



## The Connections Between Culturally Relevant Pedagogy and Ethnomathematics

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### Abstract

*The implementation of Culturally Relevant Pedagogy helps to develop student intellectual, social, and political learning by using their cultural referents to acquire knowledge. It is designed to fit together school culture with students' cultural backgrounds to help them to conceptualize knowledge. It uses prior experiences of minority students to make learning more relevant and effective in order to strengthen their connectedness with school. There is a need to examine the embeddedness of culture mathematics, which takes on the cultural nature of knowledge production into the mathematics curriculum. Ethnomathematics and culturally relevant pedagogy-based approaches to mathematics curriculum are intended to make mathematical content relevant to students. The objective of this theoretical article is to discuss the principles of culturally relevant education according to an ethnomathematical perspective.*

*Keywords: Culturally Relevant Pedagogy, Ethnomathematics, Curriculum, Freedom Quilts, Underground Railroad.*

### Introduction

Major demographic shifts in most countries have led to increasing numbers of culturally, linguistically, socio-economically diverse, and minority students in the educational system. For

example, in the United States, the passage of the *No Child Left Behind Act* (NCLB, 2001) and the resulting requirement that all schools report disaggregated data have brought increased attention to achievement gaps that have persisted for years between minority students and their mainstream peers (Gándara, Maxwell-Jolly, & Rumberger, 2008). According to a wide range of educational indicators including grades, significant inequities continue to exist for these students' scores on standardized tests, dropout and graduation rates, and enrollment in higher education (Education Trust, 2004).

One possible explanation for these gaps may be that disparities in achievement that stem in part from a lack of fit between traditional schools, in which practice is derived almost exclusively from Western cultures, and the home cultures of minority students (Ladson-Billings, 1995). Students whose cultural backgrounds are rooted in western ways of thinking possess an innate educational advantage as compared to students from alternative social cases and other cultural backgrounds. In this regard; minority students are required to learn through cultural ways of thinking and practices other than their own which students from dominate cultures do not contend with or have to do (Rosa, 2010).

In the last three decades, the theories of culturally relevant pedagogy and ethnomathematics were developed in order to ease these sociocultural concerns. This kind of pedagogy is considered as an oppositional pedagogy in which collective empowerment is its focus center. In other words, the overall goal of culturally relevant pedagogy is to empower students through learning activities that help them to develop their literacy, numeracy, technological, social, and political skills in order to be active participants in a democratic society (Ladson-Billings, 1995).

It is also important to emphasize here that culturally relevant pedagogy studies the cultural congruence between students' cultural backgrounds, communities, and schools. In relation to the pedagogical work in schools, mathematical curricular activities must be relevant to the students' cultural backgrounds. The views of pedagogy within the literature on ethnomathematics are compatible with work on culturally relevant pedagogy (Hart, 2003) because it examines the cultural congruence between students' community and school.

This means that cultural congruence indicates teachers' respect for the social, cultural, and linguistic backgrounds of their students. However, it is necessary that schools leaders and teachers acquire knowledge of and respect for the students' various cultural traditions, languages, and mathematical knowledge so they are able to implement the principle of cultural congruence in their schools and classrooms (D'Ambrosio, 1990).

On the other hand, since mathematics usually tends to be presented as a set of objective and universal facts and rules, this subject is often viewed as *culture free* and not considered as a socially and culturally constructed discipline (Lee, 2003). However, to change this perception, it is necessary that school leaders and teachers understand what counts as knowledge in mathematics as well as how knowledge may be related to norms and values of diverse cultures. If educators these professionals deal with integrating diverse cultures in the schools and classrooms, then they need a conceptual framework to make coherent decisions regarding to the curricular activities concerning the mathematics curriculum.

The aim of this paper is to show that there is a need to examine the embeddedness of mathematics in cultures by drawing from an ethnomathematical perspective that takes on the cultural nature of knowledge production into the mathematics curriculum. The argumentation is

that culturally relevant pedagogy may be considered as an ethnomathematical approach to the development of a mathematics curriculum because they intend to make school mathematics relevant and meaningful regarding the promotion of the overall quality of students' educational experience.

### **Culturally Relevant Pedagogy and Ethnomathematics: Curricular Implications**

An important change in mathematical instruction needs to take place in order to accommodate continuous and ongoing change in the demographics of students in mathematics classrooms. It is necessary to integrate a culturally relevant pedagogy into the existing mathematics curriculum because it proposes that teachers contextualize mathematics learning by relating mathematical content to students' real life-experiences (Torres-Velasquez & Lobo, 2004).

The guidelines of both the National Council of Teacher of Mathematics (NCTM, 1991) and the Brazilian Ministry of Education and Culture (Brasil, 1998) highlighted the importance of building connections between mathematics and students' personal lives and cultures. Along with this line, "when practical or culturally-based problems are examined in a proper social context, the practical mathematics of social groups is not trivial because they reflect themes that are profoundly linked to the daily lives of students" (Rosa & Orey, 2006, p. 34). In this perspective, students may be successful in mathematics when their understanding of it "is linked to meaningful cultural referents, and when the instruction assumes that all students are capable of mastering the subject matter" (Ladson-Billings, 1995, p. 141) such as mathematics.

According to this context, curricular activities developed according to the principles of a culturally relevant pedagogy focus on the role of mathematics in a sociocultural context that involves the ideas and concepts associated with an ethnomathematical perspective to solve problems. In other words, mathematics knowledge in the culturally relevant pedagogy is perceived as a version of ethnomathematics because *ethno* is defined as culturally identifiable groups with their jargons, codes, symbols, myths, and even specific ways of reasoning and inferring; *mathema* is defined as categories of analysis; and *tics* is defined as methods or techniques for solving problems faced daily. In a culturally relevant mathematics classroom, teachers build from students' previous knowledge (*ethno*) and direct the lessons toward their culture and experiences (*mathema*) while developing their critical thinking skills (*tics*) (Rosa, 2010).

The inclusion of cultural aspects in the mathematics curriculum have long-term benefits for student mathematical attainment because cultural aspects contribute to recognizing mathematics as part of daily life, enhancing the ability to make meaningful connections, and deepening the understanding of mathematics (Rosa, 2010). In this regard, the pedagogical work towards an ethnomathematics perspective allows for a broader analysis of the school context in which the pedagogical practices transcend the classroom environment because these practices embrace the sociocultural context of the students. In this regard, the pedagogical elements necessary to develop the mathematics curriculum are found in the school community.

In this direction, the field of ethnomathematics presents some possibilities for educational initiatives that help to reach this goal because it is a research program that guides educational pedagogical practices (D'Ambrosio, 1990). However, it is necessary to point out that the incorporation of the objectives of the ethnomathematics program as pedagogical practice in the

school curricula and its operationalization and transmission in the field of education is a recent field of study that is still developing its own identity in the pedagogical arena.

The trend towards ethnomathematical approaches to mathematics curriculum and culturally relevant pedagogy reflects a comprehensive development in mathematics education. Ethnomathematical approaches are intended to make school mathematics more relevant and meaningful to students in order to promote the overall quality of education. In so doing, it is necessary to plead for a more culturally relevant view of mathematics to be incorporated into the school curriculum. For example, it is necessary to elaborate a mathematics curriculum that is based on students' knowledge, which allows teachers to have more freedom and creativity to choose academic mathematical topics to be covered in the lessons (Powell & Frankenstein, 1997).

This pedagogical approach can be achieved through dialogue between teachers and students to discuss mathematical themes that help them to reflect about problems that affect society. In this context, students investigate conceptions, traditions, and mathematical practices developed by the members of distinct cultural groups in order to incorporate them into the mathematics curriculum. In so doing, teachers can engage students in the critical analysis of the dominant culture as well as the analysis of their own culture through an ethnomathematical perspective.

A culturally relevant mathematics curriculum based on an ethnomathematical perspective infuses the students' cultural backgrounds in the learning environment in a holistic. In this learning environment, students are given opportunities to relate their new learning experiences to knowledge and skills they have previously learned manner (Rosa & Orey, 2006). In this regard, it is particularly important that the mathematical learning experiences of students acknowledge their cultural backgrounds and experiences in the learning of mathematics by working with activities that are culturally relevant. This mathematical approach is presented as a cultural response to students' needs by making connections between their cultural background and mathematics (Rosa, 2010).

Culturally relevant pedagogy supports the view that "mathematics is conceived as a cultural product which has developed as a result of various activities" (Bishop, 1988, p. 182). The objective of this approach is to make mathematics more relevant to students because every culture is assumed to have mathematical responses to problems faced daily and these responses are valid content for the development of mathematics lessons. Teachers using this kind of curriculum would be full of examples that are drawn on the students' own experiences that are found in their sociocultural environment.

According to this context, ethnomathematics aims to draw from the students cultural experiences and practices of the individual learners, the communities, and the society at large, in using them as vehicles to not only make mathematics learning more meaningful, but more importantly, to provide students with the insights of mathematical knowledge as embedded in their social and cultural environments (Rosa & Orey, 2008).

### **Symmetrical Freedom Quilts: A Culturally Relevant Activity based on an Ethnomathematical Perspective**

Quilts may be considered as cultural, artistic, and mathematical expressions and manifestations of mental models that represent a specific cultural activity. One example of this

representation was related to the life of slaves in the United States, who formed part of a particular cultural group. In this activity we explored the symmetrical patterns found in specific kinds of quilts called *symmetrical freedom quilts* as well as the connections between culturally relevant pedagogy, ethnomathematics, and the tactile craft and art of quilting of this resilient group of people (Rosa & Orey, 2012).

The study of quilts made by people who endured slavery in the United States provides an opportunity to study the history of slavery in the United States from perspectives that are not well represented in history books. Fabrics used, designs constructed, and stitches made tell stories about oppression, suffering, and resilience of African-Americans living in that time period. Symmetrical freedom quilts were the physical traces (cultural artifacts) of people who made community around the creation of the quilts that expressed their shared values. In this sense, quilt making was a collective response to their human experience (Rosa & Orey, 2009).

The story of symmetrical freedom quilts offers a mixture of fact and myth. Its oral tradition may not give us absolutely accurate information but it reflects a greater truth inherent in the pride of the members of this specific cultural group (former slaves) and their hopes for the future. Maybe there was no special role symmetrical freedom quilts played in the Underground Railroad during slavery in the United States while there are some debates related to if quilts were used as directional codes in helping slaves to run to freedom.

Whether or not the story of the symmetrical freedom quilts is true, it is an appealing story and has touched the hearts of many. In our opinion, these quilts may have played a key role in the ending of slavery in the United States, however we do understand that there is no corroborating scientific evidences that may support these ideas. 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. In other words, quilts may be considered as cultural artifacts (Rosa & Orey, 2012).

The focus of this activity is on one important form of communication as used on the *Underground Railroad* by African-Americans escaping slavery. The term *Underground Railroad* has come to us from a story of a farmer chasing a runaway who testified that this slave vanished on some kind of underground railroad. It was used to describe the network of abolitionists and safe houses that helped slaves escape to Ohio and Canada. Safe houses along the way were known as *stations*, those who guided the escapees were called *conductors* and the runaways themselves were called *passengers* (Burns & Bouchard, 2003).

What we do know is that the *Underground Railroad* was organized by former slaves, freed blacks, and sympathetic whites for the slaves to find shelter, food, drinking water, safe hiding places, and safe paths to follow as they moved to the free states of the north and into Canada. The quilts are referred to as *Freedom Quilts* and they were often hung over a clothes line, porches, or balconies to signal what to do or where to go by using different designs that indicated safety, danger, clues, and landmarks to guide the slaves to freedom.



Figure 1: Freedom Quilt displayed on window-sill

The quilts were sewn to serve as a coded map for runaway slaves to memorize. Slaves followed symbols on *Freedom Quilts* that were hung out during the day to give guidance, directions or dangers that lay ahead. This method of communication was very effective, because bounty hunters apparently never caught onto the quilts and their messages (Rosa & Orey, 2009).

In so doing, quilts were hung with other items to be aired out so most people believed that quilts were just a kind of bed-covering that needed to be aired. However, to those people who knew how to identify the secret codes in the quilt pattern, this meant the difference between slavery and freedom. Since slaves were not taught to read or write in English, they developed an intricate system of secret codes, signs, and signals to communicate with one another along the routes of the Underground Railroad. In order to memorize the whole code, a sampler quilt was used. The sampler quilt included all necessary patterns that were arranged in the order of the code. Freed slaves traveled from one plantation to another to teach to other slaves the translation of the codes of the sampler quilt patterns (Wilson, 2002).

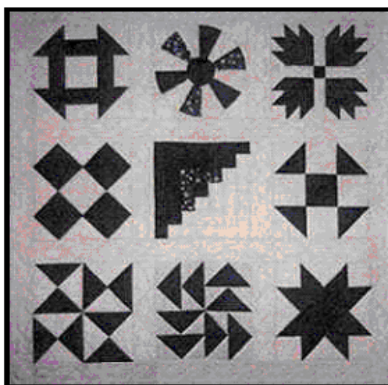


Figure 2: Ozella's Underground Railroad Symmetrical Freedom Quilt

Knot-making was a practice that has interesting historical background in Africa. In this regard, in the slave practices, knots were tied to encode objects with meaning, messages, and protective power. This means that symmetrical freedom quilts contained ties with knots that were often used to indicate the date slaves were to run away from their working plantation. For example, five knots in the cord meant that they should escape on the 5<sup>th</sup> hour, 5<sup>th</sup> day of the 5<sup>th</sup> month. If a quilt showed a house with smoke coming out of the chimney, it meant that the house was safe (Wilson, 2002). In other words, symmetrical freedom quilts present an ingenious,

indeed highly creative and complex way in which to communicate between slaves and safe houses because they did not show any overt connection to slavery (Rosa & Orey, 2012).

The ethnomathematical perspective of this context is to study the mathematical practices of this specific cultural group in the course of dealing with problems faced in their daily lives (D'Ambrosio, 1990). The quilt codes may be considered as mathematical techniques (tics) used by the slaves (ethno) who were trying to manage problems and activities that arose in their own social-political environments (mathema). These codes were transmitted to the members of the slave's families by their ancestors through generations (Rosa & Orey, 2009).

On the other hand, in the context of culturally relevant pedagogy, students “can be successful in mathematics when their understanding of it is linked to meaningful cultural referents” (Ladson-Billings, 1995, p. 41). According to this perspective, 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. For example, blocks often measure 9 x 9, but variations such as 10 x 10 and 12 x 12 may also be used. Below is an example of the Shoo Fly 10 x 10 symmetrical quilt block.

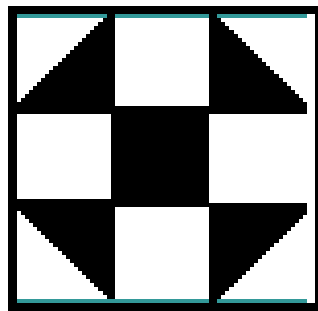


Figure 3: The Shoo Fly quilt block

The use of culturally relevant pedagogy values the previous knowledge of the members of a given community such as former slaves by developing the process of elaborating mathematical models in its different contexts such as political, social, economic, and environmental. In this kind of activity, 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 (Bassanezi, 2002).

Mathematizing ideas involves connecting the informal mathematics developed in a given cultural group to formal mathematical concepts by using ideas, procedures, and mathematical practices that are used by a specific cultural group. In this regard, symmetrical freedom quilt designs contain geometric concepts like symmetry, similarity, congruence, translations, rotations, and reflections (Rosa & Orey, 2009). For example, students mathematize a point of reflection of the Shoo Fly Quilt block, which is determined when a figure is built around a single point called its *center*. In other words, for every point in the figure, there is another point that is found directly opposite on the other side of the figure.

While any point in the  $x$ - $y$  coordinate system may be used as a point of reflection, the most commonly point used is the origin. In the *Shoo Fly* quilt block, the point of reflection is at the origin of the  $x$ - $y$  coordinate system. By applying the general mapping of transformations



$P(x, y) \rightarrow P'(-x, -y)$  in the three points of reflection in the triangle below it is possible to find their images, which are  $A(9,3) \rightarrow A'(-9,-3), B(3,9) \rightarrow B'(-3,-9),$  and  $C(3,3) \rightarrow (-3,-3)$ .

In this specific case, triangle  $A'B'C'$  is the image of triangle  $ABC$  after a reflection on the origin of the Cartesian coordinate system.

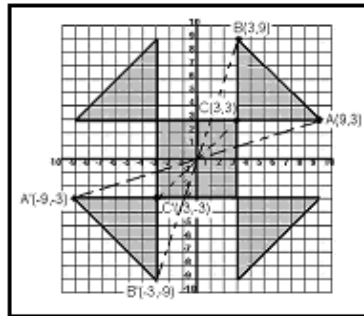


Figure 4: Point of Reflection of the Shoo Fly quilt block at the origin of the  $x$ - $y$  coordinate system

The point of reflection is also called point of symmetry. In a point of symmetry, the center point is a midpoint to every segment formed by joining a point to its image. The three straight dashed lines that connect  $A$  to  $A'$ ,  $B$  to  $B'$ , and  $C$  to  $C'$  pass through the origin, which is the midpoint of each line segment. A figure that has point symmetry is unchanged in appearance after a  $180^\circ$  rotation.

It is important to emphasize that this kind of curriculum motivates students to recognize mathematics as part of their everyday life and enhances students' ability to make meaningful mathematical connections by deepening their understanding of all forms of mathematics. For example, Duarte (2004) investigated the uniqueness of mathematical knowledge produced by workers in home construction industry through the study of mathematical ideas and practices that they develop in the construction sites. In this study, there was a reflection on the mathematical knowledge possessed by the members of this working class in order to academically legitimate their knowledge in order to determine the pedagogical and curricular implications that are inferred in the process of production of this knowledge.

The objective of developing an ethnomathematical curriculum model for classrooms is to assist students to become aware of how people mathematize and think mathematically in their culture, to use this awareness to learn about formal mathematics, and to increase their ability to mathematize in any context in the future. This kind of curriculum leads to the development of a sequence of instructional cultural activities that enables students to become aware of potential practices in mathematics in their culture so that they are able to understand the nature, development, and origins of academic mathematics (Rosa & Orey, 2007).

Students also value and appreciate their previous mathematical knowledge, which allows them to understand and experience these cultural activities from a mathematical point of view, thereby, allowing them to make the link between school mathematics and the real world. An ethnomathematical curriculum helps students understand the nature of mathematics because it is an effective tool that contributes to improve the learning of mathematics of minority students (Rosa & Orey, 2006).



The integration of ethnomathematics and culturally relevant pedagogy into the mathematics curriculum focuses on the development of this research area as a process, rather than a collection of facts because it is based on the idea that mathematics is a human creation that emerges as people attempt to understand and comprehend the world around them. Therefore, mathematics can be seen as a process as well as a human activity rather than just as a set of academic content (Rosa, 2010). The implication of this kind of curriculum is not just about the application of relevant contexts in learning and teaching mathematics, but is also about generating formal mathematics from cultural ideas. Thus formal mathematics is better understood, appreciated, and made more meaningful to its learners.

### **Final Considerations**

A culturally relevant pedagogy and ethnomathematics provide ways for students to maintain their cultural identity while succeeding academically. They are teaching methodologies designed to fit school culture to students' cultural backgrounds to form a firm basis for helping them to understand themselves and their peers, develop and structure social interactions, and conceptualize knowledge. In the context of culturally relevant pedagogy, there is a need to examine the embeddedness of mathematics in culture, drawing from an ethnomathematical perspective that takes on the cultural nature of knowledge production into the mathematics curriculum. Both ethnomathematics and culturally relevant pedagogy-based approaches to mathematics curriculum are intended to make school mathematics relevant and meaningful as well as to promote the overall success of student educational experience.

Mathematics knowledge in the context of culturally relevant can be perceived as an ethnomathematical perspective because in the culturally relevant schools and mathematics classrooms, school leaders and teachers build from the students' ethno or informal mathematics and orients the lesson toward their culture and experiences, while developing the students' critical thinking skills (Gutstein, Lipman, Hernandez, & de los Reyes, 1997). In other words, students are considered as a culturally identifiable group with their own jargons, codes, symbols, myths, and specific ways of reasoning and inferring (ethno) who develop their own categories of analysis (mathema) and apply specific methods or techniques to solve problems faced daily (D'Ambrosio, 1990).

Since ethnomathematics studies the cultural aspects of mathematics and presents the mathematical concepts of the school curriculum in a way that is related to the students' cultural backgrounds by enhancing their ability to make meaningful connections and deepening their understanding of mathematics. This perspective matches teaching styles to the culture and home backgrounds of their students (Ladson-Billings, 2001), which is one of the most important principles of culturally relevant pedagogy.

Ethnomathematics links student's diverse ways of knowing and learning and culturally embedded knowledge with academic mathematics because it explores academic and culturally rich ways to provide more inclusive developmental programs for the diverse populations served at educational institutions. It is a program that includes curricular relevance that builds a curriculum around the local interests and culture of the learners (Rosa, 2010).

Finally, teaching mathematics through cultural relevance and ethnomathematical perspective helps students to know more about reality, culture, society, environmental issues, and themselves by providing them with mathematical content and approaches that enable them to

successfully master academic mathematics. In our opinion, an ethnomathematics approach to the mathematics curriculum is considered a pedagogical vehicle for achieving such a goal.

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