

# DISCUSSING CULTURALLY RELEVANT EDUCATION AND ITS CONNECTION TO CULTURAL ASPECTS OF MATHEMATICS THROUGH ETHNOMATHEMATICS

Discutindo a Educação Culturalmente relevante a sua Conexão com os Aspectos Culturais de Matemática por meio da Etnomatemática

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## ABSTRACT

In this article, we discuss Culturally Relevant Education, Culturally Relevant Schools, Culturally Relevant Pedagogy, and the Cultural Aspects of Mathematics. The common theoretical basis of these knowledge fields is interrelated in relation to the development of Ethnomathematics. In this context, educators respect students from diverse cultures by making continued and genuine efforts to understand their social and cultural perspectives in order to welcome innovative learning experiences and pedagogical actions by approaching them with flexible attitudes and postures towards cross-cultural understandings. Thus, it is imperative to apply policies and practices that values educators, teachers, and students with the objective of enabling them to interact effectively in a culturally diverse environment.

Keywords: Culturally Relevant Schools, Culturally Relevant Pedagogy, Ethnomathematics.

## RESUMO

Nesse artigo, discutimos a Educação Culturalmente Relevante, as Escolas Culturalmente Relevantes, a Pedagogia Culturalmente Relevante e os aspectos culturais da Matemática. A base teórica comum desses campos de conhecimento está inter-relacionada no tocante ao desenvolvimento da Etnomatemática. Nesse contexto, os educadores respeitam os alunos provenientes de diversas culturas, propiciando esforços contínuos e genuínos para entender as suas perspectivas sociais e culturais, a fim de acolher experiências inovadoras de aprendizado e ações pedagógicas, abordando alunos com atitudes e posturas flexíveis em relação aos entendimentos interculturais. Portanto, é imperativo utilizar políticas e práticas que valorizem os educadores, os professores e os alunos com o objetivo de possibilitar a sua interação efetiva em um ambiente culturalmente diverso.

**Palabras chave:** Educação Culturalmente Relevante, Pedagogia Culturalmente Relevante, Etnomatemática.

## 1 INITIAL CONSIDERATIONS

An important change in mathematical instruction needs to take place to accommodate continuous and ongoing change in the demographics of students in mathematics classrooms around the world. It is necessary to integrate a culturally relevant curriculum into the existing mathematics curriculum. According to Torres-Velasquez and Lobo (2004), this perspective is an essential component of Culturally Relevant Education because it proposes that teachers contextualize mathematics learning by relating mathematical content to students' linguistic, cultural, and real-life experiences.

In this context, Rosa and Orey (2007) argue that an ethnomathematics approach to the mathematics curriculum presents us with one pedagogical vehicle for achieving such a goal. The field of ethnomathematics links students' diverse ways of knowing, learning, and culturally embedded knowledge to academic mathematics. It explores academic and culturally ways to provide more inclusive Developmental programs for the diverse populations served at educational institutions (D'Ambrosio, 1990). Ethnomathematics is a program that includes cultural relevance and builds curricula around the local interests, language, and culture of the learners (Rosa, 2010).

Teaching mathematics through cultural relevance and personal or local contexts helps students to know more about reality, culture, society, and environmental issues by providing them with mathematics content and approaches that enable them to successfully master academic mathematical contents. In this context, classrooms and learning environments cannot be isolated from the communities in which they are embedded because they are part of a community with defined cultural practices, which use a cultural context focused on school mathematics and the effect of cultural factors on teaching and learning academic mathematics in culturally relevant school contexts.

## 2 CULTURALLY RELEVANT EDUCATION

According to a wide range of educational indicators including grades, significant inequities continue to exist for student scores on standardized tests, dropout rates, graduation rates, and enrollment in higher education (Gándara, Maxwell-Jolly, & Benavídez, 2007; Rosa, 2010). One possible explanation for these gaps may be that disparities in achievement 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 students (D'Ambrosio, 1990; Ladson-Billings, 1995; Rosa, 2010). Hence, students whose cultural backgrounds are rooted in a Western way of thinking may have an innate educational advantage as compared to students from other cultural backgrounds: culturally and linguistically diverse students are required to learn through cultural ways of thinking and practices other than their own (Hollins, 1996).

This cultural mismatch is often a result of widely divergent worldviews about fundamental concepts such as human nature, natural and educational environments, and social relationships (D'Ambrosio, 2001; Sowers, 2004). Related to this argument, D'Ambrosio (2006) stated that an educational system rooted in the dominant culture is inherently biased. In this regard, Klingner, Artiles & Barletta (2006) argue that if one set of cultural beliefs is considered to be right, then the values of other cultural groups may be treated as less valid, and students from those groups may be perceived as culturally deficient.

In the field of education, the *cultural deficit*<sup>1</sup> model is used to explain differences in achievement that exist among students from different racial and ethnic groups (Katz, 1985). Similarly, Carter and Segura (1979) also stated that in the cultural deficit model, members of minority cultures and students are described as failing to attain the levels of socioeconomic and academic status obtained by the majority culture due to the disadvantages and failures within the minority cultures themselves. This argument leaves little if any responsibility for the dominant culture and its failure to be more inclusive.

Most of the criticism concerning the cultural deficit model in education is related to the promotion of cultural stereotyping that contributes to unproductive efforts that show minority or low income students' home or school settings as the source of low achievement (Kretovics & Nussel, 1994). If school educators and teachers assume a univocal view of culture as a universally valid ideal roughly equivalent to the condition of being civilized, then it is hard to determine how the label of culturally deficient adds to the common-sense notion of uneducated students and how cultural deficiency could be a cause of school failure (Rosa, 2010)

According to Sue and Sue (1990), the student achievement gap is based on environmental factors, lifestyles, and values of ethnic minorities as the basis for cultural

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<sup>1</sup>The original definition of *cultural deficit* is found in Passow's Education in Depressed Areas (1963). According to the National Commission on Excellence in Education - NCEE (1983) and Pallas, Natriello, and McDill (1989), the cultural deficit approach reappeared in the 1980s with the concept of *students at risk*.

deprivation. *Cultural deprivation* highlights the inferiority of a culture (Ridley, 1995), while Atkinson, Morten, and Sue (1993) emphasized it as the *absence*<sup>2</sup> of a specific culture: students may feel alienated not only from their school environments but from themselves as well.

In this regard, cultural deprivation is used to impose white middle-class values in an attempt to link poor school performance, as well as low self-esteem and motivation, to problems with homes, families, traditions, and cultural values (Trueba & Bartolomé, 1997). Deficient cultural values include present versus future time orientations, immediate instead of deferred gratification, an emphasis on cooperation rather than competition, and the placing of less value on education and upward mobility (Carter & Segura, 1979).

In this educational environment, educators and teachers struggle to connect with diverse student populations whose cultural backgrounds are distinctly different from their own (Marion, 2002). Thus, it is necessary that they embrace the relevance of non-dominant cultures as a means of helping students reach high standards in a culturally relevant educational environment. In other words, by adopting a culturally relevant framework, educators and teachers may be able to address issues of educational inequity and confront institutional bias and discrimination.

Educators and teachers may be able to avoid some of the consequences of the cultural deficit model such as higher rates of indiscipline and suspension among minority students (Norton, 2005). In order to reach this goal, Rosa (2010) stated that students' culture, native language, and cultural dialects and jargon must be valued and used as assets in their learning and as a vehicle for their learning process rather than deficits.

For example, Darling-Hammond (1997), the educational system must be relevant to the emotional, psychological and educational needs of all students and to the minority students. They argued that there is a link between students' cognitive performance and their cultural environmental context, and they recommended that the development and implementation of a culturally relevant educational system is one of the best approaches to ameliorate the minority student achievement gap.

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<sup>2</sup>Keddie (1973) argued that "it is not clear of what culture these families and their children can be deprived, since no group can be deprived of its own culture. It appears therefore that the term becomes a euphemism for saying that working-class and ethnic groups have cultures which are at least dissonant with, if not inferior to, the 'mainstream' culture of the society at large" (p. 8). According to this author, if sociologists focus their attention on the supposed deficiencies of students, in terms of cultural deprivation, they may fail to notice the shortcomings of schools.

Therefore, it is essential that the current educational system respect and value student cultural backgrounds and to apply instructional strategies where learners may benefit from their previous experiences and learning styles. In other words, educators and teachers need to possess a sociocultural awareness to be able to both understand their students' needs and build a school cultural climate in which all students learn and achieve (Maddahian & Bird, 2004).

In a culturally relevant educational system, the values of previous experiences and cultural backgrounds of all students are understood and have a prominent place in the teaching-learning process. For example, Klotz (2006) defines culturally relevant educational system as an educational system "that honors, respects, and values diversity in theory and in practice and where teaching and learning are made relevant and meaningful to students of various cultures" (p. 11).

This is an educational system that educates all students by incorporating their diverse emotional, social, cognitive, and cultural experiences into a successful teaching-learning environment. In this regard, Maddahian and Bird (2004) stated that in order to create a culturally relevant educational system, it is paramount for school educators and teachers set goals for students' success: this educational system is grounded in the belief that culturally and linguistically diverse students can and do excel in their academic endeavors.

Culturally relevant education instills ethics of care, respect, and responsibility in the professionals who serve culturally and linguistically diverse students such as educators and teachers (Rosa, 2010). Thus, a transformative goal of culturally relevant schools must be present in all of their activities, thereby facilitating the development of the culture of the schools that are primarily concerned with deliberative and participatory discourse practices (Gay, 2000).

Educators and teachers create and implement spaces for educators and teachers' reflection, inquiry, and mutual support around issues of cultural differences. These spaces encourage educators and teachers to understand and respect individual differences and strive for high educational standards and achievement for all students (Beauboeuf-Lafontant, 1999).

However, Gay (2000) states that if schools want to accomplish the goals of culturally relevant education, then educators and teachers need to work collaboratively with parents and the members of the school community in order to close the achievement gap of its students. In this context, it is crucial for these professionals to improve success rates for all

students by addressing their cultural and academic needs into the pedagogical action that occurs in educational settings.

### 3 CULTURALLY RELEVANT SCHOOLS

Schools across the world have worked to identify and meet the academic deficiencies and social problems prevalent in all subgroups of their students' population. The time has come to look at both the students and the public school system itself for the sources of the problems faced by students. Indeed, D'Ambrosio (2006) affirms that some of these problems may be cultural at their very core, stemming from a dissonance between the cultures of communities and the public school system. According to Gay (2000), Ladson-Billings (1995), and Rosa (2010), in culturally relevant schools, all students receive instruction through pedagogical actions that engage them intellectually by taking into account the pedagogical decisions affecting them most. This is especially important for those who have been traditionally marginalized by the school system.

Similarly, Klotz (2006) affirmed that "the benefits of culturally competent schools are numerous and include preventing academic failure, reducing drop-out rates, and engaging students and their families in the school community" (p. 11). Culturally relevant schools are grounded in the beliefs that culturally and linguistically diverse students are able to excel academically when their culture, language, heritage, and experiences are valued and used to facilitate their learning and development when provided access to high quality teachers, programs, and resources (Nieto, 1999). The "goals for culturally relevant schools are to establish settings where all students are made to feel welcome; are engaged in learning; and are included in the full range of activities, curricula, and services" (Klotz, 2006, p. 11).

One of the most important objectives of culturally relevant schools is to promote inclusiveness and institutionalize teaching-learning processes that allow for opportunities to learn about differences in order to respond appropriately to those differences (Lindsey, Robbins, & Terrell, 2003). Thus, in the context of culturally relevant schools, educators and teachers hold students to high standards and have high expectations for all of them (Rosa, 2010). In this perspective, culturally relevant schools are generally defined as environments that honor, respect, and value diversity. In these schools, the teaching-learning process is relevant and meaningful to all students, specifically, to students from various cultures (Klotz, 2006). In these schools, students' problems are examined within the context of

environmental factors, including prior educational experiences, instruction, second language acquisition, and culture (Beauboeuf-Lafontant, 1999).

The learning environment propitiated by culturally relevant schools allows learning to become the central galvanizing theme for the school community. As a result, Elmore (2000) states that the mobility of educators and teachers do not intervene with the work of the community, which remains strong and relevant to the changing needs of the families of the school community and students who attend the school. According to Burns, Keyes, and Kusimo (2005), in culturally relevant schools, all students, regardless of ethnicity or socioeconomic status, have an opportunity to learn to high standards. Students are also encouraged to learn by building and acquiring their knowledge in multiple dimensional pedagogical activities that are based on interests, experiences, knowledge, and skills that they bring daily to classrooms.

#### **4 CULTURALLY RELEVANT PEDAGOGY**

Scholars have developed a theory of culturally relevant pedagogy: this pedagogy examines the teaching-learning process within a more critical paradigm by making a more explicit connection between students' home culture and school subject matter (Ladson-Billings, 1995). In this regard, "culturally responsive teaching can be defined as using cultural knowledge, prior experiences, frames of reference, and performance styles of ethnically diverse students to make learning encounters more relevant and effective for them" (Gay, 2000, p. 29).

A culturally relevant pedagogy builds upon research in educational anthropology that examines cultural congruence between home and school (Ladson-Billings, 1994). Cultural congruence indicates educators and teachers' respect for the culture of their students. According to Zeichner (1996), in order for school educators and teachers to implement the principle of cultural congruence, they must have knowledge of and respect for the various cultural background, traditions, and languages of students in their schools.

Educators and teachers need to develop a base of general sociocultural knowledge about child and adolescent development; second language acquisition; and the ways in which socioeconomic circumstances, language, and culture shape students' school performance. Therefore, these professionals should develop a clear sense of their own ethnic and cultural identities in order to be able to understand and appreciate those of their

students. This approach helps educators and teachers to understand how their own cultural biases may influence their judgments about students' performance and obstruct students' ability to learn (Zeichner, 1996). A culturally relevant pedagogy focuses on the need for teachers to understand and value the diverse cultures of their students and allows them to explicitly address their understanding of it in the classroom.

According to Moll, Amanti, Neff, and Gonzalez (1992), teachers also need support and encouragement to teach subject matter in a culturally appropriate manner that is situated within students' funds of knowledge<sup>3</sup> they bring to school. In this regard, Ladson-Billings, (1995) stated that students need to be educated within an understanding of the historical legacy of racism in society and its current impact upon education. The understandings and processes of related to culturally relevant pedagogies underscore students' connections to their home culture and provide ways for educators and teachers to support cultural connections in school and then use them to scaffold students' learning (Gay, 2000).

Culturally relevant pedagogies engage teaching styles that validate and incorporate the cultural background, ethnic history, and current societal interests of learners into daily instructional acts. It addresses students' socio-emotional needs and uses ethnically and culturally diverse materials for its pedagogical action in classrooms (Scheurich & Skrla, 2003). It is an educational approach that empowers students intellectually, socially, emotionally, and politically by the making use of cultural and historical references to convey knowledge, impart academic skills, and change students' attitudes towards academic instruction (Ladson-Billings, 1994).

Some researchers have taken their studies one step further into the development of culturally relevant pedagogy by integrating the culture of different racial and ethnic groups of students into the overall curriculum and academic program (Gay, 2000; Howard, 2003; Rosa, 2010, Rosa & Orey, 2013a, Townsend, 2002). In this point of view, Scheurich and Skrla (2003) argued that the basic premise of a culturally relevant pedagogy "is that teachers should teach using philosophies and methods that respect, value, and use positively the strengths of students' home cultures, contexts, and languages" (p.48).

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<sup>3</sup>Moll, Amanti, Neff, and Gonzalez (1992) stated that funds of knowledge refer "to the historically accumulated and culturally developed bodies of knowledge and skills essential for household or individual functioning and well-being" (p. 133). This means that when teachers shed their role of teacher and expert and instead take on a new role as a learner, they can come to know students and their families in new and distinct ways. With this new knowledge, teachers may be able to see that the households of their students contain rich cultural and cognitive resources. These resources can and should be used in classrooms in order to provide culturally responsive and meaningful lessons to tap students' interest and prior knowledge.



For example, Rosa and Orey (2013a) affirmed that culturally relevant pedagogy delineates and promotes the achievement for all students because effective teaching and learning take place in an environment that is culturally supported and learner-centered whereby the strengths students bring to school are identified, nurtured, and utilized to promote their achievement. Some studies of culturally relevant environments (Gay, 2000, Ladson-Billings, 1994) showed that the academic achievement of students who come from culturally and linguistically diverse backgrounds improve if educators and teachers ensure that classroom instruction is conducted in a manner that is relevant to students' home and the culture of their community.

Similarly, Irvine and Armento (2001) suggested that culturally relevant pedagogy allows teachers to provide and use meaningful learning materials, create classroom environments that include cultures, customs, and traditions that are different from their own, and include lessons that assist students in making meaningful connections between their daily experiences and school-related activities. In this regard, Rosa and Orey (2013a) stated that participating in culturally relevant teaching essentially means that educators and teachers create a bridge between students' home and school lives, while they still meet the expectations of the school district, state, and federal curricular requirements.

The purpose of this instructional pedagogy is to utilize student cultural and linguistic backgrounds, knowledge, and experiences to inform teacher lesson planning, methodology, and pedagogy. In this context, Ogbu and Simons (1998) stated that a culturally relevant pedagogy provides a way for students to maintain their cultural identity while succeeding academically. Thus, it is important for teachers to contextualize instruction and schooling by applying culturally relevant forms of pedagogy in their pedagogical practices as well as by embodying relevance and rigor to the educational process.

## **5 ETHNOMATHEMATICAL ASPECTS OF MATHEMATICS**

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 culturally relevant forms of school curricula into the existing mathematics curriculum. The guidelines of the National Council of Teacher of Mathematics (NCTM, 1991) highlighted the importance of building connections between mathematics and students' personal lives and cultures.

In accordance to this approach, Rosa and Orey (2006) affirmed, “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” (p. 34). Culturally relevant mathematical pedagogies should focus on the role of mathematics in diverse sociocultural contexts that involve ideas and concepts associated with ethnomathematics, using an ethnomathematical perspective for solving problems (Rosa & Orey, 2008).

The term ethnomathematics was coined by D’Ambrosio (1985) to describe a diversity of mathematical practices found and used by the members of identifiable cultural groups and may be regarded as the study of mathematical ideas, procedures, techniques, and strategies developed in any culture. D’Ambrosio (1990) defined ethnomathematics in the following way:

The prefix *ethno* is today accepted as a very broad term that refers to the social-cultural context and therefore includes language, jargon, and codes of behavior, myths, and symbols. The derivation of *mathema* is difficult, but tends to mean to explain, to know, to understand, and to do activities such as ciphering, measuring, classifying, inferring, and modeling. The suffix *tics* is derived from *techné*, and has the same root as *technique* (p. 81).

*Ethno* refers to members of a group within a cultural environment identified by their cultural traditions, codes, symbols, myths, and specific ways used to reason and to infer (Rosa & Orey, 2008). *Mathema* means to explain and understand the world in order to transcend, manage and cope with reality so that the members of cultural groups can survive and thrive, and *tics* refer to techniques such as *counting, ordering, sorting, measuring, weighing, ciphering, classifying, inferring, and modeling* (D’Ambrosio, 1990).

*Mathema* also develops the *tics* (techniques, procedures, strategies) within the context of *ethnos* because it consists of daily problems people face, larger problems of humanity, and endeavors of humans to create a meaningful world (Rosa & Orey, 2003). According to D’Ambrosio (2001), the search for solutions for specific problems that help the development of mathematics are always imbedded in a cultural context: in order to understand how mathematics (*tics*) is created, it is necessary to understand the problems (*mathema*) that precipitate it. D’Ambrosio (1993) argued that it is necessary to understand those problems (*mathema*) by considering the cultural context (*ethnos*) that drives them.

The mission of an ethnomathematics program is to acknowledge that there are different ways of doing mathematics by considering the appropriation of the academic mathematical knowledge developed by different sectors of the society as well as by

considering different modes in which different cultures negotiate their mathematical practices D'Ambrosio (2001). In this conception, ethnomathematics is a program that investigates the ways in which different cultural groups comprehend, articulate, and apply concepts and practices that can be identified as mathematical practices. Moreover, ethnomathematics may be described as a way in which people from a particular culture use mathematical ideas and concepts for dealing with quantitative, relational, and spatial aspects of their lives (Rosa, 2010).

This way of viewing mathematics validates and affirms all people's experience of mathematics because it demonstrates that mathematical thinking is inherent to their lives. Further evidence of this assertion is given by Orey (2000), who stated that the "paradigm that diverse cultures use or work within evolves out of unique interactions between their language, culture and environment" (p. 248). Within this context, D'Ambrosio (1990) argued that in an ethnomathematical perspective, mathematical thinking is developed in different cultures in accordance to common problems that are encountered within a cultural context.

In D'Ambrosio's (1993) perspective, in order to solve specific problems, *ad hoc*<sup>4</sup> solutions are created, generalized methods are developed from those solutions to solve similar problems, and theories are developed from these generalized methods. In the context of ethnomathematics, many cultural differentiated groups know mathematics in ways that are quite different from academic mathematics as taught in schools. The tendency has been to consider these *ad hoc* mathematical practices as non-systematic and non-theoretical. In contrast, the study of ethnomathematics underlies a structure of inquiry in *ad hoc* mathematical practices by considering how these practices and problem-solving techniques can be developed into methods and theories.

Since different types of problems are common in different cultures, the kinds of solutions, methods, and theories that are developed may differ from culture to culture. In this regard, what is recognized as a problem and a solution in one culture may have no meaning at all in another culture. Mathematics is identified in cultural activities in both traditional and non-traditional contexts (D'Ambrosio, 1993). Ethnomathematics refers to mathematical concepts embedded in cultural practices and recognizes that all cultures and all people develop unique methods and sophisticated explications to understand and to transform their own realities (D'Ambrosio, 1990; Dowling, 1991; Orey, 2000; Rosa & Orey, 2007).

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<sup>4</sup>*Ad hoc* is a Latin expression that means *for this purpose*. It generally means a solution designed for a specific problem or task, non-generalizable, and which cannot be adapted to other purposes.

Ethnomathematics also recognizes that the accumulated methods of these cultures are engaged in a constant, dynamic, and natural process of evolution and growth. It has come to mean the study of how people within various cultural groups develop techniques to explain and understand their world in response to problems, struggles, and endeavors of human survival. This includes the material needs as well as art and spirituality through the use of the development of artifacts; objects created by members of a specific cultural group that inherently give cultural clues about the culture of its creator and users (D'Ambrosio, 1990).

This perspective “provides an important opportunity for educators to link current events and the importance of these artifacts in the context of ethnomathematics, history, and culture” (Rosa & Orey, 2008, p. 33). Another presupposition of ethnomathematics is that it validates all forms of mathematical explaining and understanding formulated and accumulated by different cultural groups (D'Ambrosio, 1993). This knowledge is regarded as part of an evolutionary process of change that is part of the same cultural dynamism as each cultural group comes into contact with each other one (Zaslavsky, 1996).

A study of the different ways in which peoples resolve problems and the practical algorithms upon which they base these mathematical perspectives becomes relevant for any real comprehension of the concepts and the practices in the mathematics that they have developed over time (D'Ambrosio, 2001). Ethnomathematics refers to the diversity of forms of mathematics that vary as a consequence of being embedded in cultural contexts. In this perspective, Orey (2000) affirmed that “ethnomathematics might be characterized as a tool to act in the world” (p. 250) and as such, it provides insights into the sociocultural role of academic mathematics.

## **6. CULTURALLY RELEVANT PEDAGOGY: AN ETHNOMATHEMATICAL EXAMPLE**

It is useful to examine an example of culturally relevant pedagogy applied in an ethnomathematical perspective that shows mathematical ideas found in an ivory hats or hair pins from the *Mangbetu* people, who occupy the *Uele River* area in the northeastern part of the *Democratic Republic of Congo*, and the geometric algorithm involved in its production, which “gives explicit instructions for generating a particular set of spatial patterns” (Eglash 1999, p. 61). The creation of a Mangbetu design may reflect the artisans' desire to “make it beautiful and show the intelligence of the creator” (Schildkrout & Keim 1990, p. 100) by

adhering to angles that are multiples of 45 degrees. The combination of the 45-degree angle construction technique with the scaling properties of the ivory carving may reveal its underlying structure, which has three interesting geometric features (Eglash 1999).

However, this also suggests that if there were no rules to follow, then it would have been difficult to compare designs. First, each head is larger than the one above it and faces in the opposite direction. Second, each head is framed by two lines that intersect at approximately 90 degrees: one formed by the jaw and one formed by the hair. Third, there is an asymmetry in which the left side shows a distinct angle about 20 degrees from the vertical. The decorative end of this ivory hatpin is composed of four scaled similar heads that shows a scaling design (Figure 1).



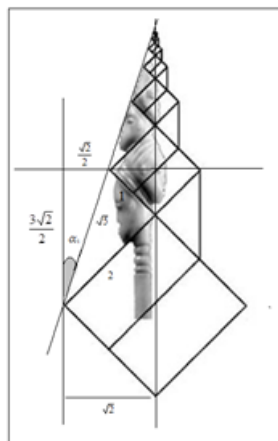
**Figure 1:** Mangbetu ivory sculpture  
Source Eglash (1999)

Then, figure 2 shows the geometric analysis of this sculpture in which the sequence of shrinking squares can be constructed by an iterative process that bisects one square to create the length of the side for the next square. However, Eglash (1999) stated that it is not possible “to know if these iterative squares construction were the concept underlying the sculpture’s design, but it does match the features identified in this process” (p. 68).



**Figure 2:** Geometric analysis of a Mangbetu ivory sculpture  
Source: Eglash (1999)

The mathematical idea implicit in this emic knowledge was passed to the members of the Mangbetu people across generations, who were responsible for the construction, and upkeep of this unique ivory cultural artifact. Consequently, figure<sup>5</sup> 3 shows the geometric relations in the sculpture iterative square structure.



**Figure 3:** Geometric relations in the Mangbetu ivory sculpture  
Source: Adapted from Eglash (1999)

Therefore, Rosa and Orey (2013b) affirm that it is possible to elaborate an etic ethnomodel to show that since  $\alpha_1$  and  $\alpha_2$  are alternate interior angles of a transversal intersecting two parallel lines, then  $\alpha_1 = \alpha_2$ . Thus, the equation shows that:

$$\tan \alpha_1 = \frac{\frac{\sqrt{2}}{2}}{\frac{3\sqrt{2}}{2}} = \frac{\sqrt{2}}{3\sqrt{2}} = \frac{1}{3} \text{ and } \alpha_1 = \arctan \frac{1}{3} \cong 18^\circ$$

The left side of the ivory sculpture is about 20 degrees from the vertical while in the iterative squares structure, the left side is about 18 degrees from the vertical (Eglash 1999). The construction algorithm of this etic ethnomodel can be continued indefinitely, and the resulting structure can be applied to a wide variety of mathematics teaching applications, from simple procedural construction to formal trigonometry. This activity is only one part of an elaborated geometric esthetic based on these angles that are used in many *Mangbetu* designs (Rosa & Orey, 2013b).

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

<sup>5</sup>This figure is not to scale.

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 a set of academic content to be consumed and forgotten (Rosa & Orey, 2013a).

In this regard, D'Ambrosio (1993) affirmed that mathematical practices are socially learned and transmitted to the members of cultural groups. In this example, an emic observation sought to understand this mathematical practice of making this sculpture from the perspective of the internal dynamics and relations within the *Mangbetu* culture by clarifying intrinsic cultural distinctions to the external observers and its contributions to the development of mathematics.

## 7 FINAL CONSIDERATIONS

Actions that include culturally relevant education are developed out of concern for the serious academic achievement gap experienced by low-income students, students of color, and students from linguistically and culturally diverse environments (Ladson-Billings, 1994). In this context, Culturally Relevant Education uses the cultural knowledge, prior experiences, frames of reference, and learning styles of ethnically and linguistically diverse students to make learning more relevant and effective with the objective to strengthen their connectedness with schools and as consequence reduce behavior problems and enhance learning (Klotz, 006).

In this regard, schools benefit from being culturally relevant by contextualizing instruction and schooling practices while maintaining expectations, academic rigor and the help students need to achieve their academic potential (Ladson-Billings, 1995). In culturally relevant schools, educators and teachers are able to recognize and build upon the strengths of students by applying instructional strategies that are culturally relevant. These professionals are able to identify and remove obstacles that may have been inadvertently placed in the path of students through their prior schooling (Nieto, 1999).

In culturally relevant schools, the teaching and learning process must be relevant and meaningful to all students, specifically, to students from diverse linguistic and cultural background (Klotz, 2006). The need for culturally relevant pedagogies reflect on the influence that culture has on learning processes (Gay, 2000) because it is rooted in culturally relevant education that is grounded in the beliefs that culturally and linguistically diverse students are able to excel in their academic endeavor (Rosa, 2010).

According to Ladson-Billings (1994), it is necessary to implement culturally relevant pedagogies into the school curriculum because it helps to develop students' intellectual, social, emotional, and political learning by using their cultural referents to impart knowledge, skills, and attitudes while ethnomathematics studies the cultural aspects of mathematics. It presents mathematical concepts of the school curriculum in a way in which concepts are related to the students' cultural background (D'Ambrosio, 1990). Thereby, encouraging the development of student abilities that allow them to see and make meaningful connections while deepening their growing understanding of mathematics.

Culturally relevant pedagogies examine the embeddedness of mathematics in culture by drawing from a body of literature that takes on the cultural nature of knowledge production into the mathematics curriculum (Rosa & Orey 2013b). This happens along with the integration of ethnomathematical approaches to mathematics curriculum and culturally relevant pedagogies, which are intended to make school mathematics more relevant and meaningful to students and to promote the overall quality of their educational experiences.

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## NOTAS

### TÍTULO DA OBRA

Discussing Culturally Relevant Education and its connection to Cultural Aspects of Mathematics Through Ethnomathematics

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