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# Reflecting on glocalization in the contexts of local and global approaches through ethnomodelling

## Refletindo sobre a glocalização no contexto das abordagens local e global através da etnomodelagem

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## ABSTRACT

*The acquisition of both local (emic) and global (etic) knowledge forms an important goal for the implementation of ethnomodelling research. Local knowledge (emic) is essential for an intuitive and empathic understanding of mathematical ideas, procedures, and practices developed throughout history. Global knowledge (etic) is essential for the achievement of cross-cultural comparisons that demand standard analytical units and categories to enable communication. Glocalization (dialogic) uses both local and global knowledge through dialogue, and interaction through translation. We define ethnomodelling as the study of mathematical phenomena within a culture because it is a culturally bound social construct while ethnomodelling brings cultural aspects of mathematics into the mathematical modelling process. The main objective of this theoretical article is to share our reflections from feedback from ongoing work in ethnomodelling. In this article we discuss the local, global, and glocal approaches necessary for the development of ethnomodeling research.*

***Keywords***: *Ethnomodelling, Global Approach, Glocalization, Local Approach. Translation.*

## RESUMO

*A aquisição dos conhecimentos local (êmico) e global (ético) constitui um objetivo importante para a implementação de pesquisas em etnomodelagem. O conhecimento local (êmico) é essencial para uma compreensão intuitiva e empática das ideias, procedimentos e práticas matemáticas desenvolvidas no decorrer da história. O conhecimento global (ético) é essencial para a realização de comparações transculturais que exigem unidades e categorias analíticas padronizadas que possibilitam a comunicação. A glocalização (dialógico) utiliza os conhecimentos local e global através do diálogo e da interação por meio da tradução. Definimos etnomodelo como o estudo dos fenômenos matemáticos dentro de uma cultura, pois é um construto social culturalmente enraizado enquanto a etnododelagem traz os aspectos culturais da*

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*matemática para o processo de modelagem matemática. Então, o principal objetivo deste artigo teórico é compartilhar as nossas reflexões sobre os comentários relacionados com o nosso trabalho em etnomodelagem. Nesse artigo discutimos as abordagens local, global e glocal, que são necessárias para o desenvolvimento de pesquisas em etnomodelagem.*

***Palavras-chave**: Etnomodelagem, Abordagem Global, Glocalização, Abordagem Local, Tradução.*

## Introduction

The main objective of this theoretical article is to share our reflections on feedback from our ongoing work in ethnomodelling. Here, we discuss the local, global, and glocal approaches necessary for ethnomodeling work. We hope that this may contribute to a holistic understanding (glocal) of mathematical ideas, procedures, and practices developed by the members of distinct cultural groups.

Throughout history, people have explored other cultures and shared or traded knowledge, often hidden in the traditions, practices, and diverse customs they embrace. This exchange of *cultural capital*[3] both enriches and values all participants. For example, Greek foundations of Euro-western civilization were founded upon science made during Egyptian civilization (POWELL; FRANKENSTEIN, 1997).

One of the consequences of this approach is a widespread consensus that supports the supremacy of Western scientific and logical systems (global) at the exclusion of most other traditions (local) (ROSA; OREY, 2013). Thus, dominant, imperialistic, and colonialistic forms of culture and values have, without a doubt, affected the way individuals understand concepts of any mathematical ideas, procedures, and practices.

With few exceptions, academic mathematics, curriculum, methods of problem solving, and teaching materials are based on the traditions of written sciences by western academia. Most examples used in the teaching of mathematics are derived from non-Latino North American and European cultures. These same problem-solving methods rely on the Euro-western view of mathematics (ROSA; OREY, 2015). There is nothing inherently wrong with this; it is just not sufficient or accurate in relation to the overall mathematical patrimony of humanity.

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[3]Cultural capital is related to the total 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).

As European colonization occurred across the planet, it quickly became known that different cultures contributed to the development of mathematical ideas, procedures, and practices that have enriched traditional concepts of mathematics. This interaction destroyed much of this information and left out a significant amount of knowledge in relation to local and cultural forms. In this regard, D'Ambrosio (2006a) states that the "culture of a group results from the fraction of reality that is reachable by the group" (p. 5).

Through ongoing investigations in many countries, of mathematical knowledge and practices developed by members of distinct cultural groups, many ethnomathematicians have come across and are documenting sets of ideas, procedures, and mathematical practices that different from those valued by and studied in academic institutions. This set of features can be translated through ethnomodelling, which is the process that involves holistic performance embodying the concepts of both *globalization* and *localization* (ROSA; OREY, 2010). This process expands an *intercultural*[4] perspective that appreciates, respects, and values mathematical knowledge developed by members of distinct cultural groups.

However, members of distinct cultural groups need to be encouraged and supported in order to find a balance that ensures that local mathematical ideas and procedures are not lost when global curricular programs and practices take over. This balance is found by looking at *glocalization*[5], which is the ability of a culture, when it encounters other cultures, to absorb influences that naturally fit into and can enrich that culture, and to resist those things that are truly alien or not useful, and to compartmentalize those things that, while different, can be enjoyed and celebrated as different (FRIEDMAN, 2000). For

[4]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 (ROSA, OREY, 2017a).

[5]*Glocalization* is a concept coined in the business field 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, 1995).

example, D'Ambrosio (2006b) argues that "every culture is subject to inter and intra-cultural[6] encounters" (p. 76).

In this regard, when researchers investigate mathematical knowledge developed by the members of distinct cultural groups, they may be able to find and save distinctive characteristics of mathematical ideas and procedures developed throughout their history. However, an outsider's (etic, global) understanding of these *cultural traits*[7] is an interpretation that could easily misinterpret the nature of the mathematical practices they developed.

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 contexts.

This perspective uses 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* (BASSANEZI, 2002). It also recognizes how the foundations of ethnomodelling often differ from traditional modelling methodologies.

## Ethnomathematics and Modelling

Historically, models that arise from reality have been the first paths that provide 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 close 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).

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[6]Intracultural encounters describe experiences between at least two people who are from the same culture or have culturally similar backgrounds (ROSA; OREY, 2017a).

[7]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. This concept identifies and coalesces a cultural group because traits express the cohesiveness of the member of the group (ROSA; OREY, 2017a).

In order to both document and study many diverse mathematical ideas, procedures, and practices found in many traditions that are in danger of being lost, modelling has become an important tool used to translate, describe and solve problems arising from cultural, economic, political, social, environmental contexts. It brings with it numerous advantages to the learning of mathematics (ROSA; OREY, 2003).

At the same time, outside of the greater 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*[8]. 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).

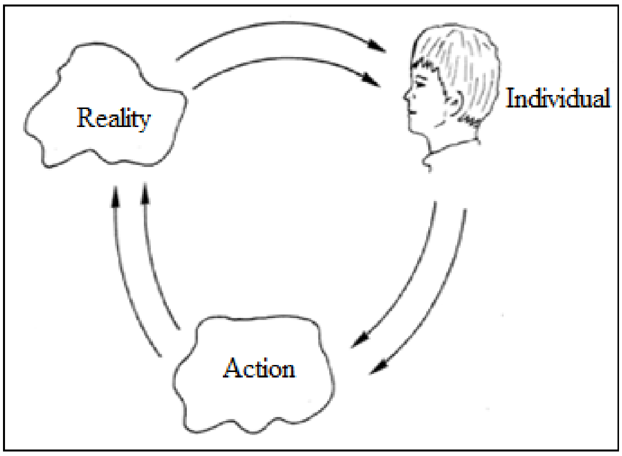
By analyzing their role in reality as a whole, this holistic context allows those engaged in the process of modelling to study systems of reality in which there is an equal effort made to create an understand components of the system as well as their interrelationships (BASSANEZI, 2002). It also has the potential for generating even more new forms of mathematics.

By having started with a social or reality-based context, the use of modelling as a tool to teaching-learning mathematics 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). The 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).

[8]Mathema includes actions taken by diverse peoples use to explain and understand the world around them. In other words, they must manage and cope with their own reality in order to survive and transcend. Throughout the history of humankind, *technés (or tics)* of *mathema* have been developed by different and diversified cultural environments, that is, in the diverse *ethnos.* Thus, in order to satisfy the drives towards survival and transcendence, human beings 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 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)

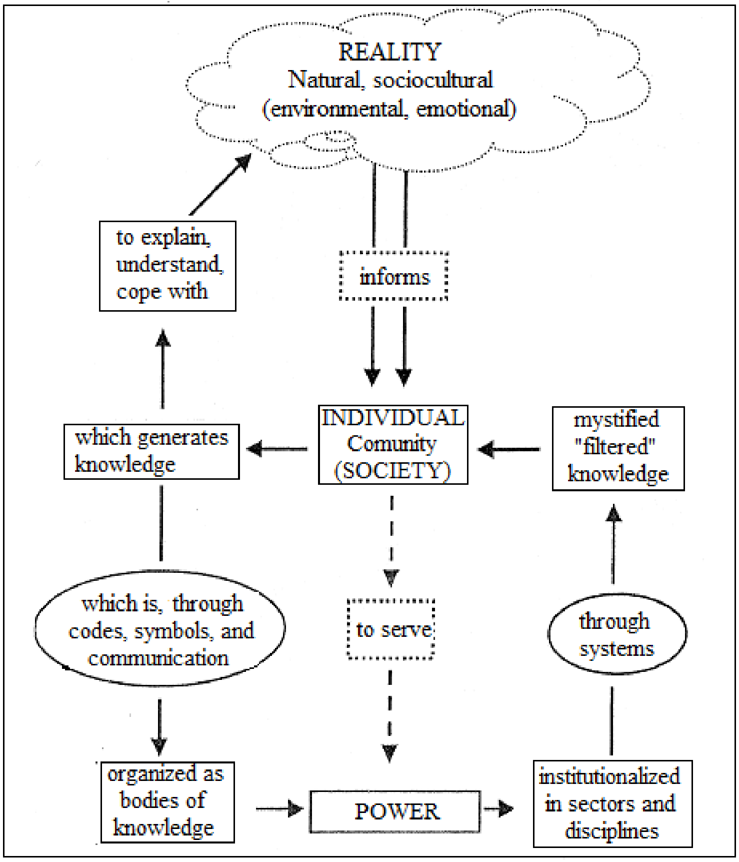
Ethnomodelling investigations translate and interpret established forms of knowledge such as communication, language, religion, the arts, techniques, sciences, and the mathematics. According to D’Ambrosio (2006b), this approach is based on an integrated study of the generation, intellectual and social organization, and diffusion of knowledge. This cycle of knowledge is affected by the cultural dynamics found in the encounters between different cultural environments.

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). According to Rosa and Orey (2017a), it is necessary to highlight how these individuals have come to create, capture, and process information in diverse ways and, as a consequence of their different perspectives, 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.

Figure 2 shows the *dambrosian cycle* of knowledge, which includes members from distinct cultural groups who participate in a similar process; the cycle is the same for all cultural groups (D'AMBROSIO, 2006a).

Figure 2: The dambrosian cycle of knowledge




Source: D'Ambrosio (1998)

Encounters between cultures or the 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, emerging *alterity*[9] may often necessitate a translation, which is primarily concerned with giving the *otherness* its due without subsuming it under pre-conceived notions (ISER, 1994).

For example, D'Ambrosio (2006b) argue that 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" (p. 78). Thus, Iser (1994) argues that

[9]Alterity derives from the Latin word *alter*, a philosophical term related to *otherness*. It is generally taken as the philosophical principle of exchanging one's own perspective for that of the other. Thus, alterity refers to the state of being that of the other and *diversity*. It contains concepts like difference and *otherness* within itself. It is important that difference and *otherness* are unpacked to begin understanding *alterity* and the cluster of meanings associated with *otherness* (LEVINAS, 1970).

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.

**Conceptualizing Ethnomodelling**

Numerous studies have demonstrated the sophisticated mathematical ideas and procedures that often include geometric principles in craftwork, architectural concepts, and practices in the activities and artifacts developed by 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).

In this context, 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).

According to Rosa and Orey (2010), ethnomodelling is a powerful tool used in the translation of problem-situations that make use of mathematical ideas and practices within a culture. It is a fluid and dynamic research approach in which incorporates both cultural universals and culturally specific phenomena. It brings innovative lenses that 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). For example, local designs may be analyzed as forms and the applications of, symmetrical classifications from crystallography to indigenous textile patterns (EGLASH at al., 2006). On the other hand, ethnomathematics can use modelling as a tool 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. For example, figure 3 shows the mathematical knowledge that lace makers in the northeast of Brazil use to make patterns that have mathematical concepts not associated with traditional geometric principles. This is possible to model by applying ethnomodelling.

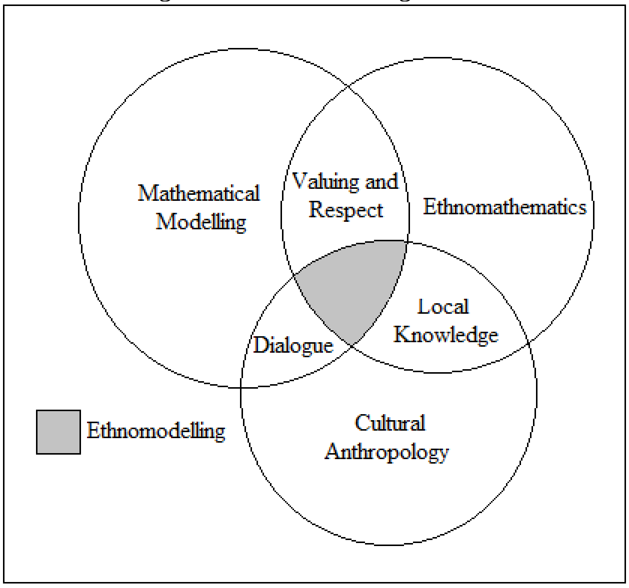
Figure 3: Geometric lace patterns

Source: Rosa and Orey (2013)

Ethnomodelling takes into consideration many diverse processes that help in the construction and development of scientific and mathematical knowledge and includes collectivity, and the overall sense of and value for, creative and new inventions and ideas. Thus, the processes and production of scientific and mathematical ideas, procedures, and practices operate as registers of the interpretative singularities that create unique possibilities for symbolic constructions of the knowledge found in diverse contexts.

As well, instead of imposing a colonial view of mathematics, it engages local voices in the act of explaining how they themselves think mathematically. 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 *tacit knowledge*[10] and traditions found in diverse contexts, and often the students there in, which enables them to assess and translate problem-situations by elaborating mathematical models in different contexts (ROSA; OREY, 2007).

Therefore, it becomes necessary to begin by using sociocultural contexts, realities, and interests or unique needs of students and not mere enforcement of a ridged set of external curricular rules and values with often decontextualized activities. This approach facilitates the development of dialogue between modelling and cultural anthropology in order to reach a *critical transitivity*.

This concept is horizontal rather than vertical or hierarchical relationship that leads to a liberated state of consciousness dealing with a *critically transitive consciousness* (FREIRE, 1998) that is characterized by:

> (...) depth in the interpretation of problems; by the substitution of causal principles for magical explanation; by the testing of one's 'findings' and by openness to revision; by the attempt to avoid distortion when perceiving problems and to avoid preconceived notions when analyzing them; by refusing to transfer responsibility; by rejecting passive positions; by soundness of argumentation; by the practice of dialogue rather than polemics; by receptivity to the new for reasons beyond mere novelty and by the good sense not to reject the old just because it is old — by accepting what is valid in both old and new (FREIRE, 1997, p. 18).

Diverse forms of local knowledge develop the context, source, and form for what is found in the intersection between mathematics and cultural anthropology and occurs when members of distinct cultural groups use it to solve problems faced in their own contexts. It also becomes a profound 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).

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[10]Tacit knowledge is the unwritten, unspoken, and hidden knowledge held by members of distinct cultural groups, which is based on their emotions, experiences, insights, intuition, observations, and internalized information developed through the resolution of phenomena they face in their daily life. It is integral to the entirety consciousness of these members because it is acquired through association with members of other cultural groups and requires joint or shared activities to be imparted from one to another. It constitutes a set of informally developed knowledge and forms the underlying framework that makes explicit knowledge possible (POLANYI, 1966).

This context uses 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.

In the ethnomodelling process, global mathematical knowledge must be reinvented and adapted to local realities. In addition, effective localization requires global mathematical knowledge just as localization, often helps to promote globalization. This process is about accessibility, namely making things easy to be accepted on terms at the local level, while rendering themselves subject to change and transformation.

In the process of glocalization, practices undergo a local transformation at the same time as it diffuses globally (LATOUR, 1993). Mathematical ideas, procedures, and practices are grounded in cultural, economic, political, environmental, and social contexts in which they unfold.

Ethnomodelling yields several 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 transformations of mathematical practices during the glocalization process.

## An Etymological Study of Ethnomodelling

In the context of the etymology of ethnomodelling, the prefix *ethno* does not only refer to specific concepts of race or ethnicity (though important), but to the *otherness*, which is the quality of being different that is an important characteristic of members of diverse groups. *Ethno* is a Greek word that refers to *people, nation, culture,* or *foreign people* in which their commonalities 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 is related to the combination (glocal) of a particular (local) plus the universal (global), which leads to the appreciation of mathematical ideas and practices that take place within a culture by developing and applying their own *technes*[11], strategies, and procedures that are important elements of the ethnomodelling process. In this context, *techné* is a form of practical knowledge that results in productive action that is rooted in

[11]The patron goddess of practical knowledge in ancient Greece was *Techné*, whose name originated from the words *technique* and *technology*, thus, *techné* is the Greek word for art (SHINER, 2001).

cultural tradition. This interaction has created many unique solutions to modern problems; one example is origami, used to ship and unfold constructions into space[12].

*Techné* forms a set of principles or methods involved in the production of objects or artifacts that guide scientists and educators to develop sociocultural standards for the teaching and learning process, which is one of the most important purposes of ethnomodelling.

*Mathema*[13] is associated with the search for explanations and for understanding of the phenomena in order to meet the challenges faced by contemporary society, as well as it is responsible for the development of body of knowledge within diverse contexts that has not been recognized in historiography. It is explicit to the ethnomodelling process because it means to learn, to know, to explain, and to cope with local notions associated with numbers and counting, hence with arithmetic and geometric reasoning. This practical knowledge coupled with modelling activities result in a productive action that adds cultural aspects in this process.

And so, ethnomodelling is a tool that flexibly responds to its surroundings and is culturally dependent on the contexts of its membership. Thus, it does not always provide a western stamp of approval of mathematical ideas, procedures, and practices of the *others*, yet recognizes that they contribute to the development of mathematics throughout history (ROSA; OREY, 2010). Since ethnomodelling studies the mathematical ideas, procedures, and practices developed in culturally different environments, it is necessary to understand how diverse mathematical concepts originate, conceptualize, and adapt to the practices developed in diverse cultures.

## Three Approaches of Ethnomodelling

The challenge researchers have in dealing with numerous connections between mathematics and culture is to apply methodological procedures that help us to understand culturally bound mathematical ideas, procedures, and practices without letting our own culture interfere with the view of the cultural background of the *other*. In this regard, it is necessary to emphasize how members of distinct cultural groups developed their own

[12]For more information, see pages: https://www.nasa.gov/jpl/news/origami-style-solar-power-20140814 and https://www.nasa.gov/feature/goddard/2017/nasa-s-new-shape-shifting-radiator-inspired-by-origami.

[13]In the context of this study, *mathema* is not only related to mathematics, which is a neologism introduced in the 15th century. Mathema is also related to the holistic process of understanding the development of mathematical ideas, procedures, and practices (D'AMBROSIO, 1990).

interpretation of the *local* culture (*emic*) opposed to the outsiders' *global* interpretation (*etic*) of that culture.

It is important to deconstruct the old-fashioned or imperialistic notions that academic mathematical ideas, procedures, and practices are only valuable if they spring from European origins and philosophical assumptions and values strongly endorsed by Western science. On the one side, there are beliefs that these mathematical practices are unique and that sociocultural units of operation are connected to the individual. As well, there are beliefs that all mathematical practices are the same and that these goals and techniques are equally applicable across all cultural groups, and if they do, they often differ and considered inferior.

An important goal of ethnomodelling is to challenge and strengthen existing theoretical models, both their assumptions of mathematical universality and their claims of descriptive, predictive, and explanatory adequacy. The second goal is to understand and explain existing variations found in diverse mathematical ideas, procedures, and practices that respectfully consider the cultures, race, ethnicity, gender, and other sociocultural characteristics.

Therefore, when working with ethnomodelling, we currently identify three approaches that help us to investigate, study, and understand 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 developed by the members of distinct cultural groups. In our opinion, globalization has reinforced the utilitarian approach of school mathematics, and the western bias in prevailing mathematics curricula, as well as in helping 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. According to Sue and Sue (2003), these individuals are called *culturally universal*.

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 local contexts, often over extremely long periods of time (CHENG, 2005). Local knowledge creates a framework from which members of distinct cultural groups can 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. According to Sue and Sue (2003), this is *culturally specific*.

3. *Glocalization* (*emic-etic*) represents a continuous interaction between globalization and localization, which offers a perspective that approaches 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). We use this, because this dialogue counteracts previous problems found in ethnomathematics that imposed an exotic and colonial view or outlook on findings.

Through focusing on local knowledge first and then integrating global influences we support individuals and collective groups, rooted in their own local cultural traditions but are also equipped with global knowledge, in creating a sort of localized globalization (CHENG, 2005) of the mathematical practices.

According to this context, often researchers get caught up in dialogue using imposed cultural universality (global) of mathematical knowledge versus taking on techniques, procedures, and practices of cultural relativism. Thus, researchers seeking to link universal (global) and community specific (local) approaches face classic dilemmas using scientific goals conflicting with investigations in ethnomodelling.

Both local and global approaches are complementary viewpoints that help us to deepen our understanding of important issues in scientific research and investigations about ethnomodelling (ROSA; OREY, 2013), which enables us to delineate forms of synergy between local and global aspects of mathematical knowledge.

A suggestion for dealing with this dilemma is to use a combined emic-etic with a dialogical approach rather than simply applying local or global dimensions of one culture to other cultures. A combined local-global approach asks researchers to move away from just merely uncovering the exotic, and begin with or first attain the perspective from local knowledge. This approach allows them to become familiar with the relevant cultural differences in diverse sociocultural settings (ROSA; OREY, 2015).

Similarly, debates regarding cultural diversity have renewed the classic global-local debate since we need to comprehend how to build scientific generalizations while trying to understand sociocultural diversity. Attending to 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 more locally born or based 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 alternative ways of doing mathematics. Local worldviews and traditions clarify intrinsic cultural distinctions while the global worldview seeks objectivity as an outside observer across cultures (ANDERSON, 2007). This unique exchange can create new options for all.

This approach seeks to examine indigenous principles of classification and conceptualization from within each cultural system. Thus, important distinctions made by members of a particular culture are emphasized because local analyses are culturally specific with the mentality of insider's beliefs, thoughts, and attitudes (ROSA; OREY, 2017b).

Local knowledge and interpretations are essential to an emic analysis. This viewpoint can convey messages about mental and behavioral dimensions for the understanding of cultural contexts. Therefore, Helfrich (1999) argued that "what is emphasized in this approach is human self-determination and self-reflection" (p. 133). It acts as a guard from colonial aspects, or impositions of outside understandings.

A global analysis develops 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 unified holistic solutions. Consequently, the intended mathematical practice is given a stake in the overall process and not just the mere ending result.

**Glocalization: The Transformative Approach to Ethnomodelling**

Historically, members of diverse cultural groups have come into close contact with other cultures. In some cases, these encounters sought a mutual understanding in terms of the culture to which one belongs to as well as in terms of the specificity of cultural knowledge pertaining to other people one may encounter (ISER, 1994).

Other encounters were no so positive, witness the invasion of the Americas by outside forces beginning in the late 1400's. 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).

We see ethnomodelling through the lens of *glocalization*, which is an approach that forms an expression and dialogical relationships between local and global mathematical practices and knowledge traditions. This dialogue provides the development of *glocal mathematical knowledge*, which has the potential to generate empowering synergies between localization and globalization, even new forms of thinking and doing mathematics. In this process, it is necessary to conceive ways used to articulate mathematical knowledge in more inclusive and synergistic modes.

Glocalization is a dialogical approach that can encourage us to create synergistic spaces of interdependent, reflexive and co-arising relationships between global and local processes (KLOOS, 2000) for the development of a *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 the development of *cultural dynamism*[14] during the encounters of diverse cultures (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, 2008a).

In this regard, intense cultural dynamics propitiated by globalization can yet produce new mathematical thinking developed from the view of solving problems in diverse contexts that are based on peace and tolerance (D'AMBROSIO, 2006b). We are not arguing that modern mathematics and science with all its technological and economic realities is wrong, we are stating that it is missing respect for, and possible solutions to extremely serious problems because it ignores non-western perspectives.

Similarly, a more glocal form of mathematical knowledge may help us to realize how objectivity and subjectivity, both the 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 offers us a base 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 can arise from localized mathematical ideas and notions.

If we look at *glocalization* more as a dialogue between local and global mathematical knowledge systems, we develop 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 becomes the interpenetration of the global and the local knowledge that results in unique outcomes in different cultural groups. This approach describes the relationship between these two forms of knowledge as interdependent and mutually constitutive in order to

[14]Cultural dynamism refers to the exchange of systems of knowledge that facilitate members of distinct cultures to exploit or adapt to the world around them. Thus, these cultural dynamics enables the incorporation of human invention, which is related to changing the world to create new abilities and institutionalizing these changes that serve as the basis for developing more competencies (ROSA; OREY, 2016).

help explain how members of distinct cultural groups experience the world in multi-scalar socio-cultural terms (ROSA; OREY, 2017b).

These theoretical perspectives are particularly useful because of the relevance of mathematics' global ubiquity and its locally specific expressions. Then, ethnomodelling becomes 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 may indeed be certain traits common to members of distinct cultural groups, ethnomodelling allows us to create unique particular identities while acting within the parameters of larger frameworks and expectations through glocalization.

According to Friedman (2000), glocalization is a process by which diverse cultures absorb distinct mathematical ideas, procedures, and practices in order to combine those with their own traditions to capture the *global-to-local-to-global* dynamic. The opposite also generates new contexts.

This approach provides the context for understanding ethnomodelling and how group identities are involved in creating new perspectives in which the processes of globalization and localization work in tandem to create innovative scientific and mathematical knowledge through the development of unique cultural forms.

**Ethnomodelling as a Translational Process through the Lens of Glocalization**

The nature of ethnomodelling is the result of individual and local members of distinct cultural groups actively contributing to the construction of the overall mathematical knowledge by applying a variety of local and foreign cultural references. For example, this mélange of influences produces an overall group identity that fits into the larger global mathematical culture (ROSA; OREY, 2016).

In this context, it is necessary that members of distinct cultural groups show a strong global awareness in relation to 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 an ongoing growth in our understanding and development of 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) that 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 allows us to apply the term *translation* between different mathematical knowledge systems to model mathematical practices developed by local (*emic*, *insiders*) and global cultures (*global, etic*, *outsiders*) (EGLASH et al., 2006; ROSA; OREY, 2006). In this regard, translation involves a process of negotiating mathematical meanings and representations expressed between local and global contexts through glocalization.

**An Ethnomodelling Example: Ancient Methods for Solving Problems**

Ancient methods for solving problems can be modeled. For example, studies of 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). This approach 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).

Historically, this aspect helped the development of a general solution to quadratic equations through a form of completing squares technique. This interest may have its origin in finding possible shapes, in the form of rectangles and squares, with given areas to land for farming and to determine areas of flooding for irrigation (ROSA; OREY, 2008b).

The following problem, found on 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 ÷ 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 an ethnomodelling point of view, the solution of this problem demonstrates how the Babylonians generated a sophisticated mathematical knowledge, which produced procedures used to solve quadratic equations similar to the algebraic method currently employed universally. According to this context, the Babylonian problem can also be solved with the application of current academic mathematical knowledge (global).

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:

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

Not unlike most ancient civilizations, the Babylonians only understood and used positive numbers. They determined only positive roots for equations. Perhaps, the Babylonians would just use positive roots because these solutions made more practical sense in solving the problems they faced. It is important to emphasize that, 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.

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

We enjoy the fact that the same results were obtained using both methods because of the close correspondence between the Babylonian approach and modern symbolic variants for the solution of this problem (JOSEPH, 1991).

In order to model the resolution method of the Babylonian quadratic problem, it is necessary to begin the ethnomodeling process by using academic mathematics procedures in translating Babylonian rhetorical methods.

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 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.

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

Then, 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 how *glocalization* becomes an expression promoting 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) Following, 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 approaches. There are ways to understand mathematical ideas, procedures, and practices that are universally applicable as general templates that are modified to reflect particular cultural traits such as the development of mathematical strategies and techniques applied to solve problems members of distinct cultural groups face daily.

An effective use of ethnomodelling helps us to establish relations between local conceptual frameworks (emic) and mathematical ideas and notions embedded in relation to global (etic) designs. Frequently, the analysis of local (emic) mathematical knowledge is erroneously developed into 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 (EGLASH et al., 2006).

In some cases, the translation of mathematical procedures to different mathematical systems is direct and simple. Such as found in calendars and counting practices. However, there are cases in which mathematical ideas and notions are embedded in iteration processes found in beadwork or in the Eulerian paths implicit in sand drawings. In this act of translation mathematical knowledge can be seen as arising from emic (local) rather than etic (global) origins (EGLASH et al, 2006).

This is a dynamic case of glocalization that has intensified in order to enable the translation between local and the global mathematical forms of knowledge. In this translational process that occurs though dialogue; glocalization is the process that captures the simultaneity, the co-presence, of both universalizing and particularizing tendencies (ROBERTSON, 1995) during the development of cultural interactions.

While Eurocentric (global) conceptions of mathematics have been imposed worldwide as the pattern of rational human behavior, it is important to understand mathematical ideas, procedures, and practices from local sources are fast spreading globally (D'AMBROSIO, 2006a). This notion of glocalization is likely to provide an inclusive environment for addressing complementary interests of globalization and localization during the conduction of research in mathematics education.

It is also important to recognize the utility of glocalization in terms of how it helps members of distinct cultural groups to explore nuanced analyses found in the simultaneous presence of global and the local features in the development of mathematical ideas, procedures, and practices through translation (ROSA; OREY, 2017b). 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).

Translation plays a key role in promoting glocalization because it calls for the recognition of the value of local cultures as well as the limitations of global cultural groups. In the ethnomodelling process, localization is manifested in translations and is considered as the act of valuing and projection with regard to local culture in the global context. Local culture is rooted in its tradition and unique problem contexts, and when confronted with a foreign cultural representation in translation, it is forced to react to cultural *otherness*[15].

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[15]Otherness is the condition of being different from the objects researched or from the context in which the research is being conducted (WOLF, 1996).

In producing adaptations to another uses, 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 process in the ethnomodelling research.

## Final Considerations

In this article, we outlined ongoing research related to cultural perspectives in ethnomodelling. Contemporary academic mathematics is predominantly Eurocentric and enables an ongoing globalization process that has hindered or obliterated many traditional forms of mathematical practices and traditions. In this context, mathematical ideas and procedures are in a constant state of negotiation and interpretation, ever changing, always contested, sometimes contradictory, and continuously repositioned by the specificities of space, time, place history, experiences, and cultures.

Developing sophisticated forms of cultural understanding presents us with an accompanied assumption that applies the perspectives of ethnomathematics and modelling needed to bring local issues into a global discussion through dialogical approach (glocalization). Hence, ethnomodelling is considered one active and participatory social product that includes a dialogic relation between local and global mathematical ´practices.

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*[16] in teaching mathematics. Ethnomodelling then is defined as the study of mathematical phenomena within a culture, and differs somewhat from traditional modelling conceptions because it relates to culturally bound social constructions.

The term glocalization appropriately applies to ethnomodelling because of its neologism that applies to the synthetic combinations of two words that capture the proportionality

[16]Cultural sensitivity is the capacity of being aware that cultural differences and similarities between individuals exist without assigning them values such as positive or negative, better or worse, and right or wrong. It simply means that individuals are aware that members of distinct cultural groups are not all the same and that they recognize that their culture is no better than any other cultural group (ROSA; OREY, 2017b).

of the local to the global and vice-versa. At its root form, localization forms the foundation; it is necessary to start with local knowledge and contexts, which form the basis of the interaction with the global in an informed and dialogical manner. The foundation of the ethnomodelling process involves the interpenetration of the local and the global in order to understand the cultural dynamism of this process.

Hence, dialogue forms an important aspect of ethnomodelling, it is one of the most important ways in which cultures glocalize their ideas, procedures, and practices (FERNANDEZ, 2009). When cultures meet and engage through interactions and dialogue, certain universal mathematical norms emerge, even new ones are created. As the members of distinct cultural groups interact, their similarities appear. Acknowledgment of similarities is important to enable that a realization that local knowledge may possess global elements.

For example, Fernandez (2009) argues that when engaged in interaction and dialogue, cultures are confronted with different and conflicting ideas and notions that lead to an awareness of alternative mathematical strategies and procedures. Equipped with an awareness of alternative techniques, then members of these groups are able to compare, contrast, and evaluate their own practices in a critical and reflective way.

Within interactions and dialogues, members of distinct cultures can interact in a democratic manner by using their abilities to express and defend ideas and procedures, as well exploring and adopting other cultural practices (FERNANDEZ, 2009). In this regard, just as these members experience the global world differently, they also experience, interpret, and conceive mathematical knowledge in different terms.

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 in order to integrate only those aspects that are valuable and necessary for their cultures (CHENG, 2005).

Having a strong local cultural framework helps these members to identify what aspects are positive and which are negative for the development of practices of their local community. Focusing on local knowledge encourages them to explore and learn about their own culture and develop an understanding the uniqueness and importance of it (ROSA; OREY, 2015).

This approach ensures that local cultures do not become overwhelmed or replaced by external influences of globalization as the world continues to interconnect (FRIEDMAN, 2000), which enables a sense of translation and sharing of mathematical ideas, procedures, and practices into a *glocalization continuum glocalization continuum*[17].

In the glocalization process, globalization and localization show a tendency towards a culturally rich *conflation*[18] that:

> (…) 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 allows for comparisons of mathematical knowledge developed by the members of distinct cultural groups because its objective is to focus on the differences and similarities of diverse cultures. 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, the process of colonialistic or imperialistics impositions of academic forms of mathematics has preoccupied us for many years. Yet, unitary and pluralistic worlds can be generated during the conduction of the ethnomodelling process. In this context, the undoing of the blockade between cultural groups begin with tending to the problem of reciprocal translation. Therefore, one of the most important characteristics of ethnomodelling is the engagement in a glocal dialogue between global (etic) and local (emic) terrain where diverse forms of mathematical knowledge intersects.

## References

[17]Globalization encompasses a wide range of processes that form a continuum ranging from the local (emic) mathematical practices on one end to the global (etic) mathematical practices on the other. The idea of a continuum makes it clear that glocalization falls somewhere between these two poles. Thus, in looking at glocal processes or phenomena, we must assess their relative degree of local and global approaches (ROSA; OREY, 2017b).

[18]In this study, conflation is considered as the process of merging ideas, procedures, and practices developed by the members of distinct cultural groups. According to Rosa (2010), this exchanging of *cultural capital* has enriched all cultures because it 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.

ANDERSON, D. Multicultural group work: a force for developing and healing. *The Journal for Specialists in Group Work*, v. 32, n. 3, p. 224–244, 2007.

BARBER, B. Jihad vs. me world. In: LECHNER, F. J.; BOLI, J. (Eds.). *The Globalization Reader*. Malden, MA: Blackwell, 2004. pp. 29-35.

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

BOURBAKI, N. *Elements of the History of Mathematics*. New York, NY: Springer-Verlag, 1998.

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

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

D'AMBROSIO, U. Etnomatemática: um programa [Ethomathematics: a program]. A *Educação Matemática em Revista*, v. 1, n. 1, p. 5-11, 1993.

D'Ambrosio, U. Introduction: ethnomathematics and its first international congress. *ZDM*, v. 31, n. 2, p, 50-53, 1998.

D'AMBROSIO, U. 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*. São Paulo, SP: FE-USP, 2000. Pp. 143-152.

D'AMBROSIO, U. The program ethnomathematics: a theoretical basis of the dynamics of intra-cultural encounters. *The Journal of Mathematics and Culture*, v. 1, n. 1, p. 1-7, 2006a.

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

EGLASH, R., BENNETT, A., O'DONNELL, C., JENNINGS, S.; CINTORINO, M. Culturally situated designed tools: ethnocomputing from field site to classroom. *American Anthropologist*, v. 108, n. 2, p. 347-362, 2006.

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

FREIRE, P. *Education for critical consciousness.* New York, NY: Continuum, 1997.

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

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

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

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

ISER, W. On translatability. *Surfaces*, v. 4307, 5-13, 1994.

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

KHONDKER, H. H. Glocalization as globalization: evolution of a sociological concept. *Bangladesh e-Journal of Sociology*, v. 1, n. 2, 1-9, 2004.

KLOOS, P. 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, 2000.

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

LEVINAS, E. *Alterity and transcendence*. Translated by Michael B. Smith. New York, NY: Continuum International Publishing Group, 1970.

NEUGEBAUER, O.; A. SACHS. *Mathematical cuneiform texts*. New Haven, CT: American Oriental Society, 1945.

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

POLANYI, M. *The tacit dimension.* London, England: Routledge & Kegan Paul, 1966.

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

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

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

ROSA, M. *From reality to mathematical modelling*: a proposal for using ethnomathematical knowledge. Master thesis. College of Education. Sacramento, CA: CSUS, 2000.

ROSA, M. *A mixed-method study to understand the perceptions of high school leaders about English Language Learners (ELLs):* the case of mathematics. College of Education. Doctorate Dissertation. Sacramento, CA: CSUS, 2010.

ROSA, M.; OREY, D. C. Vinho e queijo: etnomatemática e modelagem! [Wine and cheese: Ethnomathematics and modelling!] *BOLEMA*, v. 16, n. 20, p. 1-16, 2003.

ROSA, M.; OREY, D. C. 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*, v. 19, n. 26, p. 19-48, 2006.

ROSA, M.; OREY, D. C. Cultural assertions and challenges towards pedagogical action of an ethnomathematics program. *For the Learning of Mathematics*, v. 27, n. 1, p. 10-16, 2007.

ROSA, M.; OREY, D. C. Ethnomathematics and cultural representations: teaching in highly diverse contexts. *Acta Scientiae*, v. 10, n. 1, p. 27-46, 2008a.

ROSA, M.; OREY, D. C. A geometric solution for an ancient Babylonian problem. *CMC ComMuniCator*, v. 33, n. 2, p. 34-35, 2008b.

ROSA, M.; OREY, D. C. Ethnomodelling: a pedagogical action for uncovering ethnomathematical practices. *Journal of Mathematical Modelling and Application*, v. 1, n. 3, p. 58-67, 2010.

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

ROSA, M.; OREY, D. C. A trivium curriculum for mathematics based on literacy, matheracy, and technoracy: an ethnomathematics perspective. *ZDM*, v. 47, n. 4, p. 587-598, 2015.

ROSA, M.; OREY. D. C. Reflecting on ethnomathematics as pedagogical action in the mathematics curriculum. *RIPEM*, v. 6, n. 1, p. 157-177, 2016.

ROSA, M.; OREY, D. C. *Influências etnomatemáticas em salas de aula*: caminhando para a ação pedagógica. Curitiba, PR: Editora Appris, 2017a.

Rosa, M.; Orey, D. C. *Etnomodelagem*: a arte de traduzir práticas matemáticas locais. São Paulo, SP: Editora Livraria da Física, 2017b.

ROWE, W.; V. SCHELLING. *Memory and modernity*: popular culture in Latin America. London, England: Verso, 1991.

SHINER, L. *The invention of art: a cultural history*. Chicago, IL: The University of Chicago Press, 2001.

SUE, D. W.; SUE, D. *Counseling the culturally diverse*: theory and practice. New York, NY: John Wiley & Sons, 2003.

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

WOLF, D. *Feminist dilemmas in fieldwork.* Boulder, CO: Westview Press, 1996.

YANG, E. The circulation of East Asian trendy dramas grounded on cultural proximity. *Bansong Yeongu*, v. 69, p. 197-220, 2003.

YIFENG, S. Cultural translation in the context of glocalization. *Ariel*, v. 40, n. 2-3, p. 89–110, 2009.

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