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Revista Latinoamericana de Etnomatemática, vol. 3, núm. 2, agosto-enero, 2010, pp. 14-23,
Red Latinoamericana de Etnomatemática
Colombia

Revista Latinoamericana de Etnomatemática,
ISSN (Electronic Version): 2011-5474
revista@etnomatematica.org
Red Latinoamericana de Etnomatemática
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Artículo recibido el 25 de junio de 2010; Aceptado para publicación el 2 de agosto de 2010

Ethnomodeling as a Pedagogical Tool for the Ethnomathematics Program

A Etnomodelagem como uma Ferramenta Pedagógica para o Programa Etnomatemática

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Abstract

Mathematics used outside of the school may be considered as a process of ethnomodeling rather than a mere process of manipulation of numbers and procedures. The application of ethnomathematical techniques and the tools of modeling allow us to see a different reality and give us insight into mathematics done in a holistic way. In this perspective, the pedagogical approach that connects the cultural aspects of mathematics with its academic aspects is denominated ethnomodeling, which is a process of translation and elaboration of problems and questions taken from systems that are part of the students' reality.

Keywords: Ethnomathematics, Ethnomodeling, Holistic, Mathematics Education, Modeling

Resumo

A matemática utilizada fora da escola pode ser considerada como um processo de etnomodelagem e não como um mero processo de manipulação de números e prodecimentos. A aplicação das técnicas da etnomatemática e das ferramentas da modelagem permite a visualização de uma realidade diferente ao favorecer a introspecção sobre matemática que é realizada de uma maneira holística. Nesta perspectiva, a abordagem pedagógica que conecta os aspectos culturais da matemática com os seus aspectos acadêmicos é denominada etnomodelagem, que é um processo de tradução e elaboração dos problemas e questionamentos que são retirados dos sistemas que são parte da realidade dos alunos.

Palavras Chaves: Etnomatemática, etnomodelagem, Holístico, Educação Matemática, Modelagem

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Introduction

There are hundreds of reasons for teaching mathematics. In our work, one of the most relevant, reasons involves the consideration of mathematics as an expression of human development, culture and thought and that it is an integral part of the cultural heritage of humankind. Contemporary society places great value on a capitalistic scientific western oriented science and mathematics. On the other hand, ethnomathematics has demostrated that mathematics is composed of many diverse and distinct cultural traditions, not just those emerging from the Mediterranian basin mathematics tradition (D'Ambrosio, 1993).

Mathematical thinking has been influenced by the vast diversity of human characterisitcs such as languages, religions, morals, and economical-social-political activities. In concert with these, humans have developed logical processes related to universal needs to quantify, measure, model and explain, allshaped and operating with in different socio-historical contexts. Because each cultural group has its own way of doing mathematics, these connections often came to represent a given cultural system, especially in the way that they quantified and used numbers, geometric forms and relationships, measured or classified objects in their own environment.

For all these reasons, each cultural group has developed its own way to *mathematize*[1] their own realities. Western scientific arrogance, that is a disrespect of and outright refusal to acknowledge a cultural identity by some scientists and mathematicians puts all processes of understanding and comprehension of many non-Western cultural systems at risk (D'Ambrosio, 1985, 1990; Zaslavsky, 1996). According to Bassanezi (2002), these particularities should not be ignored and they should be respected when individuals attend school because this aspect gives confidence and dignity to students when their previous knowledge is acknowledged. In so doing, a search for new methodological approaches is necessary to record historical forms of mathematical ideas that occur in different cultural contexts.

Rosa, M. & Orey, D. (2010). Etnomodeling as a Pedagogical Tool for the Ethnomathematics Program. *Revista Latinoamericana de Etnomatemática*, 3(2). 14- 23

Ethnomathematics as a Holistic Approach to Mathematics Education

One of the most important concepts of ethnomathematics is the association of the mathematics found in diverse cultural contexts. Ethnomathematics as a research paradigm is much wider than traditional concepts of mathematics and ethnicity or any current sense of multiculturalism. D'Ambrosio (1990) referred to *ethno* as that related to distinct cultural groups identified by cultural traditions, codes, symbols, myths, and specific ways of reasoning and inferring. In so doing, ethnomathematics may be considered as the way that various cultural groups mathematize because it examines how both mathematical ideas and mathematical practices are processed and used in the daily activities. It can be also described as the arts or techniques developed by diverse students to explain, to understand, and to cope with their own environment (D'Ambrosio, 1992).

In accordance to Barton (1996) ethnomathematics embraces the mathematical ideas thoughts and practices as developed by all cultures. From his perspective, a body of anthropological research has come to focus on both the intuitive mathematical thinking and the cognitive process that are largely developed in minority cultural groups. Ethnomathematics may also be considered as a program that seeks to study how students have come to understand, comprehend, articulate, process, and ultimately use mathematical ideas, concepts, and practices that may solve problems related to their daily activity.

In this context, Barton (1996) stated that ethnomathematics is not only the study of mathematical ideas because it is also the study of anthropology and history. This means that the study of the history of mathematics and mathematics attempts to identify the cultural and mathematical contributions of different cultures across the world. Seen in this context, the focus of ethnomathematics consists essentially of a serious and critical analysis of the generation and production of the mathematical knowledge and intellectual processes, the social mechanisms in the institutionalization of knowledge; and the diffusion of this knowledge (Rosa & Orey, 2006). In this much more holistic[2] context of mathematics that uses an anthropological perspective to include diverse perspectives, patterns of thought, and histories, the study of the systems[3] taken from reality help students to come to reflect, understand, and comprehend extant relations among all of the components of the system.

Rosa (2000) defined ethnomathematics as the intersection of cultural anthropology, mathematics, and mathematical modeling, which is used to help students to translate diverse mathematical ideas and practices found in their communities.

All individuals and students as well possess and develop both anthropological and mathematical concepts. These concepts are rooted in the universal human endowments of curiosity, ability, transcendence, life, and death. They all characterize our very humanness. Awareness and appreciation of cultural diversity that can be seen in our clothing, methods of discourse, our religious views, our morals, and our own unique world view allow us to understand each aspect of the daily life of humans (Rosa & Orey, 2006).

The unique cultural background of each student represents a set of values and the unique way of seeing the world as it is transmitted from one generation to another. The principals of anthropology that are relevant to the work of ethnomathematics includes the essential elements of culture such as language, economy, politics, religion, art, and the daily mathematical practices of diverse groups of students. Since, cultural anthropology gives us tools that increase our understanding of the internal logic of a given society; detailed anthropological studies of the mathematics of distinct cultural groups most certainly allows us to further our understanding of the internal logic and beliefs of diverse group of students.

Ethnomathematics and Modeling

Historically, models that arise from reality have been the first paths towards providing abstractions of mathematical concepts. Ethnomathematics that uses the manipulations of models of reality and modeling as a strategy of mathematical education uses the codifications provided by others in place of formal language of academic mathematics. Within this context, D'Ambrosio (1993), Bassanezi (2002); Monteiro (2004); Rosa & Orey (2006) stated that mathematical modeling is a methodology that is closer to an ethnomathematics program. ethnomathematics may be defined as the intersection between cultural anthropology and institutional mathematics, that utilizes mathematical modeling to interpret, analyze, explain and solve real world problems or mathematize existing phenomena (D'Ambrosio, 1993; Rosa, 2000, Orey & Rosa, 2003).

Rosa, M. & Orey, D. (2010). Etnomodeling as a Pedagogical Tool for the Ethnomathematics Program. *Revista Latinoamericana de Etnomatemática*, 3(2). 14- 23

Investigations in modeling have been found to be useful in the translation of ethnomathematical contexts by numerous scholars in Latin America (Bassanezi, 2002; Biembengut, 2000; Ferreira, 2004; Monteiro, 2004; Rosa & Orey, 2007a, 2007b; Rios, 2000) in order to document and study the mathematical practices and ideas found in diverse traditions. It has also become an important tool used to describe and solve problems arising from specific systems such as cultural, economical, political, social, environmental, which brings with it numerous advantages to mathematics learning (Barbosa, 1997; Bassanezi, 2002; Biembengut, 1999; Cross & Moscardini, 1985; Hodgson & Harpster, 1997; Orey, 2000; Orey & Rosa, 2003).

Outside of the ethnomathematics related research paradigm, it is known that many scientists search for mathematical models that can translate their deepening understanding of both real world situations and diverse cultural contexts. This enables them to seek and take possible (i.e. political) positions in relationship to the objects of the study (Bassanezi, 2002; D'Ambrosio, 1993; Rosa & Orey, 2006). Using modeling as a tool towards pedagogical action, students have been shown to learn how to find and work with authentic situations and real-life problems.

Ethnomodeling

Ethnomodeling is a process of elaboration of problems and questions growing from real situationsthat form an image or sense of an idealized version of the *mathema*. 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). According to D'Ambrosio (2000), "this process is modeling" (p. 142). In this perspective, by analyzing their role in 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 made by them to create an understanding of all components of the system as well as the interrelationships among them (D'Ambrosio, 1993; Bassanezi, 2002).

The use of modeling as pedagogical action for an etnomathematics program values the previous knowledge of the community by developing student capacity to assess the process of elaborating a mathematical model in its different applications and contexts by having started with the social context, reality and interests of the students and not by inforcing a set of external values and curriculum without context or meaning for the learner. Bassanezi (2002) characterizes this process as "ethno-modeling" (p. 208), and defines 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 ethnmodeling, teaching is much more than the transferance of knowledge because teaching becomes an activity that introduces the creation of knowledge (Freire, 1998). This approach in mathematics education is the antithesis of turning students into containers to be filled with information (Freire, 1970).

In our opinion, it is necessary for school curriculum, to translate the interpretations and contributions of ethnomathematical knowledge into systemized mathematics because students will be able to analyze the connection between both traditional and non-traditional learning settings.

Final Considerations

Any study of ethnomathematics and mathematical modeling represents a powerful means for validating a student's real life experiences, and gives them the tools to become critical participants in society. In so doing, educators should be empowered to analyze the role of what Borba (1990) refers to as a student's ethnoknowledge[4] in the mathematics classroom. There exists a need to create a new role to mathematics instruction that empowers students to understand power and oppression more critically by considering the effect of culture on mathematical knowledge by working with their students to uncover the distorted and hidden history of mathematical knowledge.

This perspective forms the basis for significant contributions of a Freirean-based ethnomathematical perspective in re-conceiving the discipline of mathematics and in a pedagogical practice. The use of Freire's (1970) dialogical methodology is seen as

essential in developing the curricular praxis of ethnomodeling by investigating the ethnomathematics of a culture in constructing a curriculum with people from other cultures to create curricula that enable the enrichment for all people's knowledge of mathematics. Seen in this context, we would like to broaden the discussion of possibilities for the inclusion of ethnomathematics and mathematical modeling perspectives that respect the social and cultural diversity of all people with guarantees for the development of understanding our differences through dialogue and respect. This is how ethnomodeling can empower students in this century against all kinds of domination and oppression.

Endnotes

[1] Mathematization is a process in which individuals from different cultural groups come up with different mathematical tools that can help them to organize, analyze, comprehend, understand, and solve specific problems located in the context of their real-life situation. These tools allow them to identify and describe a specific mathematical idea or practice in a general context by schematizing, formulating, and visualizing a problem in different ways, discovering relations, discovering regularities, and transferring a real world problem to a mathematical idea through mathematization.

[2] A holistic context consists essentially of a critical analysis of the generation (creativity) of knowledge, and the intellectual process of its production. The focus on history analyzes the social mechanism and institutionalization of knowledge (academics), and its transmission through the educational process (D'Ambrosio, 1990).

[3] A system is a part of reality considered integrally. It is a set of components taken from the reality, which analyses components interrelationships between these components (D'Ambrosio, 1990).

[4] Ethnoknowledge is acquired by students in the pedagogical action process of learning mathematics in a culturally relevant educational system. In this process, the discussion between teachers and students about the efficiency and relevance of mathematics in different contexts should permeate instructional activities. The ethnoknowledge that students develop must be compared to their academic mathematical knowledge. In this

process, the role of teachers is to help students to develop a critical view of the world by using mathematics.

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