shona the Shurugwi County of Zimbabwe use indigenous mathematical knowledge and innovations to solve challenges they meet in their daily lives. And third, it specifically analyses the mathematics involved in building, clay pot making, traditional medicine preparation and mixing ratios and proverbs used in poems and stories. In this, observation and experience show that some of the elderly are reluctant to share their knowledge about local medicine preparation methods, and mixing ratios applied to make some medicines. Hence, as a way forward, the paper recommends the sharing of mathematical indigenous knowledge by rural communities to solve local challenges, thus, academics and researchers should record and formalize indigenous knowledge as it may contribute to a bank of African knowledge suitable for African socio-economic development, and knowledge that may also benefit other people in the world. And in conclusion, it is argued that rural folk hold rich mathematical knowledge, and the use of inexpensive and user-friendly innovations for family upbringing and survival.

Keywords: Shona, rural people's mathematical thinking, ethno-mathematics, indigenous knowledge systems, mathematical innovations, community challenges, global challenges.

Introduction

Mathematics has been nicknamed the ‘queen and servant of science’ (Bell, 1961) probably because it rules over (or is more important or useful than) other subjects but at the same time ‘serves’ them. Therefore, it is also considered as a subject that human beings mostly use to solve their daily life challenges or as a subject that ‘counts’ a lot (Cockcroft, 1986). Mathematics is a subject of study whose content is the same worldwide but the way people use mathematical knowledge and innovations to solve local challenges may be different. According to Zaslavsky (1994, p. 6):

> Students should recognize that mathematical practices and ideas arose out of the real needs and interests of human beings. They should know that a great deal of the mathematics that they learn in elementary and secondary school originated in Asia and Africa centuries before Europeans were aware of more than the most elementary aspects of mathematics.

Why then is so much debate on whether there actually is ‘African ethnomathematics’ (Huylebrouck, 2006) or mathematical indigenous knowledge (MIK) for Africans? It may be because of colonialism and the rise and support of capitalism that “Most textbooks credit Europeans with the origin of mathematics and omit the contributions of non-Europeans” (Lumpkin, 1987, p. 2).

It could thus be argued that African communities possess mathematical knowledge and skills that they use to overcome challenges of shelter, food insecurity, risks to human health and the environment and shortage of recreation facilities. The mathematical operations or activities involved could be counting, measuring, drawing, constructions (building) or even more ‘complex’ ones like the Yoruba numeration system (Zaslavsky, 1994) or finding the length of the hypotenuse of a right angled triangle. These operations help them as they engage in activities such as hut building, clay pot making, medicine preparation and also recreational activities involving cultural riddles for mental mathematics (Chikodzi and Nyota, 2010) or proverbs and idioms used in, for example, Shona poems and stories.

According to Shona People Traditions and Culture (n.d.):

> The Shona people are Zimbabwe's largest indigenous group, their language is also called Shona (Bantu) and their population is around 9 million. They are found in Zimbabwe, Botswana and southern Mozambique in Southern Africa and bordering South Africa. Representing over 80% of the population, the Shona tribe is culturally the most dominant tribe in Zimbabwe. There are five main Shona language groups: Korekore, Zezuru, Manyika, Ndau, and Karanga. The Ndebele largely absorbed the last of these groups when they moved into western Zimbabwe in the 1830s.

Theoretical Framework

This paper is anchored on the theory of indigenous mathematical knowledge systems often called, among other terms, ethnomathematics (Gerdes, 1994) or sociomathematics (Zaslavsky, 1994; Wedege, 2010). According to Gerdes (1994, p. 347), "The concept of sociomathematics may be considered a forerunner of the concept of *ethnomathematics.* It is ethnomathematics as a discipline that studies mathematics (and mathematical education) as embedded in their cultural context." In particular, ethnomathematics includes the mathematics of different cultural groups of people as they engage in activities such as counting, locating, measuring, designing, playing, and explaining (Bishop, 1988). Sociomathematics is defined as, "… a concept addressing relationships between people, mathematics and society, which encompasses the studies of, for example, numeracy, ethnomathematics and workplace mathematics in a single term." (Wedege, 2010, p. 452). Thus one may conclude that different cultural groups possess different or similar mathematical knowledge, practices and beliefs which may have arisen out of the people's real needs or interests. It could be argued that the rich mathematical knowledge, skills and beliefs that the different ethnic and cultural groups have could be tapped, documented and shared among other people who might face similar challenges. The information could also be preserved as banks of African knowledge for African communities.

Conceptual Framework

The paper is hinged on the concept or idea that, "*There exists* "hidden" or "frozen" mathematics" (Gerdes, 1985, p.12) in the formerly colonised people of Africa. The hidden mathematical knowledge needs to be reconstructed or "unfreezed" (Gerdes, 1998) and then utilised. "Utilizing IK helps to increase the sustainability of development efforts because the IK integration process provides for mutual learning and adaptation, which in turn contributes to the empowerment of local communities" (Gorjestani, 2000, p. 2). From this brief conceptual framework and the theoretical framework outlined above, one may infer that rural people in Zimbabwe also posses rich mathematical knowledge, skills, attitudes, beliefs and practices which they use to solve their daily life problems and to meet their real needs and interests. What kind of mathematical knowledge, skills and beliefs do they possess? How can these 'possessions' be tapped and put to use in different cultural contexts and even in schools? This paper analyses 'what exists' and 'what works' in the mathematical indigenous knowledge systems of the Zimbabwean rural people, giving examples of the Shona speaking people living in Shurugwi county, in the Midlands Province of Zimbabwe where most of the people speak version of Shona called Karanga or Chikaranga.

It is believed that some important mathematical ideas and practices among rural people in Zimbabwe may have been lost due to colonisation or enculturation and one may, as Gerdes (1998, p.4) points out, "… try to reconstruct or 'unfreeze' the mathematical thinking, that is 'hidden' or 'frozen' in old techniques, like, e.g., that of basket making." MIK may also be used in the improvement of the education system, "…that is supposed to equip citizens with high quality cultural tools, skills and attitudes to keep up with the pace and innovations of cultural development" (van Oers, 2013, p. 267).

Statement of the Problem

Many western researchers and even some African people themselves have been indoctrinated to believe that Africans do not possess any (useful) mathematical knowledge. Some useful indigenous mathematical knowledge systems among the rural Shona people which could lead to community or global innovations and development initiatives have therefore been untapped and not put to maximum use.

Purpose of the Study

As pointed out by Huylebrouck (2006, p. 135), "Indeed, even in the 21st century, the prejudice persists mathematical activity was completely lacking in Africa, despite the many publications, conferences and lectures on the topic." The objective of this paper, therefore, is to investigate the type of mathematical indigenous knowledge systems that existed and still exist among the so called uneducated and primitive rural Shona people in Shurugwi County, Zimbabwe (which is in Africa). In particular the paper aims to show how these rural people use the mathematical knowledge that they possess in areas such as hut building, clay pot making and proverbs used in poems and stories. It is also felt necessary to record and preserve the indigenous mathematical knowledge of the rural Shona speaking people of Zimbabwe.

Research Questions

The research questions of the study were: what kind of mathematical knowledge do rural Shona elderly people in Shurugwi County possess; what are the perceptions of the rural Shona elderly people in Shurugwi County regarding the importance of indigenous mathematical knowledge in their community; what extent can indigenous mathematical knowledge and innovations be used to solve community challenges among the rural Shona people in Shurugwi County; and how do the rural Shona elderly people in Shurugwi County compare their indigenous mathematical knowledge systems with school mathematics (Western mathematics) knowledge systems?

Methodology

Research Paradigm and Design

This study was guided by the ethnographic paradigm. According to Gee and Ullman (1998, p. 3) ethnography, "… is a form of qualitative research that includes descriptions of people, places, languages, events, and products. The data is collected by means of observation, interviewing, listening, and immersion with the least amount of distortion and bias." Due to time constraints and other logistical reasons, the researcher decided to live with the people, observe and interview them during a period of only one week.

Sampling and Sample Size

Two elderly men and one woman were purposively chosen from a village in Shurugwi County. They were observed for a week while doing their daily chores and interviewed. Interview excerpts and (participant) observation notes were transcribed by the researcher. Two more participants (one elderly man and one elderly woman) were also purposively sampled to make a total sample size of five people and later on joined the first group of participants during a traditional beer drink at the first elderly woman's compound.

Data Collected

The study investigated how rural Shona people in Shurugwi county of Zimbabwe use mathematical knowledge and innovations to solve challenges they meet in their daily lives. The study specifically investigated what kind of mathematical knowledge the rural Shona elderly people in Shurugwi County possess, their perceptions towards the use of mathematical indigenous knowledge within their community, their comparison of school mathematics and indigenous mathematical knowledge, and the mathematics involved in hut building, clay pot making, traditional medicine preparation and mixing ratios and proverbs used in poems and stories. Data were also gathered through review of related literature.

Data Analysis Procedure

The data were analysed using discourse analysis. Jørgensen and Phillips (2002, p. 2) define a discourse as, "… *a particular way of talking about and understanding the world (or an aspect of the world).*" Thus discourse analysis involves the analysis of language as it is used in texts or speech and in different contexts such as, for example, medical, political or social. As people engage in 'discourse' or verbal communication, one may identify key topics (called domains) in the contents of the data and establish relationships between them. This is called domain analysis which is the analysis of language of people in a cultural context (Spradley, 1979).

In this study language as well as actions of the people were critically analysed with the aim of establishing any mathematical indigenous knowledge or concepts, mathematical actions or activities, mathematical thinking processes and mathematical innovations which were being used. Thus, the researcher wrote some field notes of observations made and transcribed data from the unstructured interviews. The researcher triangulated the participants' data with data from review of related literature and data noted from daily experiences with the people. The data were translated into English. The product of the analysis was a narrative description of what the participants said with some selected quotes.

Observations and Findings

The Characteristics of Participants

Two elderly men aged 88 years (a grandfather) and 62 years (his first born son) were interviewed by the researcher. The 'son' was observed as he was engaged in the process of building a round pole and dagga hut at the compound. One elderly woman aged 65 years and residing in the same village and three homesteads away from the elderly man and his son was also interviewed and observed as she was involved in the process of making one clay pot. The following letters stand for the pseudo names of the participants involved in the study:

R: Researcher

GF: Old man or grandfather aged 88 years (as seen on his national identity card provided by his son). The old man claimed that he had never been to school. He said his parents had died while he was young and the uncle who looked after him was not in favour of him going to school but instead made sure that, in his own words, "he was made useful herding his uncle's large herd of cattle and hunting bush meat for the family." [The terms 'grandfather' and 'father' were used by the researcher only to show respect.]

S: Grandfather's son aged 62 years. The man said that he attended school only up to grade four. He said he had not been good at school.Whenever S and GF excused themselves to do other chores, the researcher stopped the interviews and the observations and proceeded to EW1 (the other participant three homesteads away within the same village) to execute other aspects of the study.

EW1: The first elderly woman aged 65 years and involved in clay pot making. The woman claimed not to have attended any formal school because her poor parents wanted her to get married early so that they could get 'lobola' (bride price). [The term 'mother' was also used by the researcher only to show respect and not because EW1 was his mother.]

EW2: The second elderly woman and neighbour of EW1. She appeared slightly younger than EW1.

EM: A well-known herbalist and elderly man at EW1’s compound during the beer drink. His age could not be ascertained.

Indigenous Mathematical Knowledge: Building

R: [After making formal greetings to GF and S and seeking permission to ask a few questions about Indigenous Knowledge of the Shona people]. *Nhai sekuru, munofunga ruzivo rwedu isu vanhu vechiShona rwunokosha here muno munharaunda? Nditsanangurireivo ndapota.* [Grandfather, do you think the indigenous knowledge of us the Shona people is important to this community? Please explain.]

GF: *Hongu. Ruzivo rwedu rwechiShona rwunotibatsira kuchengetedza tsika nemagariro edu.* [Yes. Our indigenous knowledge for the Shona helps us to preserve our culture and ways of living.]

R: *Ko nhai baba, munofunga ruzivo rwemasvomhu rwevanhu vechiShona rwunobatsira here vanhu vekumaruwa vemunharaunda ino? Nditsanangurireivo ndapota.* [Father, do you think mathematical indigenous knowledge of the Shona people is useful to rural people in this area?]

S: *Hongu mwanagu. Ini handina ruzivo nezvamunoti masvomhu enyu iwayo amunoti munoita kuchikoro, handingatauri nezvazvo. Edu ‘masvomhu’ ndingati ndirwo ruzivo rwatakapiwa nemadzitateguru edu. Ndingangoti ruzivo urwu rwunotibatsira chaizvo nokuti tinorushandisa kugadzira zvivezwa zvedu, midziyo yedu, kurima nekukohwa zvakatikwanira uye nokuvaka misha yedu.* [Yes my son. I do not have knowledge about what you call mathematics and that you claim to do at school. I cannot talk about that. Our ‘mathematics’ is the knowledge given by our ancestors. What I can say is that this knowledge helps us a lot because we use it to make our carvings, our utensils, to plough and harvest enough and to build our homes.]

R: *Iyezvino sekuru, munganditsananguririrawo here zvamunoziva muchienzanisa ruzivo rwechivanhu vechiShona neruzivo rwevanhu vechichena?* [Now grandfather, can you explain what you know as you compare our indigenous Shona knowledge and the knowledge of the white man?]

GF: *Hongu, ndingati ruzivo rwevarungu rwuri pamberi muzukuru. Asi zvinhu zvizhinji zvinogadzirwa nevarungu ava zvinodhura chose. Zvedu zvatinogadzira neruzivo rwatakapiwa nevakuru vedu hazvidhuri asi zvakasimba uye hazvitinetsi kushandisa.* [Yes, what I can say is that the white men's knowledge is ahead of ours. But most of the things made by these white men are very expensive. The things we make ourselves using the knowledge given to us by our own elders are not expensive but they are strong and easy to use.]

R: *Ndiri kuona baba vari mushishi kuvaka ravati igota revakomana. Nditsananguririrei sekuru pfungwa dzinotanga kuuya mumusoro memunhu kana achida kuvaka imba seiri kuvakwa nababa apo.* [I can see father is busy building what he called boys' sleeping hut. Tell me grandfather the thinking processes involved in the head of a person when he wants to build a hut as the one father is building over there.]

Mathematical Thinking Processes and Concepts

[As GF was explaining the researcher took note of important points, transcribed and translated them to English. The words in **bold** and ***italics*** showed that GF had ideas of mathematical concepts although he never mentioned the word 'mathematics.']

GF: When a man wants to build a hut, he first thinks of its place (or ***location***) within his compound. How ***big*** the hut is going to be (i.e., ***size***) is thought in terms of the ***number*** of regular human occupants of the hut or the number and sizes of items he is going to keep in the hut. He should also decide whether he wishes to build a ***round*** (i.e., ***circular***) or '***four corner***' (i.e., ***rectangular***) hut. The man then thinks of where (***location***) he is going to get the materials with which to build the hut and how far the place is (**distance**).

R: [Now talking to S]. The one you are building is circular. Why did you choose a circle?

S: A circle encompasses the greatest area with a given perimeter. A circle is economical.

R: Why do you use poles and tree bark from the forest? Why don't you buy planks and nails from the shops?

S: Western materials are costly and sometimes scarce. Instead of using the white man's instruments, [*referring to metal pegs, twine and compass for drawing the circle or rectangle*] we can use readily available local materials which are cheaper. Because of urgency we usually help one another during *nhimbe* [community team work] and finish our work in the shortest possible time.

R: [To GF]. Why do you thatch it with grass?

GF: Thatching with grass makes the room warm in winter and cooler in hot summer.

R: Why do women smear (plaster) the wall with mud and polish the floor with cow dung?

GF: Mud smeared on the wall closes the holes and prevents cold air and rain from penetrating. We use special mud, often from anthills (where we normally bury our ancestors). Mud reminds us that we were created from earth or dust; it reminds us of the closeness with our ancestors. Cow dung is an insect repellant, it is waterproof on the floor and can be applied also to the inside wall to insulate the hut from heat loss or heat entry. Cow dung also reminds us of our cattle wealth.

Indigenous Mathematical Knowledge Involved in Clay Pot Making

R: *Ndiri kuona amai kuti muri mushishi kuumba hari yevhu. Nditsanangurirei amai pfungwa dzinotanga kuuya mumusoro memunhukadzi kana achida kuumba hari seyenyu iyi.* [I can see mother that you are busy molding your clay pot. Tell me mother the thinking processes involved in the head of a woman when she wants to make a clay pot like this one of yours.]

EW1: *Ndatenga mwanangu. Kana achida kuumba hari mukadzi akangwara anofanira kutanga kufunga zvinhu izvi*: [Thank you my son. When she wants to make her pot of clay, a clever woman should start to think of these things.]

Mathematical Thinking Processes and Concepts

[As EW1 was explaining the researcher took note of important points, transcribed and later translated them to English. The words in **bold** and ***italics*** showed that EW1 had ideas of mathematical concepts although she did not mention the word ‘mathematics.’]

EW1: A clever woman should think of the ***size*** of the pot to be molded, the ***shape*** of the pot and ***texture*** of the soil to be used. She should have an ***appreciation*** of ***different colours*** and shapes. She should think about how she is going to ***paint*** and ***draw patterns*** on the finished pot. The ***decorations*** on the pot should be appealing and ***continuous*** (in other words be ‘***symmetrical***’) so that people will buy it. ***Buying*** and ***selling*** will be done by exchanging goods (barter trading).

R: *Ndatenda amai. Zvino nditsanangurireivo kuti hari yevhu inogadzirwa sei*. [Thank you mother. Now tell me how a clay pot is made.]

EW1: [EW1 explained in Shona and R translated the information as follows]: Specific type of soil (strong, not easily breakable, easy to mold and shape) is sourced, mixed with water to desirable texture and sufficient amount is taken to make clay pots of desired sizes and shapes. The molder uses knowledge passed on by elders and grandparents to design the pots. We make the decorations with sharpened sticks. We design these patterns and shapes as you see here [*The researcher saw hexagons, pentagons, triangles and other zig-zag patterns and circular arcs with symmetry*]. We heat the pots on fire to make them strong. When they are red-hot, we remove them from the fire and when they are cold, we then paint them with paint made from crushed stones or soils of different colours. Here are some of them. [*The researcher noticed crushed stones and soils of black, brown, red, cream, white and golden colours heaped on the ground and some in plastic bags.*] Sometimes we use paint that we make from crushed leaves and oil or that we buy from shops. We sell the pots to make money or we exchange them with goats, hens, maize or other grains.

Indigenous Mathematical Knowledge in Shona Proverbs and Idioms Used in Poems and Stories

[EW1, S, GF and other elderly people (among them EW2 and EM) were gathered at EW1's compound during a traditional beer drink. R bought them a calabash (about 5 liters) of beer which they happily shared as they talked. While the people were talking, the researcher took note of some Shona phrases, proverbs and idioms used in daily talk, in poems and stories and critically analysed their mathematical contents. The following proverbs and idioms were sampled and analysed and the mathematical aspects are shown in **bold** and ***italics***.]

Basa mangwanani (One should start work early in the morning in order to accomplish one's tasks). This shows the importance of ***time*** management in doing ***work***.

Kandiro kanoenda kunobva kamwe (One good turn deserves another). This shows the importance of ***sharing*** and concept of ***symmetric relation*** (If I give you something, then you should also give me something, though not necessarily in equal ***proportions***).

Gumi rakadya vaviri (Literally translated to "A ***ten*** that ate ***two*****).** This shows the concept of two people fighting or wrestling and falling down together.

Kure kwegava ndokusina mutsubvu (Meaning that if one needs something precious or important, one will go and fetch it no matter how difficult it may appear or how far the ***distance*** is). Therefore there exists a ***positive correlation*** between importance and ***distance*** travelled.

Potsi haarwirwi, piri haarwirwi, asi tatu torwa (Meaning ***first*** mistake is not punishable, ***second*** same mistake is also not punishable (one is given another ***chance***) but the ***third*** same mistake is punitive). This shows the ideas of chance or ***probability***. In other words, the **probability** of making a mistake and being punished for it is ***1/3*** =0.3333=33.33%.

The above examples show that the Shona language has sayings which are rich in mathematical concepts. The ideas of meeting targets and importance of time management among the Shona people were also mentioned by Chikodzi and Nyota (2010). Since mathematics is viewed as a vehicle for critical thinking (Chirume & Chikasha 2014), the sayings together with the mathematical concepts inherent in them can be used to improve cognitive skills, and also in the teaching of good morals and survival skills.

Indigenous Mathematical Knowledge Involved in Medicine Mixing

[At the beer drink R tried to persuade EM to share his knowledge of preparing and mixing some traditional medicines to heal wounds like snake bites and cure stomach ache.]

R: Could you tell me father how you prepare and mix some of your medicines? You may talk about any medicine such as the one that heals snake bite wounds or that cures sicknesses like stomach ache.

EM: No my child, my *mudzimu* (ancestral spirit) does not allow me to disclose such information. If I disclose the information, you may share it with your friends in the city and my medicines will not work.

EW2: [To R]. That is true my son. Only your vadzimu are supposed to give you such information. They may give it to you in your dreams.

R: [To both EM and EW2]. Thank you for clarifying this issue to me.

Discussion

It was found that rural folk possess rich mathematical knowledge, and use cheap and user-friendly innovations for family upbringing and survival. Indigenous elderly men and women had their reasons for doing things the way they did. When asked why they do it their way and not the other way, their answers were "… it is the only possible, or optimal, or cheapest, or strongest, or easiest solution…" The researcher noted that the elderly people had indigenous knowledge of heat loss and heat gain when, for instance, GF said, "Thatching with grass makes the room warm in winter and cooler in hot summer." The researcher has also observed that some lodges in the towns are grass thatched probably because of the same reason.

However, the interviewees in this study said they did not know or understand any mathematics. By this they were referring to school mathematics. They regarded what they were doing not as 'mathematical activities' but as activities for survival, for preservation of their culture, for problem solving, for sharpening the mind, for fun and recreation and for the sustenance of livelihoods. This has led to the debate of what counts as mathematics and what other people may regard as not mathematics, leading to the terms "academic mathematics" and "ethnomathematics" (D'Ambrosio, 1985). These views are in line with Powell and Frankenstein (1997, p. 195) who say, "However, the academically enforced disjuncture between 'practical' and 'abstract' mathematical knowledge contributes to students feeling that they *do not understand or know any mathematics*" [researcher's stress]. Nevertheless the participants in this study were actually carrying out some mathematical activities because by its very nature, mathematics encompasses problem solving, critical thinking, fun and recreation.

This paper has shown that the Shona language has idioms and proverbs which also have or include mathematical concepts. The idioms and proverbs discussed above help children in mental calculations, problem solving, creativity, music making and recreation. This can lead to children growing up being critical thinkers, innovators and inventors. However, it would appear that such mathematical activities and concepts are rarely taught in formal schools. Since nowadays most of the rural children spend most of their day-time at school and night-time doing school homework, tired and sleeping, it would mean that most children are likely to lose touch with their culture.

During the beer drink, the researcher tried to persuade some elderly people to talk about how they prepare and mix some traditional medicines. The researcher noted that the people were reluctant to share their knowledge about mixing ratios applied to make some medicines and the reasons thereof probably because they wanted to guard against their cultural beliefs and practices being polluted by 'foreign' intruders.

The importance of IK, especially to the poor people, has been emphasized by Gorjestani (2000) and Mohamedbhai (2013). For instance Mohamedbhai (2013) points out that IK is important as it improves and maintains livelihoods of the community. He also says that:

> In shaping the future development agenda for Africa, it must be recognised that for the continent to meet its development challenges, especially the eradication of poverty, it is vital to integrate indigenous knowledge in the development process. Unfortunately, global support for IKS in Africa appears to be waning.

Gorjestani (2000, p. 1) refers to IK as "… the social capital of the poor'' and as their main asset for survival. Mathematical indigenous knowledge and innovations can therefore be used to solve challenges especially among the rural and poor communities.

Conclusion

This study concludes that in general: some Shona elderly men and women do not think that they possess mathematical knowledge. To them, mathematical knowledge refers to school mathematics; Shona elderly men and women in the rural areas are rich sources of mathematical knowledge; Shona elderly men and women in the rural areas use the knowledge to meet their daily needs of shelter, food, utensils and to preserve their culture through fun and recreation; indigenous elderly men and women have their reasons for doing things the way they do. They choose the only possible, optimal, cheapest, strongest or easiest solutions; cheap and user-friendly mathematical innovations can be used for family upbringing and survival; and that some elderly people are reluctant to share their knowledge about mixing ratios applied to make some medicines and the reasons thereof probably because they want to guard against their cultural beliefs and practices being polluted by 'foreign' intruders.

Recommendations

The study recommends the imparting of adult basic education among the elderly people in the rural communities which may enable them to have positive attitude towards their indigenous mathematical knowledge which, if well exploited, is just as good as school mathematics. The study also recommends the sharing of mathematical indigenous knowledge by rural communities to solve local challenges using cheap, strong and user-friendly mathematical innovations. Academics and researchers should record and formalize the indigenous knowledge as it may contribute to banks of African knowledge suitable for African socio-economic lives. The knowledge may also benefit other people in the global world.

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