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Incorporating Religious Mathematics In The Teaching And Learning Of Formal Geometry: A Case Of The Apostolic Church Sector In Zimbabwe.

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Abstract

This paper argues for the inclusion of cultural geometry in formal school mathematics curriculum. In Zimbabwe members of the apostolic church apply geometrical concepts with meticulousness without the practitioners receiving school education. A descriptive ethno mathematics research that revealed how religious-cultural geometry could enhance understanding of school mathematics was employed in this study. Data were collected through observation and interviews. Twenty households' which were conveniently sampled and three purposively sampled mathematics educators constituted the sample. This paper highlights how geometry is used in the apostolic church sector and how it could be used in to enhance students' geometry conceptual understanding in school mathematics as the concept is widely believed to be difficult. The inclusion of religious mathematics could bridge the gap between school and the cultural mathematics since improving mathematics education was the original motivation for ethno mathematics. One of the recommendations of this paper is to include a course on ethno mathematics in teacher education programmes that will enhance educators' content and pedagogical content knowledge.

Keywords: School mathematics; cultural mathematics; cultural-religious mathematics; ethnomathematics; cultural geometry; geometry; apostolic church sector

1. Introduction

African apostolic church was founded in 1932 by John Marange, who converted, baptized and organised thousands into his congregation. These African believers do not have church buildings, were not involved in nonspiritual education and do not make use medicine. All the same with the education for all policy in Zimbabwe that requires all the children to be literate, they revisited their beliefs and now send children to schools. Since most of the church members were not into secular education, most of them depend on self-employment or self-help project. His followers were to survive by making and selling baskets, furniture and tin ware [8]. Masowe proclaimed a message of withdrawal from European things- no bibles for his followers, no schools; no one was to be employed in companies [8]. Church members were taught trades such as tinsmith, basketry, carpentry, motor mechanics and shoe making so that they can be self-reliant. These religious-cultural trades have several applications and practices of mathematical concepts together with geometry.

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This value of mathematics in the existing world cannot be over stressed. Mathematics is a very important tool for the understanding and application of science and technology in all societies as well as in the apostolic church sector. In understanding the principal role of mathematics to Zimbabweans, the ministry of education made the subject compulsory at both primary and secondary levels. This was to ensure the inculcation of mathematics literacy and conceptual thinking needed for living, problem solving and continuation of education both in formal and informal sectors. In spite of the value attached to mathematics, Zimbabwe appearances to have the problem of low levels of achievement in mathematics summative examinations.[10] lamented the poor state of mathematics instruction in Zimbabwe and averred that the problems of quality of mathematics instruction and learning are from varied sources, where the mathematics educator has been blamed. These educators also seem to have snags with their own subject content knowledge [10]. In this scenario, both students and mathematics educators experience the subject as strange and worthless subject. They view it as something imported from outside Zimbabwe and that is found in books, which do not present the content in an elaborate way which could provide sufficient room for students to develop conceptual understanding knowledge and schools only. [1] asserted that school mathematics by contrast is often carried out for its own sake, unrelated to any real or particular context, and almost always involves recording using written symbols. [3] noted that students around the world are experiencing a dissonance between the cultural tradition mathematics represented outside the school and that is represented inside school. Mathematics is obscure in people's everyday life and they do not feel the relevance of studying mathematics. For instance, people find themselves to be competent in their jobs without an awareness of how mathematics plays a role in their activity [16].

Quite a number of the students fail to develop an adequate understanding of geometry concepts, geometry reasoning, and geometry problem solving skills [9]. This lack of understanding in learning geometry often causes discouragement among the students, which invariably will lead to poor performance in geometry. Some factors like geometry language, visualization abilities, and ineffective instruction have been put forward to understand why geometry learning is viewed to be difficult [9]. As a result low achievement in school mathematics has been increasing and exhibits no sign of reversal [6].

Although, Zimbabwe has a single mathematics curriculum for the diverse secondary schools with different cultures, [12] noted that teachers' curriculum knowledge at any given class level was similar, but they differed in pedagogical approach, characterized mainly by teacher demonstrations , lecture methods and pupils' imitations, followed by drill and practice through written work. Zimbabwe's educators are guided by the summative examination system that relies deeply on recall and procedural application of mathematical results [15]. The examination system emphasizes correct computations that encourage students to memorize the procedures at expense of logical reasoning and thinking. This type of procedural learning of school mathematics does not allow students the elasticity to link the concepts in their cultural-religious environments. Thus learning becomes forced and seldom brings satisfaction to the students.

The poor state of mathematics instruction, geometry encompassed in Zimbabwe, gave birth to mathematics curriculum reform, that encourages educators to adopt constructivist approaches they enabled learners to transfer school mathematics to contextualised situations through modelling and problem solving [15]. The reform is also rooted with the idea of ethno mathematics which is grounded in the constructivist methodology that is based on the premise that pupils construct knowledge through experience. From a social- constructivist perspective, mathematical knowledge is not build individually, but in a wider social context which is linked to the learners' environment and cultural activities and institutions [4]. The learning of mathematics should consider the culture and the environment in which mathematics arises.

2. **Cases of incorporating ethno mathematics into school mathematics**:

In South Africa, a colourful style of geometric wall decoration has been developed by the Ndebele women [7]. The Ndebele/Tonga women are also known for building and decorating round huts, using different informal geometrical

concepts in Zimbabwe. [17] used the shapes of the Ndebele/Tonga houses in her curriculum unit, to challenge students to find the largest area that could be enclosed by a given perimeter. This approach to solving mathematical problem gave the researcher's students the chance to appreciate how the builders of such structures in Africa arrived at solutions to the many problems they encountered in authentic life circumstances.

In a different study, [13] taught geometrical concepts using the Navago learning tradition at reservation schools near Arizona. On a similar research, [7] used a variety of customary material from Mozambique to expose the "inner moment of geometrical thinking." He showed that studying the geometry behind certain types of Mozambican elements and Navago ethno geometry had made students to reconsider the value of their cultural heritage, as a result of which they concluded that students do not have to rely on rote- learning of cognitive materials that appears alien.

Mogari in South Africa made a study of boys making toy cars out of steel wire. In the process [11] documented the closeness between shapes the boys formed and techniques they had developed, that are also taught in schools. The informal geometrical knowledge used in the construction of wire cars is neither influenced by the school geometrical knowledge nor learned at school, but instead comes about through observation and interaction with materials during the activity. Students can learn about how their culture and environment interacts with their views of mathematics and their ways of thinking mathematically, so that they are convinced that they already think mathematically and that they can learn school mathematics. There is need to connect students' cultural and environmental mathematical understanding with school mathematics they are learning.

Therefore the objective of this paper is to answer the question; what is the geometrical knowledge posed in the apostolic church sector that can be incorporated in school mathematics instruction?

3. Data collection

A descriptive ethno mathematics research that focuses on how geometry is used in everyday life and its potential for inclusion in the school maths curriculum was employed. The apostolic church was purposively sampled as it was one of the churches that has the highest number of unskilled people who are involved in different activities that includes farming, mining and black smiting. The church is believed to be the one that dominant in the area under study. Twenty households were conveniently selected from two apostolic church village, Mafararikwa and Marange in Marange District in the Eastern Highlands of Zimbabwe. Three mathematics educators who were purposively sampled participated in the research and were involved in observing different household artefacts produced by the members of the apostolic church sector. Purposive sampling was employed to make the study more practical and participants more accessible. Observations were useful in capturing everyday practices of church members. Interviews were conducted with the three educators after the observation process. The informal interviews focused on what the teachers think on what they had observed in line with the teaching of geometry.

4. Geometrical concepts used in the apostolic church sector

Cultural activities that measure rainfall, temperature, wind direction, speed, clouds and hours of sunshine are not considered and yet they are practised in Zimbabwe[11]. Similarly mathematical aspects of the apostolic church are not being incorporated in geometrical classroom yet they are notable in Zimbabwe. Ethno mathematics had been active and continuing independent of school mathematics in Zimbabwean

An analysis of the apostolic members' work showed many geometrical concepts that are used with or without knowledge of their theoretical meaning. Men are well known for making different household artefacts such as pots, pans, conical lamp holders, cylindrical water buckets and dishes. These containers are usually made by joining aluminium metal. There are many scientific ideas explaining why aluminium as a metal is favoured by apostolic members. For instance, scientists believe that aluminium is durable and does not corrode easily. Although these apostles are not scientists they are able to use scientific knowledge informally. Men are also involved in carving wooden cooking sticks, straw mats, candle sticks and flow mats from bark of the baobab trees. In each household

you could find curved polished wooden (crooks) sticks for men.On the other side, women are good at clay pottery that comprises the production of pots and flower vessels with different designs and shapes. Nearly all clay products are decorated with triangles and circles of countless colours.

Most of these households' artefacts are cylindrical in shape and a variety of geometrical concepts are used in making these containers, especially circle geometry. The apostolic church members make use of geometrical concepts without a formal understanding of them. They use the concepts of circumference, radius, diameter and volume of cylindrical household containers. They even use informal mathematics to find the volumes of the containers, without the school mathematical concept of volume.

Pots showed a great application of geometry in the art of making household artefacts. A single pot carries several meaning with geometry, measurement, logic and reasoning. It is a combination of art and geometry in real sense that can be living context in classroom teaching of locus, curves, circumferences, radius and volume. The concept of menstruation is also applied in producing the containers.

One more area which depicts geometry characterizing the artwork of this religion is the weaving of baskets, mats, hats and hand bags. These are professionally crafted from reeds. Various types of mats are produced for a variety of purposes, such as bedding, room dividers, floor coverings, gifts, ceremonial exchanges and clothing. Different patterns are used which vary from very small to large. Some mats were circular disc and some were rectangles. These mats carried a living geometry with menstruation and other areas of mathematics.

Baskets, made of reeds, appeared to be the most fascinating application of menstruation and design applying some geometrical sense and some arithmetical calculation as well. Some lines are straight and some are curved. There are several geometrical shapes of triangles, quadrilaterals, pentagons and hexagons. These different artefacts carry a lot of mathematical meaning that could be real evidence of context for classroom teaching and learning of mathematics. These can be helpful to teach geometrical transformations such as rotation and reflection.

One mathematics educator had this to say, "Participation in this research helped me to appreciate that mathematics can be taught by means of different techniques, which include the religious cultural activities and this has provided me with so many answers to the questions that are widely asked by my students".

Another educator lamented that, they became aware of their religious environment, seeing the apostles not only as christians but as people religiously-culturally developers of meaningful geometrical patterns that possess interesting geometric transformations and symmetries, that can be used as examples in teaching and learning of geometry. I learnt how the church members utilize geometry in their religious culture; the question is how the teachers best can implement these ideas.

The above sentiments revealed that connections between cultural and school mathematics are possible but there is no guidance on how to structure learning experiences so that religious-cultural mathematics can be integrated into the formal mathematics curriculum. A culture-sensitive mathematics curriculum contributes significantly to fostering students' cultural self-esteem and cultural identities [13].

5. Pedagogical and social implications of this study

A close examination of the apostolic cultural-religious practices revealed informal geometric concepts linked directly to the practices and day-to-day life activities that could be incorporated in the teaching and learning of secondary school mathematics. If these practices were integrated into the curriculum, this will augment students' learning of school mathematics.

One of the pedagogical implications of this study is the practicability of cultivating meaningful teaching and learning approaches in relation to the apostolic cultural contexts. The study has established the opportunity of incorporating religious cultural practices into the existing curriculum; this approach can be disseminated among in-

service and pre-service teachers so that they can incorporate the notion of religious cultural contextualisation in their teaching. Instructional methods based on students' cultural perspective may include using applicable illustrations from the students' own religious culture and revealing students to a mixture of cultural situation in which mathematical concepts are implanted. The amalgamation of cultural-religious and school mathematics enhances the removal of the abstractness in which mathematics is taught in school and enables students' conceptual understanding.

Giving a picture of the apostolic church cultural experience and practices, as an element of ethno mathematics allows for an easier flow of mathematical ideas, thereby reducing the cultural- religious obstructs. Scrutinizing educationally mathematical ideas entrenched in and imitated from technologies in various cultural-religious practices may contribute more to bridge the gap between cultural-religious and school mathematics.

One key social implication of this research is that the use of ethno mathematics particularly in secondary school mathematics could do much to improve the quality of mathematical learning and teaching at very little extra financial cost. The use of ethno mathematics in the teaching of school mathematics also implies that there is no need to over depend on textbooks which are hardly ever available in most rural public schools and which also promote rote learning like in most Zimbabwean schools. This is so because the teacher will make use of the mathematics experience of the student at the apostolic church level to build the academic mathematical concepts not only in geometry but in all mathematical concepts.

The research indicated how parents and elders can help their children to learn mathematics at home by engaging them consciously in local activities linked directly to mathematics such as geometry, estimations and menstruation. Given that the children cannot escape from religious practices, a possibility observed in the study was that children can enrich their mathematical understanding by linking their classroom learning with daily activities. It was also noted that ethno mathematics might provide numerous educational outcomes, empowering students with expressive mathematical knowledge and self-sustaining skills for an array of feasible social roles, including home-making, employment in local communities and academic success leading to higher education.

6. Conclusion and recommendations

The notion that the members of the Apostolic sector lack prescribed academic knowledge of mathematics yet they can apply some process skills from mathematics to solve problems that arise in their environments can be used to deduce that significant mathematical competencies are developed outside the school. In this situation, it is essential to connect the cultural-religious mathematical abilities that students develop from religious practices in their environment with school mathematics through the use of culturally geometric concepts in teaching and learning. Perspective teachers should be aware of the possibilities connected to the use of ethno mathematics into mathematics education. Students having mathematical knowledge built both in and out of school and with the ability of recognizing the links between religious - cultural and school mathematics their understanding and performance in both situations would expand.

It is the view of this research that mathematics educators in both their pre-service and in-service training at secondary school level should be exposed to the ethno mathematical practices of Zimbabwe's different cultures including the apostolic church practises, so that they make use them in formal mathematics teaching. Although, ethno mathematics is not a solution to all problems of poor achievement in mathematics, to a certain extent this study advocates for mathematics educators to reflect the contributions of cultures in mathematics classrooms. This study also strongly recommends that the curriculum planners should make an effort to bring ethno mathematics officially in the study of school mathematics.

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