ETHNOMODELLING: EXPLORING GLOCALIZATION IN THE CONTEXTS OF LOCAL (EMIC) AND GLOBAL (ETIC) KNOWLEDGES

ETHNOMODELAGEM: EXPLORANDO A GLOCALIZAÇÃO NOS CONTEXTOS DOS CONHECIMENTOS LOCA (ÊMICO) E GLOBAL (ÉTICO).

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ABSTRACT

The acquisition of both *local* (emic) and *global* (etic) knowledge forms is an alternative goal for the implementation of ethnomodelling research. Local knowledge is essential for an intuitive and empathic understanding of mathematical ideas, procedures, and practices developed by the members of distinct cultural groups, which is important for conducting effective ethnographic fieldwork. Furthermore, local knowledge is a valuable source of inspiration for the development of global hypotheses, while global knowledge is essential for the achievement of cross-cultural comparisons. Such comparisons demand standard analytical units and categories to facilitate communication. Glocal (dialogical) knowledge is the third approach for conducting ethnomodelling research that makes use of both local and global knowledge through processes of dialogue and interaction. In this paper, we define ethnomodelling as the study of mathematical phenomena within a culture because it is a social construct and is culturally bound. Thus, ethnomodelling brings the cultural aspects of mathematics into mathematical modelling process. Finally, the main purpose of this paper is to share the use of a combination of local, global, and glocal approaches in the research area of ethnomodelling, which contributes to the acquisition of a more complete understanding (glocal) of mathematical practices developed by the members of distinct cultural groups.

Keywords: Ethnomodelling; Local Approach; Global Approach; Glocalization

RESUMO

A aquisição de ambos os conhecimentos local (êmico) e global (ético) é um objetivo alternativo para as pesquisas em etnomodelagem. O conhecimento local é essencial para uma compreensão intuitiva e empática das ideias, procedimentos e práticas matemáticas desenvolvidas pelos membros dos grupos culturais distintos, sendo importantes para a realização de um trabalho de campo etnográfico eficaz. Além disso, o conhecimento local é uma valiosa fonte de inspiração para os desenvolvimento de hipóteses globais enquanto o conhecimento global é essencial para a realização de comparações interculturais, que exigem categorias e unidades padronizadas de análise para facilitar a comunicação. O conhecimento glocal (dialógico) é a terceira abordagem para a condução de pesquisas em etnomodelagem, que utiliza ambos os conhecimentos local e global por meio de um processo interacional e dialógico. Definimos a ethnomodelagem como o estudo de fenômenos matemáticos que ocorrem em uma determinada cultura, pois é uma construção social e culturalmente enraizada. Assim, a ethnomodelagem traz os aspectos culturais da matemática para o processo de modelagem matemática. Finalmente, o principal objetivo deste artigo é discutir como utilizar uma combinação das abordagens dos conhecimentos glocal e local em nosso trabalho na área de etnomodelagem, que contribui para a aquisição de uma compreensão mais completa (glocal) das práticas matemáticas desenvolvidas pelos membros de grupos culturais distintos.

Palavras chave: Etnomodelagem; Abordagem Local; Abordagem Global. Glocalização.

1. Introduction

Throughout history, people have explored other cultures and shared or traded knowledge, often hidden in traditions, practices, and diverse customs. This exchange of *cultural capital*[1] has enriched and equalized all cultures; even the Greek foundations of European civilization were founded upon Egyptian civilization (Powell & Frankenstein, 1997).

One consequence of this approach is a widespread consensus, which supports the supremacy of Western scientific and logical systems (global) at the exclusion of most other traditions (local). Thus, dominant, imperial, and colonial forms of culture and values considerably affect the way individuals understand concepts of any mathematical ideas and practices.

In mathematics, methods of problem solving, and teaching materials are based on the traditions of written sciences, with very few exceptions, by Western academics. Most examples used in the teaching of mathematics derive from non-Latino North American and European cultures. These same problem-solving methods rely primarily on the European view on mathematics.

On the other hand, it is necessary to acknowledge that different cultures have contributed to the development of mathematical ideas, procedures, and practices that have enriched traditional concepts of mathematics. This interaction may leave out a significant amount of knowledge in its local and cultural forms. In this regard, “the culture of a group results from the fraction of reality that is reachable by the group” (D’Ambrosio, 2006a, p. 5).

During the conduction of investigations of mathematical knowledge developed by the members of distinct cultural groups, researchers come across a set of ideas, procedures, and mathematical practices that are different from those studied in academic institutions. This set of features can be translated academically through ethnomodelling (Rosa & Orey, 2010), the process that involves a holistic performance that embodies the

[1]Cultural capital is the knowledge, experiences, and connections that individuals have had through the course of their lives, which enables them to succeed more than individuals from a less experienced background. It also acts as a social relation within a system of exchange that includes the accumulated cultural knowledge that confers power and status to the individuals who possess it (Rosa, 2010).

concepts of globalization and localization. This process expands an intercultural[2] perspective that appreciates, respects, and values the mathematical knowledge that was developed by members of distinct cultural groups.

However, the members of distinct cultural groups need to find a balance in order to ensure that local mathematical ideas and procedures are not overwhelmed by the global notions and practices. This balance can be found by the use of *glocalization*[3], which is the ability of a culture, when it encounters other cultures, to absorb influences that naturally fit into and can enrich that culture, to resist those things that are truly alien and to compartmentalize those things that, while different can nevertheless be enjoyed and celebrated as different (Friedman, 2000).

According to this assertion, "every culture is subject to inter and intra-cultural[4] encounters" (D'Ambrosio, 2006b, p. 76). In this regard, when researchers investigate mathematical knowledge developed by the members of distinct cultural groups, they may be able to find distinctive characteristics of mathematical ideas and procedures these members developed throughout history. However, an outsider's (etic, global) understanding of these *cultural traits*[5] is an interpretation that may misinterpret the nature of the mathematical practices developed by the members of these cultural groups.

The multiplicity of cultures, each one with a system of shared knowledge and a compatible set of behavior and values facilitates cultural dynamics by enabling an expanding familiarity with the rich diversity of humanity, which creates an important need for a field of research that studies the phenomena and applications of modelling in diverse cultural settings. This kind of cultural perspective used in problem solving methods, conceptual categories and structures, and models used in representing data that translates cultural mathematical practices by using modelling processes is *ethnomodelling* (Bassanezzi, 2002). It also recognizes how the foundations of ethnomodelling differs from the traditional modelling methodologies.

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[2]Intercultural encounters describe experiences between at least two people who are different in significant ways culturally or have distinct cultural backgrounds such as regional, social, linguistic, economic, political, ethnic, or religious backgrounds.

[3]*Glocalization* is a concept coined in business circles that means to create products for the global market but customized to suit local cultures and tastes. It is a term coined by Japanese marketing professionals as *dochakuka*, which is composed by three ideographs *do* (land), *chaku* (arrive at), and *ka* (process of). This neologism is composed of the terms *globalization* and *localization*, which has emerged as the new standard in reinforcing positive aspects of worldwide interaction, be it in textual translations, localized marketing communication, and sociopolitical considerations Glocalization serves as a negotiated process whereby local customer considerations are coalesced from the onset into market offerings via bottom-up collaborative efforts. The concept of glocalization follows a sociological/historical approach regarding society and its dynamic social transformations (Khondker, 2004). For example, it is possible to refer to a glocalized product if it meets most of the needs of an international community as well as customized for the people in a specific group (Robertson, 1999).

[4]Intracultural encounters describe experiences between at least two people who are from the same culture or have culturally similar backgrounds.

[5]A cultural trait is a socially learned system of beliefs, values, traditions, symbols, and meanings that the members of a specific culture acquire throughout history. It identify and coalesce a cultural group because traits express the cohesiveness of the member of the group.

2. Ethnomathematics and Modelling

Historically, models that arise from reality have been the first paths that have provided numerous abstractions of mathematical concepts. Ethnomathematics uses the manipulations of models taken from reality and modelling as a strategy of mathematical education and incorporates the codifications provided by others in place of a formal language of academic mathematics.

Mathematical modelling is a methodology that is closer to an ethnomathematics program (D'Ambrosio, 1993) and is defined as the intersection between cultural anthropology and institutional mathematics, and utilizes mathematical modelling to interpret, analyze, explain, and solve real world problems (Rosa, 2000). In order to document and study diverse mathematical ideas, procedures, and practices found in many traditions, modelling has become an important tool used to describe and solve problems arising from cultural, economic, political, social, environmental contexts.

The modelling process brings with it numerous advantages to the learning of mathematics (Rosa & Orey, 2003). At the same time, outside of the community of ethnomathematics researchers, it is known that many scientists search for mathematical models that translate their deepening understanding of both real world situations and diverse cultural contexts. This enables them to take social, economic, political, and environmental positions in relationship to the objects of the study (Rosa & Orey, 2007).

Ethnomodelling is a process of the elaboration of problems and questions that grow from real situations (systems), and forms an image or sense of an idealized version of the *mathema*[6]. This perspective essentially forms a critical analysis for the generation and production of knowledge (creativity), and forms the intellectual process for its production, the social mechanisms of institutionalization of knowledge (academics), and its transmission (education). This process is modelling (D'Ambrosio, 2000).

In this context, by analyzing their role in reality as a whole, this holistic context allows those engaged in the process of modelling to study systems of reality in which there is an equal effort made to create an understand of the components of the system as well as their interrelationships (Bassanezi, 2002). By having started with a social or reality-based context, the use of modelling as a tool begins with the knowledge of the student by developing their capacity to assess the process of elaborating a mathematical model in its different applications and contexts (D'Ambrosio, 2000). This ethnomodelling process uses the reality and interests of the students, versus the traditional model of instruction, which makes use of external values and curriculum without context or meaning (Bassanezi, 2002).

[6]Mathema is the actions taken by people from distinct cultural groups to explain and understand the world around them. In other words, they have to manage and cope with their own reality in order to survive and transcend. Throughout the history of humankind, *technes (or tics)* of *mathema* have been developed in very different and diversified cultural environments, that is, in the diverse *ethnos.* Thus, in order to satisfy the drives towards survival and transcendence, human beings have developed and continue to develop, in every new experience and in diverse cultural environments, their own ethnomathematics (D'Ambrosio, 1990).

Ethnomathematics can be defined as the mathematics practiced and elaborated by the members of distinct cultural groups and involves the mathematical practices that are present in diverse situations in the daily lives of these members (D’Ambrosio, 1998). Figure 1 shows that this interpretation is based on the dambrosian trinomial: *Reality → Individual → Action → Reality.*

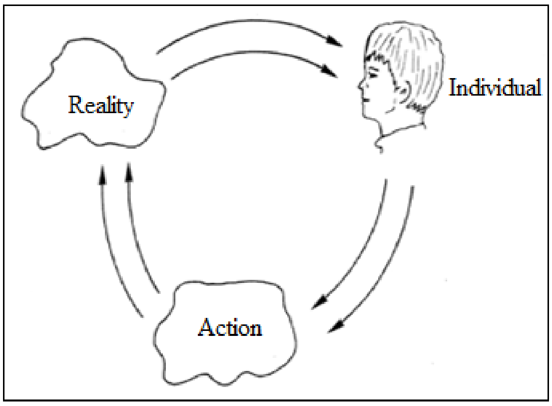

Figure 1. The dambrosian trinomial
Source: D’Ambrosio (1998)

Investigations in ethnomodelling interpret established forms of knowledge such as communications, languages, religions, arts, techniques, sciences, mathematics in different cultural environments. This approach is “based on an integrated study of the generation, intellectual and social organization, and diffusion of knowledge. (…) This cycle of knowledge is affected by the cultural dynamics of the encounters of different cultural environments” (D’Ambrosio, 2006b, p. 77). Figure 2 shows the dambrosian cycle of knowledge.

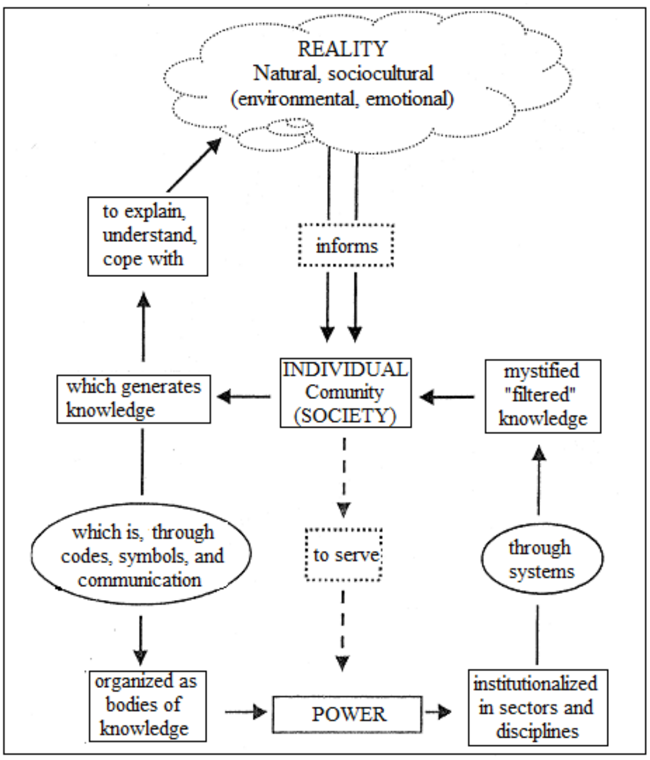

Figure 2. The dambrosian cycle of knowledge
Source: D’Ambrosio (1998)

There are members from distinct cultural groups who participate in a similar process, thus, the cycle is the same for all cultures. Individual agents are permanently receiving information and processing it, and performing action, but although immersed in a same global reality, the mechanisms to receive information of individual agents are different (D'Ambrosio, 2006a).

It is necessary to highlight how members of distinct cultural groups have come to capture and process information in diverse ways and, as a consequence of their different locations, needs and actions in the knowledge cycle. This context allows for the translation of interpretations and contributions of ethnomathematical knowledge into systemized mathematics as students learn to construct their own connections between both traditional and non-traditional learning settings through translations and symmetrical dialogues.

Encounters between cultures or interactions between levels of culture involve dialogues that make inroads into one another, different intra-cultural levels seem attractive and useful to both sides. In this context, the emerging *otherness* necessitates a translation, which is primarily concerned with giving the *otherness* its due without subsuming it under pre-conceived notions (Iser, 1994).

These "encounters are examined in various ways, thus permitting the exploration of more indirect interactions and influences, and the examination of subjects on a comparative basis" (D'Ambrosio, 2006b, p. 78). Thus, translation is a key concept for understanding encounters between cultures and interactions within the members of distinct cultural groups. This approach implies in translation of otherness (mathematical ideas, procedures, and cultures) without subsuming it under preconceived notions (Iser, 1994).

3. Defining Ethnomodelling

Numerous studies have demonstrated sophisticated mathematical ideas and practices that include geometric principles in craftwork, architectural concepts, and practices in the activities and artifacts of many indigenous, local, and vernacular cultures (Eglash et al, 2006; Orey, 2000; Rosa & Orey, 2013; Urton, 1997). Mathematical concepts related to a variety of mathematical procedures and cultural artifacts form part of the numeric relations found in universal actions of measuring, calculation, games, divination, navigation, astronomy, and modelling (Eglash et al., 2006).

It is necessary to "invoke a notion of local vitality, which releases an unexpected and astonishing cultural power, reinforced by the advantage supplied by the continual full participation in the community, simultaneous with the action in the global world" (D'Ambrosio, 2006b, p. 76). The study of ethnomodelling is a powerful tool used in the translation of problem-situations that make use of mathematical ideas and practices within a culture. Therefore, ethnomodelling is a fluid and dynamic research approach in which incorporates both cultural universals and culturally specific phenomena. Its innovative lenses lead to new findings in the development of inclusive approaches in mathematics education.

We apply the term translation to describe the process of modelling local cultural systems, which may have Western academic mathematical representations (Rosa & Orey, 2010). Indigenous designs may be simply analyzed as forms and the applications of symmetrical classifications from crystallography to indigenous textile patterns (Eglash at al., 2006). On the other hand, ethnomathematics uses modelling to establish the relations found between local conceptual frameworks and mathematical ideas embedded in numerous designs. We define this relationship as *ethnomodelling*, which is the act of translation that is an essential part of the modelling process.

In some cases, translation into Western-academic mathematics is direct and simple such as that found in counting systems and calendars (Eglash at al., 2006). For example, figure 3 shows the mathematical knowledge that lace makers in the northeast of Brazil use to make geometric lace patterns have mathematical concepts that are not associated with traditional geometrical principles, which is possible to model by applying ethnomodelling.

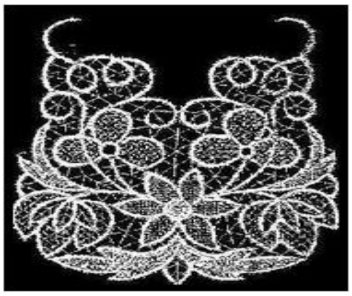

Figure 3. Geometric lace patterns
Source: Rosa and Orey (2013)

Ethnomodelling takes into consideration diverse processes that help in the construction and development of scientific and mathematical knowledge that includes collectivity, and the overall sense of and value for creative and new inventions and ideas. The processes and production of scientific and mathematical ideas, procedures, and practices operate as a register of the interpretative singularities that regard possibilities for symbolic constructions of the knowledge in different cultural groups. In this context, figure 4 shows ethnomodelling as the intersection of three research fields: cultural anthropology, ethnomathematics, and mathematical modelling.

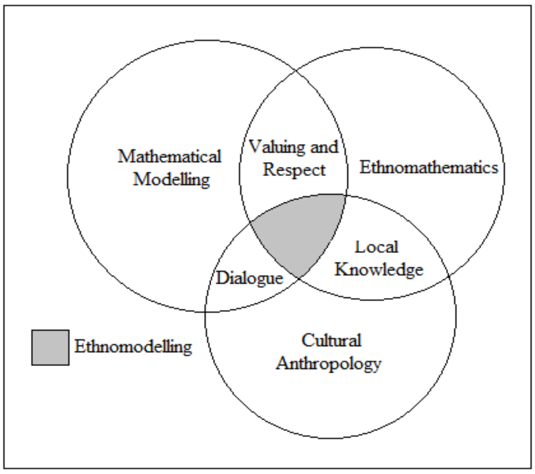

Figure 4. Ethnomodelling as the intersection region of three knowledge fields
Source: Rosa and Orey (2013)

In this process, the intersection between mathematical modelling and ethnomathematics relates to the respect and the valorization of the previous knowledge and traditions developed by the students, which enables them to assess and translate problem-situations by elaborating mathematical models in different contexts (Rosa & Orey, 2007). Thus, it becomes necessary to start by using the sociocultural contexts, realities, and interests or unique needs of students and not mere enforcement of a ridged set of external curricular values or often-decontextualized activities. This approach facilitates the development of dialogue between modelling and cultural anthropology in order to reach a critical transitivity, which is a horizontal rather than vertical or hierarchical relationship (Freire, 1998).

Local knowledge then becomes the sources and forms the intersection between ethnomathematics and cultural anthropology when members of distinct cultural groups use it to solve problems faced in their own contexts. It also becomes a body of knowledge often built up by these members over time and across generations of living in close contact with their own historical, social, cultural, and natural environment (D'Ambrosio, 1990).

This context allows for the development of a definition of ethnomodelling as the translation of mathematical ideas, notions, procedures, and practices in which the prefix *ethno* relates to the specific mathematical knowledge possessed by the members of distinct cultural groups, where ethnomathematics adds cultural perspectives to the modelling process through ethnomodelling.

In the process of ethnomodelling, global mathematical knowledge must be reinvented and adapted to the local reality. In addition, effective localization requires global mathematical knowledge just as localization, paradoxically, also helps to promote globalization. This process is essentially about accessibility, namely making things easy to be accepted on local terms by the local while rendering selves subject to change and transformation. It is important to focus on the process of glocalization, whereby a practice undergoes local transformation at the same time as it diffuses globally (Latour, 1993). Thus, mathematical ideas, procedures, and practices are grounded in the cultural, economic, political, environmental, and social contexts in which they unfold.

Ethnomodelling yields a number of insights into glocalized research, including the interplay of political, cultural and technical dimensions of institutional work in the process of internationalizing new practices, and in particular, the interaction of symbolic transformation of mathematical practices during the glocalization process.

3.1. An Etymological Study of Ethnomodelling

In the context of the etymology of ethnomodelling, the prefix *ethno* does not refer to any specific race or people only, but also to differences between the members of distinct cultural groups. Ethno is a Greek word that means *people*, *nation, culture,* or *foreign people* in which their basic differences are based on language, history, religion, customs, institutions, and on the subjective self-identification of the people, as well as on racial oppression or nationality. Thus, ethno represents the combination of the particular and the universal, which leads to mathematical activities that take place within a culture.

Since the art of using techniques and the application of procedures are important elements of the ethnomodelling process, it is important to highlight here that the patron goddess of practical knowledge in ancient Greece was *Techne*, whose name originated from the words *technique* and *technology*, thus, *techne* is the Greek word for art. In this context, *techne* is a form of practical knowledge that results in productive action. This etymology reveals a deep connection between technology and the practices of living and creating diverse forms of techniques and procedures to solve problems faced in daily lives. Techne is the set of principles or methods involved in the production of objects or the accomplishment of artifacts that guides scientists and educators to develop a sociocultural standard for the teaching and learning process. This is one of the most important purposes of ethnomodelling.

Mathema is associated with the search for explanations, for understanding, meeting the challenges of contemporary society, as well as it is responsible for some body of knowledge within a certain context, which has not been recognized in historiography. It is implicit in the ethnomodelling process because, etymologically, it means to learn, to know, to explain, and to cope with notions associated with numbers and counting, hence with arithmetic, and with geometric reasoning. This practical knowledge coupled with modelling process results in productive action. In this context, *mathema* is not related to mathematics, which is a neologism introduced in the 15^{th} century.

Ethnomodelling is a tool that responds to its surroundings and is culturally dependent (Rosa & Orey, 2010), thus, it does not to provide a Western stamp of approval to mathematical ideas, procedures, and practices of other cultures, but to recognize that they contributed to the development of mathematics throughout history. Since ethnomodelling studies mathematical ideas, procedures, and practices developed in culturally different environments, it is necessary to understand how mathematical concepts originate, conceptualize, and adapt into the practices developed in distinct cultural groups.

4. Three Approaches of Ethnomodelling

The challenge researchers have to deal with this issue is to develop methodological procedures that help them to understand or perceive the culturally bound mathematical ideas, procedures, and practices developed by the members of distinct cultural groups without letting their culture interfere with the cultural background of these members. In this context, the members of distinct cultural groups developed their own interpretation of the *local* culture (*emic* approach) opposed to the outsiders' *global* interpretation (*etic* approach) of that culture.

It is necessary to deconstruct the notion that mathematical ideas, procedures, and practices are uniquely European in origin as they are based on certain philosophical assumptions and values that are strongly endorsed by Western civilizations. On the one side are beliefs that mathematical procedures are unique and that the sociocultural unit of operation is the individual; on the other side are beliefs that mathematical practices are the same and that its goals and techniques are equally applicable across all cultural groups. An important goal is to challenge and strengthen existing theoretical models, both their assumptions of mathematical universality and their claims of descriptive, predictive and explanatory adequacy. A second goal is to understand and explain existing variation of mathematical ideas, procedures, and practices that vary in culture of origin, race, ethnicity, gender, and other sociocultural characteristics.

Therefore, when working with ethnomodelling, it is possible to identify at least three approaches that help us to investigate, study, and understand the mathematical ideas, procedures, and practices developed by the members of any given cultural group:

1. *Global* (*etic-outsider*) is the outsiders' view on beliefs, customs, and scientific and mathematical knowledge of the members of distinct cultural groups. Globalization has reinforced the utilitarian approach to school mathematics and the Western bias in the prevailing mathematics curricula, as well as helped to globalize pervasive mathematical ideologies. In particular, school mathematics is criticized as a cultural homogenizing force, a critical filter for status, a perpetuator of mistaken illusions of certainty, and an instrument of power. The mathematics curriculum is central to cultivating values as well as fostering the conscientization of learners. In this approach, comparativist researchers attempt to describe differences among cultures. These individuals are *culturally universal* (Sue and Sue, 2003).

2. *Local* (*emic-insider*) is the insiders' view on their own culture, customs, beliefs, and scientific and mathematical knowledge. Local knowledge is important because it has been tested and validated within the local context (Cheng, 2005). Local knowledge creates a framework from which members of distinct cultural groups are able to understand and interpret the world around them (Barber, 2004). Currently, there is a recognition of the importance of local contributions to the development of scientific and mathematical knowledge. In this approach, the members of distinct cultural groups describe their culture in its own terms. These individuals are *culturally specific* (Sue and Sue, 2003).

3. *Glocalization* (*emic-etic*) represents a continuous interaction between globalization and localization, which offers a perspective that both approaches are elements of the same phenomenon (Kloos, 2000). It involves blending, mixing, and adapting two processes in which one component must address the local culture, system of values and practices (Khondker, 2004). In a glocalized society, members of distinct cultural groups must be "empowered to act globally in its local environment (D'Ambrosio, 2006b, p. 76). In this context, it is "necessary to work with different cultural environments and, acting as ethnographers, to describe mathematical ideas and practices of other peoples. It is fundamental to give meaning to these findings" (D'Ambrosio, 2006b, p. 79).

Through focusing on local knowledge first and then integrating global influences creates individuals and collective groups that are rooted in their local cultural traditions but are also equipped with global knowledge, creating a sort of localized globalization (Cheng, 2005). According to this context, should researchers agree with the imposed cultural universality (global) of mathematical knowledge or take on techniques, procedures, and practices of its cultural relativism? Thus, researchers seeking to link universal (global) and community specific (local) approaches face the classic dilemma of scientific goals conflicting with investigations in ethnomodelling.

The local and global approaches are often perceived as incommensurable paradigms. While they are thought of as creating a conflicting dichotomy, they are considered as complementary viewpoints. Thus, rather than posing a dilemma, the use of both approaches deepens our understanding of important issues in scientific research and investigations about ethnomodelling (Rosa & Orey, 2013). Since these two approaches are complementary, it is possible to delineate forms of synergy between the local and global aspects of mathematical knowledge.

A suggestion for dealing with this dilemma is to use a combined local-global approach, rather than simply applying local or global dimensions of one culture to other cultures. A combined local-global approach requires researchers to first attain local knowledge developed by the members of distinct cultural groups. This approach may allow them to become familiar with the relevant cultural differences in diverse sociocultural settings (Rosa & Orey, 2015). Similarly, the resurgence of debates regarding cultural diversity has also renewed the classic global-local debate since we need to comprehend how to build scientific generalizations while trying to understand sociocultural diversity. Yet, attending to the unique mathematical interpretations developed in each cultural group challenges fundamental goals of mathematics in which the main objective is to build theories that describe the development of mathematical practices in academic ways.

A local observation seeks to understand culture from the perspective of internal dynamics and relationships as influenced within a culture. A global approach is a cross-cultural contrasting or comparative perspective, which seeks to comprehend or explain different cultures from the outside worldview. Local worldview clarifies intrinsic cultural distinctions while the global worldview seeks objectivity as an outside observer across cultures (Anderson, 2007). This local approach seeks to examine native principles of classification and conceptualization from within each cultural system. The important distinctions made by members of a particular culture are emphasized. Hence, a local analysis is culturally specific with the mentality of insider's beliefs, thoughts and attitudes. Local knowledge and interpretations are essential to an emic analysis. It is from the viewpoint of the participant that will convey messages about mental and behavioral dimensions for the understanding of cultural context. Therefore, "what is emphasized in this approach is human self-determination and self-reflection" (Helfrich, 1999, p. 133).

A global analysis has a cross-cultural approach. In this context, etic-oriented researchers examine the question of a cross-cultural perception so that their observations are taken according to externally derived criteria. This context allows for the comparison of multiple cultures where "both the objects and the standards of comparison must be equivalent across cultures" (Helfrich, 1999, p. 132). Accordingly, in the conduction of ethnomodelling research, cultural, social, linguistic, political, religious, and ethnic affiliations are researched and integrated into a unified holistic solution. In this manner, the intended mathematical practice is given a stake in the overall process and not just the mere ending result.

5. Glocalization: A Transformative Approach of Ethnomodelling

During history, the members of many different cultural groups have come into close contact. In some cases, these cultural encounters sought for a mutual understanding in terms of the culture to which one belongs as well as in terms of the specificity of cultural knowledge pertaining to the cultures encounters (Iser, 1994). Therefore, as a "result of the encounters, no culture is static and definitive" (D'Ambrosio, 2006b, p. 76). It is necessary to present an alternative approach to the hegemonic views of the *globalization* (etic-outsiders) by arguing for a contextualization guided by *localization* (emic-insiders).

In this context, we conceive ethnomodelling through glocalization, which is an approach that is as an expression of dialogical relationships between local and global mathematical practices. This dialogue provides the development of *glocal mathematical knowledge*, which have the potential to generate empowering synergies between localization and globalization. In this process, it is possible to conceive ways to articulate mathematical knowledge in more inclusive and synergistic modes. Dialogical approach help us create synergistic spaces of interdependent, reflexive and co-arising relationships between global and local processes (Kloos, 2000) for the development of glocal mathematical knowledge. It is important that global mathematical practices adapt themselves to local cultures and vice versa. This contact of local knowledge with other external knowledge systems provokes cultural dynamism (D'Ambrosio, 1998).

It is possible to distinguish between Western and non-Western mathematical ideas, procedures, and practices that are used to describe, explain, understand, and comprehend the knowledge generated accumulated, transmitted, and diffused, internationalized, and globalized by people from other cultures" (Rosa & Orey, 2008). In this regard, the "intense cultural dynamics caused by globalization will produce a new [mathematical] thinking" (D'Ambrosio, 2006b, p. 75). Similarly, glocal mathematical knowledge help us realize how objectivity and subjectivity, global and local, transcendental and cultural, universal and contextual, and Western and non-Western coexist side-by-side (Robertson, 1995) in the development of mathematical ideas, procedures, and practices.

In the ethnomodelling process, glocalization may offer us a basis for incorporating knowledge systems arising from local cultural practices, linking with knowledge systems arising from multiple worldviews; and conceiving meaningful pedagogies of mathematics for diverse cultural contexts. From this perspective, globalized mathematical procedures and practices may arise from localized mathematical ideas and notions. If we look at glocalization as a dialogue between the local and global knowledge systems, we can get an understanding of its challenges and potential benefits.

When the members of distinct cultural groups connect, local communities play important roles in developing and sustaining global mathematical practices. Thus, glocalization is the interpenetration of the global and the local knowledges that results in unique outcomes in different cultural group by describing the relationship between these two approaches as interdependent and mutually constitutive in order to help explain how members of distinct cultural groups experience the world in multi-scalar socio-cultural terms.

These theoretical perspectives are particularly useful because of mathematics' global ubiquity and locally specific expressions. In this regard, ethnomodelling is a sociocultural approach for studying globalization and localization of mathematics expansiveness. In this process, members of distinct cultural groups preserve or create cultural diversity in the "ways in which forms become separated from existing practices and recombine with new forms in new practices" (Rowe & Schelling, 1991, p. 231).

While there are certain traits common to the members of distinct cultural groups, ethnomodelling illustrates how they can distinguish themselves and create unique, particular identities while acting within the parameters of larger frameworks and expectations. Although these members do not explicitly perceive glocalization, or the *particular* and the *universal*, they certainly convey these ideas when they proclaim that they solve problems faced in their daily lives like everyone else, but in their own way. Furthermore, in the ethnomodelling process, these members particularize universal traits in the development of mathematical practices by imbuing them with local meanings and values.

In this context, the term glocalization is a process by which a culture easily absorbs foreign ideas and best practices and melds those with its own traditions, which captures only the global-to-local dynamic, while missing the other side of the equation, the iterative interactivity of the local actors that generates the global context (Friedman, 2000). This approach provides the context for understanding the ethnomodelling process, how the group identity is constructed, and how processes of globalization and localization work in tandem to create innovative scientific and mathematical knowledge through the development of unique cultural forms.

6. Ethnomodelling as a Translational Process through Glocalization

The nature of ethnomodelling is the result of individual, local actors actively contributing to the construction of the overall group by using a variety of local and foreign cultural references. This mélange of influences produces an overall group identity that fits in the larger global mathematical culture. It is necessary that members of distinct cultural groups show a strong global awareness in relation to their mathematical knowledge, yet they also must attach strongly to the local knowledge and create a broad community through a common interest in their mathematical ideas, notions, procedures, and practices.

Hence, glocalization illustrates how members of distinct cultural groups view themselves regarding to their understanding of the development of their local and global mathematical knowledge. Ethnomodelling is useful for examining and understanding how various cultural influences come together in specific formations. Thus, "translation is a dynamic process of cross-cultural exchange" (Yifeng, 2009, p. 89), which includes the diffusion, interpretation and sharing of values, beliefs, histories, scientific and mathematical knowledge, and narratives across linguistic, social, cultural, and geographical boundaries.

This context allowed us to apply the term *translation* to describe the process of modelling local cultural systems (*emic, insiders*) that may have Western-academic representations (*global, etic, outsiders*) (Eglash et al., 2006; Rosa & Orey, 2006). In this regard, translation involves a process of negotiating mathematical meanings expressed between local and global contexts through glocalization. For example, ethnomodelling also studies ancient methods for solving problems.

In 2002, numerous clay tablets in the Iraqi National Museum were destroyed during the war. This provides an important opportunity for educators to link current events and the importance of these artifacts in the context of ethnomathematics, modelling, history, and culture (Rosa & Orey, 2008b). Studies of ancient Babylonian tablets provide an understanding of how ancient peoples arrived at geometric solutions to solve problems involving the area and dimensions of rectangles and squares (Hoyrup, 2002).

Historically, this aspect helped the development of a general solution to quadratic equations through a form of the completing squares technique. This interest may have its origin in finding possible shapes of rectangles and squares with given areas to allot land for farming and to determine areas of flooding for irrigation (Rosa & Orey, 2008). The following problem, found on the tablet YBC 6967, was written in the Akkadian dialect around 1500 BCE and was studied and edited by Neugebauer and Sachs in 1945. *The length of a rectangle exceeds its width by seven units. The area of the rectangle is made up of 60 square shaped units. What are the length and the width of the rectangle?*

The rhetorical solution (local mathematical knowledge) developed by the Babylonians (Joseph, 1991) can be verified by applying six steps:

1) Determine the half of the amount by which the rectangle is longer than the width. The result is $7 \div 2$ which is equal to 3.5.
2) Multiply 3.5 by 3.5. The result is 12.25.
3) Add 60 and 12.25. The result is 72.25.
4) Determine the square root of 72.25. The result is 8.5.
5) Subtract 3.5 from 8.5. The result is 5.
6) Add 3.5 to 8.5. The result is 12.
The length of the rectangle is 12 units and its width is 5 units.

This rhetorical procedure adopted by the Babylonians to solve quadratic equations reveals a simple and successful technique regarding their ability to develop a mathematical procedure that allowed them to solve this particular problem. This procedure directed the Babylonians to the development of a general method to solve quadratic equations (Joseph, 1991). From the ethnomodelling point of view, the solution of this problem shows that the Babylonians generated a certain kind of mathematical knowledge, which produced a procedure to solve quadratic equations that is similar to the algebraic method currently used.

In this context, glocalization through translation can be perceived as the universalization of the particular, which can be considered as the global outreach of this mathematical practice that is culturally specific. Similarly, the members of distinct cultural groups may be successful in positioning their particular local knowledge as universal to make visible the development of their own mathematical ideas to the academy.

According to this context, the Babylonian problem can also be solved with the application of current academic mathematical knowledge. Thus, we consider ***L*** and ***W*** as the length and width of the rectangle, respectively:

$$I)\, L = W + 7$$

$$II)\, L \bullet W = 60$$

Then, it is necessary to replace equation I in equation II.

$$(W+7)\bullet w=60$$
$$W^{2}+7W=60$$
$$W^{2}+7W-60=0$$

After, we need to apply the quadratic formula:

$$W=\frac{-7\pm\sqrt{49+240}}{3}$$

Since the Babylonians only worked with positive numbers, thus, they only determined the positive roots of the equations. Perhaps, the Babylonians would use only positive roots because these solutions acquired sense in solving problems faced in their daily lives. Historically, negative numbers were only accepted as true numbers only in the 16^{th} century (Bourbaki, 1998).

Continuing with the resolution of the quadratic formula, the following equation is obtained.

$$W=\frac{-7+\sqrt{289}}{2}$$
$$W=\frac{-7+17}{2}$$
$$W=5$$

At last, we need to replace ***L = 5*** in the equation I.

$$L=W+7$$
$$L=5+7$$
$$L=12$$

It is important to highlight that the same results were obtained in both methods because there is a very close correspondence between the Babylonian approach and modern symbolic variant for the solution of this problem (Joseph, 1991). In order to model the resolution methods of Babylonian quadratic problem, it is necessary to begin the ethnomodeling process by translating the current academic and the Babylonian rhetorical methods, which were used to solve the problem proposed in this investigation. Thus, to model these two methods it is important to establish that a) the difference between the measurements of the two dimensions of the rectangle is represented by variable ***d*** and b) the area of this geometric figure is represented by variable ***A***.

To model the current academic method it is important to establish that ***L*** and ***W*** are the length and width of the rectangle.

$$I)W=L+d$$
$$II)W\bullet L=A$$

Then, we need to replace equation I into equation II.

$$(L + d) \bullet L = A$$
$$L^2 + Ld - A = 0$$

After, the quadratic formula must be applied.

$$L = \frac{-d \pm \sqrt{d^2 - 4 \bullet 1 \bullet A}}{2 \bullet 1}$$
$$L = \frac{-d \pm \sqrt{d^2 - 4A}}{2}$$
$$L = \frac{-d + \sqrt{d^2 + 4A}}{2}$$

By replacing L into equation I, we can determine the width of the rectangle.

$$L = W + d$$
$$W = \frac{-d + \sqrt{d^2 + 4A}}{2} + d$$
$$W = \frac{-d + \sqrt{d^2 + 4A} + 2d}{2}$$
$$W = \frac{d + \sqrt{d^2 + 4A}}{2}$$

This example shows that glocalization is an expression that can promote a positive dialogic relationships between different cultures and worldviews (Yang, 2003).

On the other hand, the ethnomodelling process of the Babylonian method is a way that helps us to figure out why this mathematical procedure works in practical terms. This perspective promotes the view that local knowledge systems can be included in the global repository, thereby creating possibilities for generating spaces for promoting dialogue between diverse knowledge systems (Robertson, 1992) such as the local and global mathematical knowledge. In this context, dialogue helps to prevent the “global from overwhelming the local, while the local is still benefitting from what the global has to offer” (Fernandez, 2009, p. 46).

a) To start this process, it is necessary to compute half the difference between the two dimensions.

$$\frac{d}{2}$$

b) Then, we need to square the result obtained in step a.

$$\left(\frac{d}{2}\right)^2 = \frac{d^2}{4}$$

c) After, the area ***A*** of the rectangle must be added to the result obtained in step b.

$$\frac{d^2}{4} + A$$

$$\frac{4A + d^2}{4}$$

d) The square root of the result obtained in step c must be determined.

$$\sqrt{\frac{4A + d^2}{4}}$$

$$\frac{\sqrt{4A + d^2}}{2}$$

e) The width of the rectangle is determined by adding half of the difference ***d*** to the result obtained in step d.

$$W = \frac{d}{2} + \frac{\sqrt{4A + d^2}}{2}$$

$$W = \frac{d + \sqrt{4A + d^2}}{2}$$

f) The length of the rectangle is determined by subtracting half of the difference in the result obtained in step e.

$$L = -\frac{d}{2} + \frac{\sqrt{4A + d^2}}{2}$$

$$L = \frac{-d + \sqrt{4A + d^2}}{2}$$

This local rhetorical method used by the Babylonians to solve this problem can be considered as a derivation of the quadratic formula, which is obtained by applying the Completing the squares method. In this example, glocalization may be understood as the particularization of the universal**,** which is the local adaptation and translation between global and local principles. There are ways to understand mathematical ideas, procedures, and practices that are universally applicable as general templates that modified to reflect particular cultural traits such as the development of mathematical procedures and techniques applied to solve problems societies face daily.

An effective use of ethnomodelling helps to establish relations between local conceptual frameworks (emic) and mathematical ideas and notions embedded in relation to local designs. Frequently, the analysis of local (emic) mathematical knowledge has a global (etic) interpretation. One example of this practice might include the applications found in the symmetry and classifications in crystallography to local textile patterns. In some cases, the translation of mathematical procedures and practices to Western mathematics is direct and simple such as found in counting systems and calendars (Eglash et al., 2006).

However, there are cases in which mathematical ideas and concepts are embedded in iteration processes found in beadwork or in the Eulerian paths implicit in sand drawings (Eglash et al, 2006). In this act of translation mathematical "knowledge can be seen as arising from emic [local] rather than etic [global] origins" (Eglash et al, 2006, p. 349). This notion of glocalization is likely to provide an inclusive environment for addressing complementary interests of globalization and localization in Mathematics Education.

This dynamic of glocalization has been intensified in order to facilitate the translation between the local and the global mathematical knowledge. In this translational process, though dialogue, glocalization is able to capture "the simultaneity, the co-presence, of both universalizing and particularizing tendencies" (Robertson, 1997, p. 16) in cultures interactions. It is also important to recognize the utility of glocalization in terms of how it helps to explore nuanced analyses of the simultaneous presence of global and the local features in the development of mathematical ideas, procedures, and practices in distinct cultural groups through translation.

In this regard, it is important to highlight that:

> Through translation, a universalized and universalizing cultural language reawakens and reinforces cultural identification. Translation activities are part of local realities in relation to the global world of transnational cultures. In this respect, indigenous or local knowledge is indispensable to successful cultural translation by means of negotiating an acceptable cultural discourse for the target system. More than ever before, cultural translation is characterized by mixture and hybridity; yet it is still fraught with sharp cultural and political tensions (Yifeng, 2009, p. 89).

According to this assertion, translation plays a key role in promoting glocalization because it calls for the recognition of the value of local cultures as well as the limits of global cultures.

In the ethnomodelling process, localization as manifest in translation is an act of erasure and projection with regard to local culture in the global context. Local culture is rooted in its tradition, and when confronted with a foreign cultural representation in translation, it is forced to react to cultural otherness. In producing adaptation to another use, translation needs to consider wider contexts since events, circumstances, daily phenomena, and asymmetrical power relations dictate it (Yifeng, 2009).

Hence, ethnomodelling aims to enhance students' understanding of how historical and contemporary cultural interactions can be examined and conceptualized with the application of the translational paradigm.

7. Final Considerations

This article sought to outline ongoing research related to cultural perspectives in ethnomodelling. Contemporary academic mathematics is predominantly Eurocentric. This Eurocentrism facilitates an ongoing globalization that has hindered mathematics ideas, procedures, and practices coming from local traditions.

The motivation towards a cultural approach presents us with an accompanied assumption that makes use of cultural perspectives of ethnomathematics and uses mathematical modelling to bring local issues into global discussion through dialogical approach (glocalization). Mathematics education that is an active and participatory social product including a dialogical relation between mathematics and society.

Moreover, westernized (global) mathematics as primarily dominated by the preferences of the West (European-North American) and this Eurocentrism poses many problems in Mathematics Education in non-Western cultures. For example, Eurocentric conceptions of mathematics have been imposed globally as the pattern of rational human behavior. Conversely, from local sources, new mathematical ideas will fast spread globally (D'Ambrosio, 2006a).

A systematic study of ethnomodelling aims at developing skills to observe mathematical phenomena rooted in distinct cultural settings. The results may then lead to new viewpoints into mathematics education in order to improve cultural sensitivity in teaching mathematics. In this regard, ethnomodelling is defined as the study of mathematical phenomena within a culture, thus, it differs from the traditional conception that considers it as the foundations of mathematics education as constant and applicable everywhere. Therefore, in the ethnomodelling process, mathematics is a social construction and culturally bound.

The term glocalization applies to ethnomodelling. It forms a neologism that demonstrates a synthetic combination between two words that captures a sense of proportionality between the local to global and vice-versa. In its roots form, localization is the foundation of the word. In this context, it is necessary to start with the local knowledge, which forms the basis of the interaction with the global in a dialogical way. The foundation of the ethnomodelling process is the interpenetration of local and global in order to understand the cultural dynamism of this process.

Hence, dialogue is an important aspect of ethnomodelling. Dialogue is one of the most important ways in which cultures can glocalize (Fernandez, 2009). When cultures meet and then engage in interactions and dialogue, certain universal mathematical norms may emerge. As the members of distinct cultural groups interact, their similarities can appear. Acknowledgment of similarities leads to a realization that local knowledge may have global elements.

When engaged in interaction and dialogue, cultures are confronted with different and conflicting ideas and notions that lead to an awareness of alternative mathematical procedures and practices. Equipped with an awareness of alternative ideas and notions, then members of these groups are able to compare, contrast, and evaluate their own procedures and practices a critical way. Within interactions and dialogues, cultures are able to interrelate in a democratic way, where each culture has the ability to express and defend ideas and notions as well as explore and adopt other cultural procedures and practices (Fernandez, 2009).

Thus, the members of distinct cultural groups are then able to assess and explore the influences of globalization while being rooted in their own culture. Essentially, once they have developed a strong cultural framework, they are also able to embrace the foreign influences of globalization and integrate only those aspects that are valuable and necessary for their culture (Cheng, 2005).

Having a strong local cultural framework helps these members to identify what aspects are positive and which are negative for their local community. Focusing on local knowledge encourages individuals and collective groups to explore and learn about their own culture and develop an understanding of the uniqueness and importance of it. This approach helps to ensure that local cultures will not become overwhelmed or even replaced by the external influences of globalization as the world becomes increasingly interconnected (Friedman, 2000).

Translation moves mathematical ideas, procedures, and practices into the glocalization continuum in a way in which globalization and localization shows a tendency towards a culturally rich conflation. It "gains prominence, as the various levels appear to be mutually exclusive and yet provide stances for looking at and assessing one another. (…) In this respect, translatability proves to be a counter-concept to the otherwise prevailing idea of cultural hierarchy" (Iser, 1994, p. 5).

In the ethnomodelling process, translation does mean to compare mathematical knowledge developed by the members of distinct cultural groups because the objective of comparison is to focus only on the differences and similarities of the cultural practices of scrutinized cultures. It is necessary that in this process mathematical knowledge accommodates regarding other worldviews. This "transposition runs counter to the idea of the hegemony of one culture over the other, and hence the notion of translatability emerges as a counter-concept to a mutual superimposing of cultures" (Iser, 1994, p. 4). Thus, translation aims at comprehension and understanding of mathematical ideas, procedures, and practices used by these members to solve phenomena that occur in their daily lives.

In closing, unitary and plural worlds can be generated during the conduction of the ethnomodelling process. In this context, the undoing of the blockade between cultural groups begins with tending to the problem of reciprocal translation. Therefore, one of the most important characteristic of ethnomodelling is the engagement in the glocal dialogue between global (etic) and local (emic) terrain, where diverse forms of mathematical knowledge intersects.

8. References

Anderson, D. (2007). Multicultural group work: a force for developing and healing. *The Journal for Specialists in Group Work, 32*(3), 224–244.

Barber, B. (2004). Jihad vs. me world. In Frank J. Lechner & John Boli (Eds.), *The Globalization Reader* (pp.29-35). Malden, MA: Blackwell.

Bassanezi, R. C. (2002). *Ensino-aprendizagem com modelagem matemática* [Teaching and learning with mathematical modelling]. São Paulo, SP: Editora Contexto.

Bourbaki, N. *Elements of the history of mathematics*. New York, NY: Springer-Verlag, 1998.

Cheng, Y. C. (2005). *New paradigm for re-engineering education.* New York, NY: Springer.

D'Ambrosio, U. (1990). *Etnomatemática* [Ethnomathematics]. São Paulo, SP: Editora Ática.

D'Ambrosio, U (1993). Etnomatemática: um programa [Ethomathematics: a program]. A *Educação Matemática em Revista, 1*(1), 5-11.

D'Ambrosio, U. (1998). Introduction: Ethnomathematics and its first international congress. *ZDM, 31*(2), 50-53.

D'Ambrosio, U. (2000). Etnomatemática: uma proposta para a civilização em mudança [Ethnomathematics: a proposal for a changing civilization]. In. Domite, M. C. (Ed.). *Anais do Primeiro Congresso Brasileiro de Etnomatemática – CBEm-1* (143-152). São Paulo, SP: FE-USP.

D'Ambrosio, U. (2006a). The program ethnomathematics: A theoretical basis of the dynamics of intra-cultural encounters. *The Journal of Mathematics and Culture, 1*(1), 1-7.

D'Ambrosio. U. (2006b). The program ethnomathematics and the challenges of globalization. *Circumscribere: International Journal for the History of Science, 1*, 74-82.

Eglash, R., Bennett, A., O'Donnell, C., Jennings, S., & Cintorino, M. (2006). Culturally situated designed tools: ethnocomputing from field site to classroom. *American Anthropologist, 108*(2), 347-362.

Fernandez, S. A. (2009). A theory of cultural glocality. Master Thesis. College of Arts and Science. Department of Philosophy. Jacksonville, FL: University of North Florida.

Freire, P. (1998). *Pedagogy of freedom*: ethics, democracy, and civic courage. New York, NY: Rowman and Litttlefield.

Friedman, T. (2000). *The Lexus and the olive tree*: understanding globalization. New York, NY: Random House.

Hoyrup, J. (2002). *Lengths, widths, surfaces: a portrait of old Babylonian algebra and its kin*. New York, NY: Springer-Verlag.

Helfrich, H. (1999). Beyond the dilemma of cross-cultural psychology: Resolving the tension between etic and emic approaches. *Culture and Psychology, 5,* 131–153.

Iser, W. On translatability (1994). *Surfaces, 4307*, 5-13.

Joseph, G. G. (1991). *The crest of the peacock:* non-European roots of mathematics. Princeton, NJ: Princeton University Press.

Khondker, H. H. (2004). Glocalization as globalization: evolution of a sociological concept. *Bangladesh e-Journal of Sociology*, *1*(2), 1-9.

Kloos, P. (2000). The dialectics of globalization and localization. In D. Kalb, M. van der Land, R. Staring, B. van Steenbergen & N. Wilterdink (Eds.), *The ends of globalization*: bringing society back in (pp. 281-298). Lanham, MD: Rowman & Littlefield.

Latour, B. (1993). *We have never been modern*. Cambridge, MA: Harvard University Press.

Neugebauer, O., & A. Sachs. (1945). *Mathematical cuneiform texts*. New Haven, CT: American Oriental Society.

Orey, D. C. (2000). The ethnomathematics of the Sioux tipi and cone. In Selin, H. (Ed.). *Mathematics across culture*: the history of non-western mathematics (pp. 239-252). Dordrecht, The Netherlands: Kulwer Academic Publishers.

Orey, D. C., & Rosa, M. (2007). POP: A study of the ethnomathematics of globalization using the sacred Mayan mat pattern. In Atweb, B.; Barton, A. C.; Borba, M. C.; Gough, N.; Keitel, C.; Vistro-Yu, C.; Vithal, R. (Eds.). Internacionalisation and Globalisation in Mathematics and Science Education (pp. 227-235). Dordrecht, Netherlands: Springer.

Powell, A. B. & Frankenstein, M. (1997). Introduction. In Powell, A. B., & Frankenstein, M. (Eds.). *Ethnomathematics*: challenging eurocentrism in mathematics education (pp. 1-4). New York, NY: State University of New York Press.

Robertson, R. 1992. *Globalization: social theory and global culture*. London, England: Sage.

Robertson, R. (1995) Glocalization: time-space and homogeneity- heterogeneity, M. Featherstone et al (Eds.), *Global modernities* (pp. 25-44), London, England: Sage.

Robertson. R. (1997). Comments on the global triad and glocalization. Paper presented at the Globalization and Indigenous Culture Conference, Institute for Japanese Culture and Classics. Tokyio, Japan: Kokugakuin University.

Rosa, M. (2000). From reality to mathematical modelling: A Proposal for using ethnomathematical knowledge. Master thesis, California State University, Sacramento. Publication No. R7880 2000.

Rosa, M., & Orey, D. C. (2003). Vinho e queijo: Etnomatemática e modelagem! [Wine and cheese: Ethnomathematics and modelling!] *BOLEMA*, *16*(20), 1-16.

Rosa, M., & Orey, D. C. (2006). Abordagens atuais do programa etnomatemática: delinenando-se um caminho para a ação pedagógica [Current approaches in the ethnomathematics as a program: delineating a path toward pedagogical action]. *BOLEMA*, *19*(26), 19-48.

Rosa, M., & Orey, D. C. (2007). Cultural Assertions and Challenges towards Pedagogical Action of an Ethnomathematics Program. *For the Learning of Mathematics*, *27*(1), 10-16.

Rosa, M., & Orey, D. C. (2008a). Ethnomathematics and cultural representations: Teaching in highly diverse contexts. *Acta Scientiae, 10*(1), 27-46.

Rosa, M.; & Orey, D. C. (2008b). A geometric solution for an ancient Babylonian problem. *CMC ComMuniCator*, *33*(2), 34-35.

Rosa, M.; & Orey, D. C. (2010). Ethnomodelling: a pedagogical action for uncovering ethnomathematical practices. *Journal of Mathematical Modelling and Application, 1*(3), 58-67.

Rosa, M., & Orey, D. C. (2013). Ethnomodelling as a methodology for ethnomathematics. In G. A. Stillman & J. Brown. (Orgs.), *Teaching mathematical modelling*: connecting to research and practice. International perspectives on the teaching and learning of mathematical modelling (pp. 77-88). Dordrecht, The Netherlands: Springer.

Rosa, M., & Orey, D. C. (2015). A trivium curriculum for mathematics based on literacy, matheracy, and technoracy: an ethnomathematics perspective. *ZDM*, *47*(4), 587-598.

Rowe, W.; & V. Schelling (1991). *Memory and modernity*: popular culture in Latin America. London, England: Verso.

Sue, D. W.; & Sue, D. (2003). *Counseling the culturally diverse*: Theory and practice. New York, NY: John Wiley & Sons.

Urton, G. *The social life of numbers*: a Quechua ontology of numbers and Philosophy of arithmetic. Austin, TX: University of Texas Press, 1997.

Yang, E. (2003). The circulation of East Asian trendy dramas grounded on cultural proximity. *Bansong Yeongu, 69*, 197-220.

Yifeng, S. (2009). Cultural translation in the context of glocalization. *Ariel*, *40*(2-3), 89–110.