An Ethnomathematical Perspective of Symmetrical Freedom Quilts as Cultural Artifacts

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Abstract: Quilts often have a visual balance as well as produce pleasing effects. Since quilts may be considered as cultural artifacts as well as artistic and mathematical manifestations and expressions of the daily life of slaves, who were part of a particular cultural group. The purpose of this article is to explore the symmetrical patterns found in a specific kind of quilts, symmetrical freedom quilts, and to explore the connections between mathematics, ethnomathematics, and the tactile craft and art of quilting of this resilient group of people.

Key words: Symmetrical Freedom Quilts, Ethnomathematics, Cultural Artifacts.

Introduction

Culture and society considerably affect the way in which individuals understand mathematical ideas and concepts. Ethnomathematics has demonstrated how mathematics is made of many diverse and distinct cultural traditions. In this regard, each cultural group has developed unique ways of incorporating mathematical knowledge and has often come to represent given cultural systems, especially in ways that members of cultural groups quantify and use numbers, incorporate geometric forms and relationships, and measure and classify objects (D'Ambrosio, 1990).

Each cultural group has developed unique and distinct ways to *mathematize* their own realities. Mathematization is a process in which individuals from different cultural groups come up with different mathematical tools that help them to organize, análise, comprehend, understand, model, and solve problems located in the context of real-life situations (Rosa & Orey, 2006). These tools allow them to identify and describe specific mathematical ideas, concepts, procedures, and practices by schematizing, formulating, and visualizing a problem in different ways, discovering relations, patterns, and regularities, and transferring a real world problem to a mathematical idea through mathematization.

Inclusion of a diversity of ideas brought by students from other cultural groups can give confidence and dignity to these students, while allowing them to see a variety of perspectives and provide them a base in which they are able to learn academic-Western mathematics (Bassanezi, 2002). Equally important is the search for alternative methodological approaches. As Western mathematical practices are accepted worldwide, it is vital to record historical, diverse and alternate forms of mathematical ideas that occur in different cultural contexts before many of these ancient or local practices are lost to time. One alternative methodological approach is *ethnomodeling* (Rosa & Orey, 2010), which may be considered as the practical application of ethnomathematics, which adds the cultural perspective to academic modeling concepts, which satisfy the necessities and the life history of the participants of this specific cultural group

When justifying the need for a culturally bound view on mathematical modeling, our sources are rooted on the theory of ethnomathematics (D'Ambrosio, 1990; Bassanezi, 2002; Rosa & Orey, 2003). Research

of culturally bound modeling ideas addresses the problem of mathematics education in non-Western cultures by bringing the cultural background of students into the mathematics curriculum in order to connect the local and cultural aspects of the school community into the teaching and learning of mathematics (Rosa & Orey, 2010).

Ethnomathematics

Ethnomathematics as a research paradigm is much larger than traditional concepts of mathematics, ethnicity, and any current sense of multiculturalism. D'Ambrosio (1990) affirmed that *ethno* is related to distinct groups identified by cultural traditions, codes, symbols, myths, and specific ways of reasoning, inferring, and modeling. Ethnomathematics is the way that various cultural groups mathematize their own reality because it examines how both mathematical ideas and mathematical practices are processed and used in daily activities. Ethnomathematics is described as the arts and techniques developed by students from diverse cultural and linguistic backgrounds to explain, to understand, and to cope with their own social, cultural, environmental, political, and economic environments (D'Ambrosio, 1993).

Ethnomathematics seeks to study how people (students) understand, comprehend, articulate, process, and ultimately use mathematical ideas, concepts, procedures, and practices that are able to solve problems related to their daily activities. This holistic context helps students reflect, understand, and comprehend extant relations among all components of the system. Rosa (2000) defined ethnomathematics as the intersection of cultural anthropology, academic mathematics, and mathematical modeling, which is used to help students to translate diverse mathematical ideas and practices found in their communities.
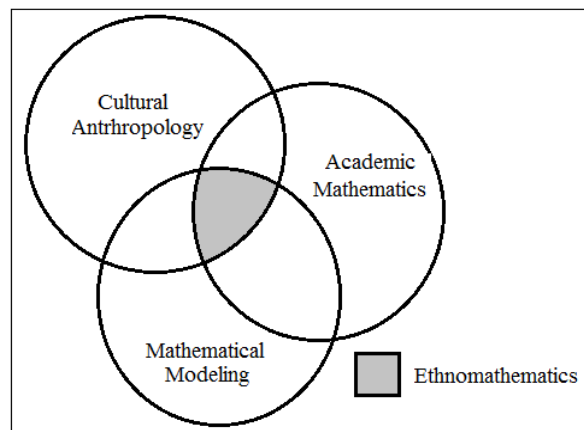

Figure 1: Ethnomathematics as an intersection of three disciplines

Detailed studies of mathematical ideas and practices of distinct cultural groups most certainly allow us to further our understanding of the internal logic and mathematical ideas of diverse group of students.

Ethnomodeling

Ethnomodeling is a process of the elaboration of problems and questions that grow from real situations that form an image or sense of an idealized version of the *mathema*. Rosa and Orey (2006) stated that the focus of this perspective essentially forms a critical analysis of the generation and production of knowledge (creativity), and forms an intellectual process for its production, the social mechanisms of institutionalization of knowledge (academics), and its transmission (education).

D'Ambrosio (2000) affirmed that "this process is modeling" (p. 142). In this perspective, by analyzing reality as a whole, this holistic context allows those engaged in the modeling process to study systems of reality in which there is an equal effort to create an understanding of all components of the system as well as the interrelationships among them (D'Ambrosio, 1993; Bassanezi, 2002).

Rosa and Orey (2007) affirmed that the use of modeling as pedagogical action for an ethnomathematics program respects and values previous knowledge and traditions by developing student capacity to assess and translate the process by elaborating a mathematical model in its different applications. In this regard, it is necessary to start with the social context, reality, and interests of the students and not by enforcing a set of external values and decontextualized curricular activities without meaning for the students. Bassanezi (2002) characterized this process as "ethno-modeling" (p. 208) and defined ethnomathematics as "the mathematics practiced and elaborated by different cultural groups, and involves the mathematical practices that are present in diverse situations in the daily lives of members of these diverse groups" (p. 208).

In considering ethnomodeling as tool to study ethnomathematics, teaching is much more than the transference of knowledge because teaching becomes an activity that introduces the creation of knowledge. According to Freire (1970), this approach in Mathematics Education is the antithesis of turning students into containers to be filled with information. In our opinion, it is necessary for mathematics curriculum to translate the interpretations and contributions of ethnomathematical knowledge into systemized mathematics because students need to be able to analyze the connection between both traditional and non-traditional learning settings. According to Bassanezzi (2002), ethnomodeling uses mathematics as a language for understanding, simplification and resolution of real world problems and activities.

On the other hand, many Western mathematical activities are regarded as modeling by this definition and due to its cultural roots in non-Western society it can be defined as ethnomodeling of the mathematical practices found in non-Western settings. A characteristic of these new problems is that they cannot be solved using syllogistic, that is, classical Aristotelian logic, but need multivalued logic, often called *fuzzy logic*, which is the logic that underlies inexact or approximate reasoning (Zadef, 1984). In this context, Ascher and Ascher (1986) argued that multivalued logic is used in attempts to formalize human-like processes that are culturally bound.

Ethnomodels

In general, a model is a representation of an idea, a concept, an object, or a phenomenon (Gilbert, Boulter & Elmer, 2000). We define ethnomodels as cultural artifacts, which can be considered the pedagogical tools used to facilitate the understanding and comprehension of systems that are taken from reality of cultural groups (Rosa & Orey, 2009).

In this regard, ethnomodels are external representations that are precise and consistent with the scientific and mathematical knowledge, which is socially constructed and shared by members of specific cultural groups. The primary objective for the elaboration of ethnomodels is to *translate* the mathematical ideas, concepts, and practices developed by the members of distinct cultural groups.

Applying Ethnomodeling

An example of the ethnomodeling process is the practice of *quilting* as a pedagogical proposal to elaborate activities for the teaching and learning of mathematics. This process shows the importance of the contextualization of problems in the learning environment of ethnomodeling through the elaboration of ethnomodels. According to our studies in the area of ethnomathematics and modeling, this

ethnomathematical example naturally comes across as having a mathematical modeling methodology (D'Ambrosio, 2002) through ethnomodeling.

The Symmetrical Freedom Quilt

Rosa and Orey (2009) affirmed that a quilt theme is a way to introduce work in ethnomodeling by integrating mathematics, art, history, and reading in an interdisciplinary approach. In so doing, it is necessary to propose lesson plans, which combine an ethnomathematical-historical perspective that elaborates a history project related to the *Underground Railroad*. This project allows teachers to develop classroom activities that help students to better understand history and geometry, especially concepts of symmetry and transformations through ethnomodeling.
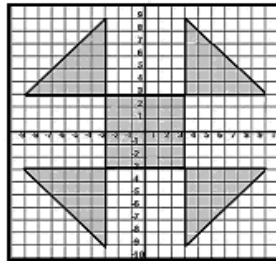

Figure 2: The Freedom Shoo Fly quilt block

Making quilt blocks are an excellent way to explore concepts of symmetry. As quilts are made from square blocks, usually 9, 16, or 25 pieces to a block, with each smaller piece consisting of fabric triangles, the craft lends itself readily to the application of concepts of symmetry.

Cultural Background of Freedom Quilts

Today's patterned African quilts would be all but unrecognizable to the people of African descent brought to the Americas as slaves (Rosa & Orey, 2009). Currently, African-American quilters continue the use of patterns as well as African textiles and beadwork to establish a cultural link back to African roots.

One fascinating reality is concerned with African quilts designs and the belief that evil travels in straight lines. Thompson (1983) stated that quilt patterns may be used in several ways to stop the flow of evil such as by breaking patterns within the block unit; staggering designs, using a strip-piecing technique, and by placing different patterns next to one another in a samplerlike fashion.

The first cultural group of African quilt-makers would not apply symmetrical patterns because they believed that evil spirits would travel in a straight line (Dobard & Tobin, 1999). In this regard, in order to throw off the demon spirits they could not apply a perfectly aligned pattern and they should mix-up the design.
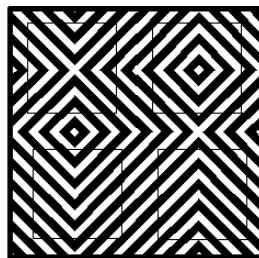

Figure 3: A visual illusion of an interrupted quilt block

This is similar to the concept of *interrupted systems* used in op-art (Barrett, 1970) in which the pattern is broken or interrupted. The pattern in this system is composed of straight, corresponding, and parallel lines in which all angles are right angles. This design is used in some patterns of the Freedom Quilts.

In much of the North American quilting tradition, strip construction, large-scale designs, strong contrasting colors and variations from symmetrical patterns all appear to reflect symmetrical textile patterns found in parts of Africa.

A specific tradition brought over from Africa is the strip quilt. Many times, strips of cloth called *kente* were woven together in order to make one big blanket. Scholars consider this strip quilting technique to be the ancestor of modern African quilts.

By using the strip quilting technique, patterns were often broken up and uneven, which was said to break up the line of evil (Dobard & Tobin, 1999). The strips are assembled along their selvages in order to form an overall lengthwise stripe pattern, which indicates that may be arranged symmetrically within a grid or on a central axis.

Figure 4: Adire oniko in the African sahada pattern

Repetition of symbols and patterns indicate a symmetrical mathematical structure, a spiritual synthesis embracing a celestial world and protection because patterns were sometimes used as protection to ward off evil spirits. In this context, different quilt designs may be based on the principle of modularity, which is based on the use of a small set of basic elements called *prototiles* and their recombination in order to create a large or even infinite series of modular designs (Jablan, 1992).

In the same way as in Africa and Freedom Quilts, some basic pieced blocks, which are squares with a set of diagonal fields, are used as modules. The *Flying Geese Freedom Quilt* design is a basic pieced block formed by a square with a set of diagonal fields, which are used as modules.

Figure 5: The flying geese freedom quilt pattern

The concept of modularity may be also used by the African quilt-makers and by the runway slaves in the United States in the 19th century as a tool for the elaboration of some symmetrical patterns used in their quilt designs.

The quilt-makers from both African descent and runaway slaves believed that changing the pattern would protect them from others copying their exact creation as well as breaks in the pattern were essential as they both confused evil spirits thought to travel in linear directions (Dobard & Tobin, 1999) and disorient slave hunters by walking in an unusual manner. Runaway slaves should follow a zigzag trail in order to make their tracks difficult for slave hunters to follow.

Figure 6: The drunard's path quilt pattern

Throughout time, quilts have been created as a vehicle for sharing family history, a moral message, or as a reflection of historical and cultural events (Rosa & Orey, 2009). In other words, quilts may be considered as cultural artifacts.

Freedom Quilts as Cultural Artifacts

Cultural artifacts are objects created by the members of cultural groups, which give cultural clues and information about the culture of its creators and users (D'Ambrosio, 1993). In this regard, Torsney and Elsley (1994) stated that quilts are considered as cultural artifacts that have been recognized as one of the most compelling symbols of cultural diversity since they are part of the story, fact, and work of art from the past of any cultural group.

Cultural artifacts have some significance in the daily life of distinct cultural groups because "the language of the shapes, the designs, the myths, and the colors, confirm the community's sense of reality and give it control over its own time and its own space" (Voltz, 1982, p. 45). These artifacts are not made only to "adorn walls, ceilings, baskets, utensils, clothes, jewelry, and even the human body itself (…) but (...) may serve religious purposes as well" (Onstad, Kasanda & Kapenda, p. 40).

In this context, quilts are considered as cultural artifacts because contain both qualitative and quantitative cultural messages that are of high importance to the members of cultural groups (Rosa & Orey, 2009).

Modelling the Shoo Fly Symmetrical Quilt Block

Shoo Fly is one the simplest traditional Symmetrical Freedom Quilts. Although *Shoo Fly* is a basic pattern, its versatility provides quilters with some wonderful opportunities for creative use of colors, fabrics and stitching. *Shoo Fly* may be adapted to a variety of sizes. Blocks often measure 9 x 9, but variations such as 10 x 10 and 12 x 12 may also be used.

An Ethnomodel about Rotation

A rotation turns the figure through an angle about a fixed point called the center. The center of rotation is assumed to be the origin of the x-y coordinate system. A positive angle of rotation turns the figure counterclockwise, and a negative angle of rotation turns the figure in a clockwise direction. A rotation

creates a figure that is congruent to the original figure and preserves distance (isometry) and orientation (direct isometry).

Rotation is a transformation that is present in the *Shoo Fly* quilt block because it moves every point 90° counterclockwise around the origin of the x-y coordinate system. The mapping of this rotation is $R_{90°}(x, y) = (-y, x)$. In so doing, the coordinates of point *A* in its rotation around the x-y coordinate system are:

$$R_{90°} A(9,3) = A'(-3,9)$$
$$R_{90°} A'(-3,9) = A''(-9,-3)$$
$$R_{90°} A''(-9,-3) = A'''(3,-9)$$
$$R_{90°} A'''(3,-9) = (9,3)$$

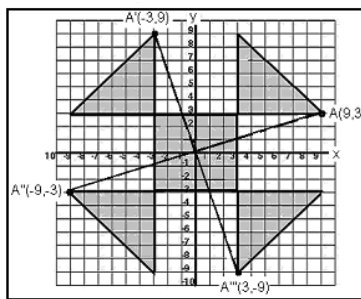*Figure 7: Rotation of point A around the x-y coordinate system*

The other mappings for rotation are rotation of 180°, that is, $R_{180°}(x, y) = (-x, -y)$. This is the same as the reflection in the origin of the x-y coordinate system and rotation of 270°, that is, $R_{270°}(x, y) = (y, -x)$.

Some Considerations Regarding the Freedom Quilt Ethnomodel

An ethnomathematical observation sought to understand this mathematical practice for the freedom quilt from the perspective of internal dynamics and relationships within the slave culture. The modeling perspective uses aspects of academic mathematics to translate this phenomenon for understanding by those from different cultural backgrounds to comprehend and explain this mathematical practice as a whole from the point of view of researchers.

Ethnomathematics helps to clarify intrinsic cultural distinctions while modeling seeks objectivity as an outside observer across cultures. Both ethnomathematics and modeling are essential to help us to understand this mathematical practice through ethnomodeling.

Final Considerations

A study of ethnomathematics using modelling represents a powerful means for validating the real life experiences of students and allows them to become familiar with tools that may enable them to become critical participants in society. In this process, the discussion between teachers and students about the efficiency and relevance of mathematics in different contexts should permeate instructional activities. In this context, the role of teachers is to help students to develop a critical view of the world by using mathematics.

Researchers should be encouraged to give the ethnomodeling of non-Western cultures increased opportunities to introduce new views into old themes. In this regard, we would like to broaden the discussion of possibilities and potentialities for the inclusion of ethnomathematics and mathematical modeling perspectives through ethnomodeling that respect the social and cultural diversity of all students with guarantees for the understanding of our differences through dialogue and respect.

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