How we came to use a combination of emic, etic and dialogical approaches in the field research ethnomodeling

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Abstract: In this paper we offer an alternative goal for research, which is the acquisition of both emic and etic knowledge for the implementation of ethnomodeling. Emic knowledge is essential for an intuitive and empathic understanding of mathematical ideas of a culture. We have come to see it as essential for conducting effective ethnographic fieldwork. Furthermore, emic knowledge is a valuable source of inspiration for etic hypotheses. Etic knowledge, on the other hand, is essential for cross-cultural comparisons, and the essential components of ethnology, because such comparison demands standard units and categories to facilitate communication. We also offered here a third approach for ethnomodeling research; which is the dialogical approach that makes use of both emic and etic knowledge traditions through processes of dialogue and interaction. Finally, we have defined ethnomodeling as the study of mathematical phenomena within a culture because it is a social construction and is culturally bound

Key words: Etic, Emic, Ethnomodeling, Culture, Ethnomathematics, Mathematization.

Introduction

In this paper, we would like to share how we have come to use a combination of emic, etic and dialogical approaches in our research field. When investigate forms of knowledge possessed by members of distinct cultural groups, we easily find unique and interesting mathematical ideas, characteristics, procedures, and practices that are forms of ethnomathematics. This information can be used to express and explore the relationship between culture and mathematics. Our work incorporates the term ethno, which describes characteristics related of a group's cultural identity such as language, codes, values, jargon, beliefs, food and dress, habits, and physical traits. To us the term ethnomathematics expresses a broader view of mathematics and includes diverse forms ciphering, arithmetic, classifying, ordering, inferring, modeling and the ability to communicate and dialogue about it (D'Ambrosio, 2001).

Any outsider's understanding of cultural traits is based on unique interactions and interpretations that may emphasize inessential features to the misinterpretation of distinctly unique and culturally mathematical forms of knowledge. The challenge that arises from this understanding is how culturally bound mathematical ideas are better understood without letting the culture of the researcher-investigator interfere with the culture of the members of the cultural group under study. This is not easy, and may only happen when the members of cultural group under study share the same interpretation of their culture (emic), as opposed to an outsider's interpretation (etic)[1].

Emic perspectives are the factors such as cultural and linguistic backgrounds, social, moral values, and lifestyle that directly influence mathematical ideas, procedures, and practices developed by the people of their own culture and context. Over time, different cultural groups have shared, developed and evolved different ways of doing mathematics in order to understand and comprehend their own cultural, social, political, economic, and natural environments (Rosa, 2010). Every cultural group has developed many unique and distinct ways to mathematize their own realities (D'Ambrosio, 1990). Mathematization is the process in which we come up with different mathematical tools that help us to organize, analyze, solve, and model specific problems located in the context of our own real-life contexts and situations (Rosa & Orey, 2006). This allows us to identify and describe specific mathematical ideas, procedures, or practices by schematizing, formulating, and visualizing problems in different ways, discovering relations and regularities, and transferring real world problems to academic mathematics through the process of mathematization.

As increasingly diverse elements engage with each other, it is important to search for alternative methodological approaches in order to record mathematical ideas, procedures, and practices that occur in different cultural contexts. One alternative methodological approach to this is ethnomodeling, which we consider the practical application of ethnomathematics (Rosa & Orey, 2010a). This need for a culturally bound form of mathematical modeling is rooted in the theory of ethnomathematics developed by Ubiratan D'Ambrosio (1990).

Ethnomathematics

Ethnomathematics is wider than traditional or academic concepts of mathematics, ethnicity or common ideas found in multiculturalism[2]. It is the intersection of cultural anthropology, mathematics, and mathematical modeling, which is used to help us understand and connect diverse mathematical ideas and practices found in our communities to traditional and academic mathematics (Rosa, 2000). Figure 1 shows how ethnomathematics is an intersection of these three research fields.

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[1] The concepts of emic and etic were first introduced by the linguist Pike (1954) who drew upon an analogy with two linguistic terms. Phon***emic***, which are the sounds used in a particular language and phon***etic***, which are related to general aspects of vocal sounds and the actual sound produced in language. In other words, all the possible sounds human beings can make constitute the phonetics of language. However, when people actually speak a particular language, they do not hear all its possible sounds. In this regard, as modeled by linguists, not all sounds make a difference because they are locally significant, or they are the phonemics of that language

[2] We describe ethnomathematics as the arts and techniques (*tics*) developed by members from diverse cultural and linguistic backgrounds (*ethno*) to explain, to understand, and to cope with their own social, cultural, environmental, political, and economic environments (*mathema*). *Ethno* refers to distinct groups identified by cultural traditions, codes, symbols, myths, and specific ways of reasoning and inferring. Detailed studies of mathematical procedures and practices of distinct cultural groups most certainly allow us to further our understanding of the internal logic and mathematical ideas of diverse groups of people (D'Ambrosio, 1990).

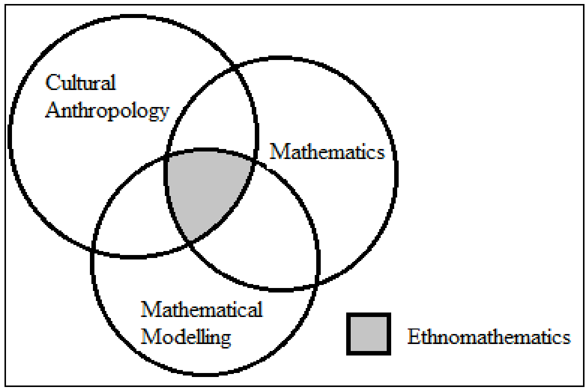

Figure 1 - Ethnomathematics as an intersection of three research fields (Rosa 2000)

Ethnomathematics, as well, is a program of study that allows us to understand, comprehend, articulate, process, and ultimately use mathematical ideas, procedures, and practices that enable us to solve problems related to our daily activities (Rosa, 2000). This helps students reflect, understand, and comprehend the relations among components of systems under study. As educators we can learn to analyze the role of our students' ethnoknowledge in the classroom (Borba, 1990).

Ethnomodeling

Ethnomodeling as the study of mathematical ideas and procedures elaborated by members of distinct cultural groups involves mathematical practices developed, used, practiced, and presented in diverse situations in the daily life of the members of these groups (Rosa & Orey, 2010a). This allows those engaged in this process to study mathematics as a system relative to their own contextual reality in which there is an equal effort to create an understanding of all components of these systems as well as the interrelationship among them (D'Ambrosio, 1993; Bassanezi, 2002; Rosa & Orey, 2003).

Researchers and investigators such as Ascher (2002), Eglash (1999), Gerdes (1991), Orey (2000), Urton (1997), and Rosa and Orey (2009) revealed a diversity of elegant and extremely sophisticated mathematical practices that include the geometric principles in craft work, architectural concepts, and practices in the activities and artifacts of many indigenous and local cultures (Eglash, Bennett; O'Donnell; Jennings; & Cintorino, 2006). Many of these concepts are related to the numerically-based relations found in measuring, calculating, gaming, divining, navigating and astronomy, modeling, and a wide variety of other mathematical procedures and artifacts (Eglash at al, 2006). From this context, ethnomodeling is the intersection of cultural anthropology, ethnomathematics, and mathematical modeling, which as "a tool towards pedagogical action of an ethnomathematics program, students have been shown to learn how to find and work with authentic situations and real-life problems" (Rosa & Orey, 2010a, p. 60). Figure 2 shows ethnomodeling as an intersection of three research fields.

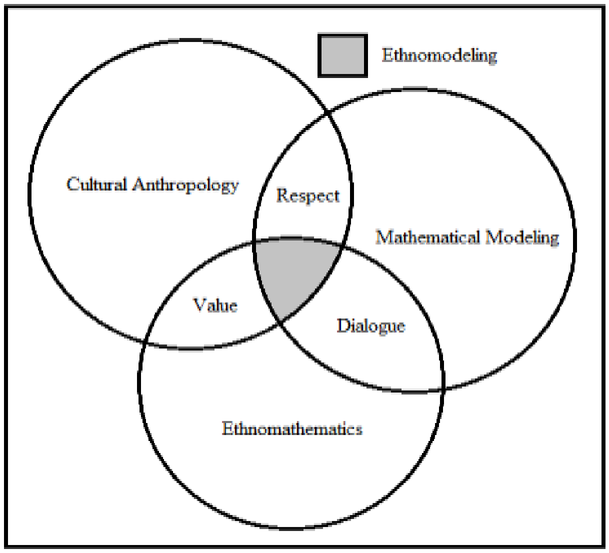

Figure 2 - Ethnomodeling as an intersection of three research fields (Rosa e Orey, 2010a)

We have come to use the term translation to describe the process of modeling local cultural systems (emic) and which may have a western-academic representation (etic) (Eglash et al., 2006; Rosa and Orey, 2006). An effective use of ethnomathematics makes use of modeling in order to establish relations between local conceptual frameworks (emic) and the mathematics embedded in relation to local designs. More often than not local designs have been analyzed and interpreted from a western view (etic). One example of this practice might include the applications found in the symmetry and classifications in crystallography to indigenous textile patterns. In some cases, "the translation [of mathematical procedures and practices] to Western mathematics is direct and simple such as counting systems and calendars" (Eglash et al, 2006, p. 347). However, there are cases in which mathematical ideas and concepts are "embedded in a process such as the iteration found in bead work, or in the Eulerian paths in sand drawings" (Eglash et al, 2006, p. 348). And so it is that this act of translation as applied in this process is best referred to as ethnomodeling where mathematical "knowledge can be seen as arising from emic rather than etic origins" (Eglash et al, 2006, p. 349).

An emphasis of ethnomodeling takes into consideration processes found in the construction and development of mathematical knowledge and can includes the "curious and unique" aspects as well as patterns of collection, creativity, and invention. It has become impossible for us to imprison mathematical concepts in one form of reality because, as we are seeing when many of our communities interact in a globalized context, distinct systems provide unambiguous representations of reality (Craig, 1998).

Curious enough, and because its principles, concepts, and foundations are not always the same everywhere, mathematics may no longer be conceived entirely as a universal language (Rosa, 2010). The choice among equivalent systems of representation can be founded on considerations of modeling simplicity, and for no other consideration than simplicity, can justly "adjudicate between equivalent systems that univocally designate reality" (Craig, 1998, p. 540). The dynamic processes found in the production of a diversity of mathematical ideas, procedures, and practices operate in the register of interpretative singularities that regard possibilities for a symbolic construction of knowledge in different cultural groups (Rosa & Orey, 2006).

Mathematical Phenomena and their Subsequent Ethnomodels

Researchers and investigators have made extensive use of mathematical procedures ranging from statistical methods for the interpretation of patterns in behavior to mathematical representations in the processes of local conceptual and logical systems. Mathematical modeling has been considered as a pedagogical tool and by others as a way to understand anthropological and archaeological perspectives of mathematics. Yet, others have decried the use of the mathematical, and in particular, the statistical and quantitative modeling as fundamentally in opposition to a humanistic approach to understanding human behavior and the knowledge that takes into account contingency and historical embeddedness and in turn, decries universality. Traditional mathematical modeling practices have not fully taken into account widespread implications of diverse aspects of human social behavior.

It seems to us that this cultural component is critical, and emphasizes "the unity of culture, viewing culture as a coherent whole, a bundle of [mathematical] practices and values" (Pollak & Watkins, 1993, p. 490) that often appears incompatible with the rationality and the elaboration of traditional mathematical modeling process. However, in the context of mathematical forms of knowledge, what is meant by the cultural component varies widely and ranges from viewing mathematical practices as learned and transmitted to and from members of diverse groups to mathematical practices viewed as abstract symbolic systems with a deep internal history and logic that provides a symbolic system to its mathematical structure.

If the former is considered, then it is the process by which knowledge transmission can take place from one person to another, which is central to elucidating the role of culture in the development of mathematical knowledge (D'Ambrosio, 1993). If the latter is considered, then culture plays an important role in the constructive role with respect to mathematical practices that we cannot induce through observation and study (Eglash et al, 2006).

Mathematical knowledge developed by members of a specific cultural group and that consists of abstract symbol systems is the consequence of a unique internal logic and historical-cultural events. Then it is that people have developed transmitted, diffused, and learned instances and definite usages of symbol systems. What is derived from those instances forms a cognitively-based understanding of the internal logic of unique mathematical symbolic systems. Cognitive aspects needed in this framework become primary decision-making processes by which members either accept or reject an ethnomodel as part of their own repertoire of mathematical knowledge. The conjunction of these two scenarios appears to be adequate to the depth needed to encompass a full range of cultural mathematical phenomena.

There are two ways in which we learned to recognize, represent and make sense of the diverse mathematical phenomena we encounter. First, there appears to be a level of cognition that we all share, to varying degrees, with the members of our own and other cultural groups. One can say this is part of the overall human cognitive endowment. This level includes cognitive models that we elaborate on at a non-conscious level, which serves to provide an internal organization of external mathematical phenomena in order to provide the basis upon which diverse mathematical practices take place. Second, there are any numbers of culturally constructed representations of external mathematical phenomena that provide us with a sense of an internal organization. However, this representation arises through the formulation of abstract and conceptual structures that provide forms and a sense of organization for external phenomena we encounter. Cultural constructs provide us with representations for systems taken from reality. The implications for this form of mathematical modeling are that these models engage cultural constructs and are considered symbolic systems organized by an internal logic of the cultural group members themselves. Models built without a first-hand sense for the world being modeled should be viewed with suspicion (Eglash et al, 2006; Rosa and Orey, 2010b). Researchers and investigators, if not blinded by their own cultural backgrounds are profoundly influenced by the paradigm in which they are immersed, which includes all prior theory and ideology they have absorbed. If they are aware of this they should come out with an informed sense of distinction that makes a difference from the point of view of the mathematical knowledge of the work being modeled. In so doing, they will in the end be able to tell outsiders (etic) what matters to insiders (emic).

The Emic and Etic Constructs of Ethnomodeling

In using an ethnomodeling approach, the emic constructs are accounts, descriptions, and analyses expressed in terms of conceptual schemes and categories regarded as meaningful and appropriate by the members of the cultural group under study (Lett, 1996). This means that an emic construct is in accordance with the perceptions and understandings deemed appropriate by the insider's culture. The validation of emic knowledge comes through consensus, which is the consensus of local people who must agree that these constructs match the shared perceptions that portray the characteristic of their culture (Lett, 1996). The emic approaches investigate mathematical phenomena and their interrelationships and structures through the eyes of people in a particular cultural group. It is important to note here that the particular research technique used in acquiring emic mathematical knowledge has nothing to do with the nature of that knowledge. In this regard, the "emic mathematical knowledge may be obtained because it is possible that objective observers may infer local perceptions" (Lett, 1996, p. 382) about mathematical ideas, procedures, and practices.

It is necessary to state that etic constructs are considered accounts, descriptions, and analyses of mathematical ideas, concepts, procedures, and practices expressed in terms of the conceptual schemes and categories that are regarded as meaningful and appropriate by the community of scientific observers, researchers, and investigators (Lett, 1996). An etic construct is precise, logical, comprehensive, replicable, and observer-researcher independent. In so doing, the validation of the etic knowledge thus becomes a matter of logical and empirical analysis, in particular, the logical analysis of whether the construct meets the standards of comprehensiveness and logical consistency, and then the empirical analysis of whether or not the mathematical concept has been replicated (Lett, 1996). It is important to emphasize that particular research techniques used in the acquisition of etic mathematical knowledge that may have little bearing on the nature of that knowledge. The etic knowledge may be obtained at times through questioning as well as observation, because it is entirely possible that informants possess scientifically valid knowledge (Lett, 1996). Researchers and investigators must come to acknowledge and recognize that local people possess both scientifically and mathematically valid knowledge (D'Ambrosio, 1990).

The Dialogical Approach in Ethnomodeling Research

If we come to make any analogies in regard to ethnomodeling, it may be possible to state that emic perspectives are concerned with differences that make mathematical practices unique from the insider's view point. We argue that emic ethnomodels are grounded in what matters in the mathematical world of those being modeled. On the other hand, many ethnomodels are etic in the sense that they are built on data gleaned from the outsider's view that is being modeled. Etic ethnomodels therefore represent how the modeler thinks the world works through systems taken from reality while emic ethnomodels represent how people live in such worlds think these systems work in their own reality. It is important here to emphasize how etic perspectives play an important role in ethnomodeling research, yet at the same time emic perspectives should be taken into consideration in this process. Emic ethnomodels sharpen questions related to what an agent-based model should include in serving practical goals in modeling. Thus, etic mathematical ideas and procedures can be compared across cultures using common definitions and metrics while the focus of the analysis of these aspects are emic if the mathematical ideas, concepts, procedures, and practices are unique to a subset of cultures that are rooted in diverse ways in which etic activities are carried out in a specific cultural setting.

The debate between the emic-etic dynamism is one of the most intriguing questions in ethnomathematics and mathematical modeling. Researchers continue to deal with two major questions:

1. Are there mathematical patterns that are identifiable and/or similar across cultures?
2. Is it better to focus on these patterns particularly arising from the culture under investigation?

While emic and etic are often thought of as creating a conflicting dichotomy, Pike (1967) originally conceptualized them as complementary viewpoints. According to this context, rather than posing a dilemma, the use of both approaches deepens our understanding of important issues in scientific research and investigations (Berry, 1999). A suggestion for dealing with this dilemma is to use a combined emic-etic approach, rather than simply applying emic or etic dimensions to study or examine mathematical procedures and practices employed by members of distinct cultural groups. A combined emic-etic approach requires researchers to attain the emic knowledge developed by members of cultural groups under study. This encourages researchers to put aside any perceived or unperceived cultural biases so that they may be able to become familiar with the cultural differences that are relevant to the members of these groups (Berry, 1990).

Usually, in ethnomodeling research, an emic analysis focuses on a single culture and employs descriptive and qualitative methods to study a mathematical idea, concept, procedure, or practice of interest. Its focus becomes the study within a cultural context in which a researcher examines internal characteristics or the logic found in the cultural system itself. In this perspective, meaning is gained relative to the context and therefore not easily, transferable to other contextual settings. The primary goal of an emic approach is a descriptive idiographic orientation of mathematical phenomena because it puts emphasis on the uniqueness of each mathematical idea, procedure, or practice developed by the members of cultural groups. Thus, if researchers and educators wish to highlight meanings of these generalizations in local or emic ways, then they will need to refer to precisely specified mathematical events.

In contrast, an etic analysis is comparative, and examines cultural practices by using standardized methods (Lett, 1996). The etic approach tries to identify lawful relationships and causal explanations valid across different cultures. Thus, if researchers and educators wish to make statements about universal or etic aspects of mathematical knowledge, these statements need to be phrased in abstract ways.

On the other hand, an etic approach may be a way of examining the emics of the members of cultural groups because it may be useful for discovering and elucidating emic systems (Pike, 1954). In so doing, while traditional concepts of emic and etic aspects are important points of view for understanding and comprehending cultural influences on mathematical modeling, we propose a different view of ethnomathematics and modeling which is dialogical in its approach (Martin & Nakayama, 2007). In this approach, the etic perspective claims that the knowledge of any given cultural group will have no real priority over the emic. It is necessary then that we make use of "acts of translation between emic and etic perspectives" (Eglash et al, 2006, p. 347). In other words, cultural specificity may be better understood with the background of communality and the universality of theories and methods and vice versa. It is important to analyze the insights that have been acquired through subjective and culturally contextualized methods. The rationale behind any emic-etic dilemma is found in the dialogue and argument that the mathematical phenomena possesses in their full complexity and can only be understood within any context of culture.

The Wine Barrel: The Dialogical Ethnomodel

One classic example ethnomodeling and accompanying methodology was elaborated by a group of Brazilian students who studied wine production in the south of Brasil. They wanted to find the volume of wine barrels by applying techniques learned by their Italian ancestors who came to Brasil as immigrants in the early twentieth century.

Initially, when the students began their research, they visited wineries in order to conduct interviews with the wine producers themselves. Data was then collected and supplemented by a literature review. The ethnological and historical research theme of the construction of wine barrels formed the first stage of the ethnomodeling process. In the ethnological portion of the study, students identified characteristics of this particular group so that they were able to understand some of the cultural elements that shaped their mathematical thinking (BASSANEZI, 2002). Students found that, in addition to actually producing wine, wine producers constructed their own wooden wine barrels by using geometric schemes inherited from their Italian ancestors.

The Wine Barrel Ethnomodels

During their research, students found that in order to construct barrels with pre-established volumes, it was necessary for producers to cut wooden staves to fit perfectly together. This process drew the attention of the students who were interested in exploring the inherited mathematical idea that wine producers used; that is their geometric scheme in constructing barrels. For example, figure 3 shows one geometric scheme made by the wine producers in the construction of wine barrels.

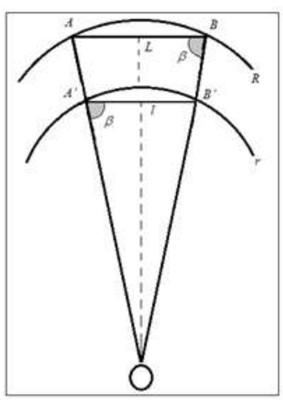

Figure 3-Geometric scheme made by wine producers in the construction of wine barrels (Bassanezi 2002)

In the scheme in figure 3, L is the maximum width of the stave, ℓ is the width to be determined and β is the fitting angle between the staves, which depend on the initial width of the stave L and the volume required for the wine barrel. In figure 4, the larger circle (R) represents the base of the barrel while the smaller circle (r) represents its cover. The wine producers constructed barrels shaped like truncated cones by interlocking wooden staves whose dimensions are 2.5 cm in length and width ranging from 5cm to 10cm (BASSANEZI, 2002).

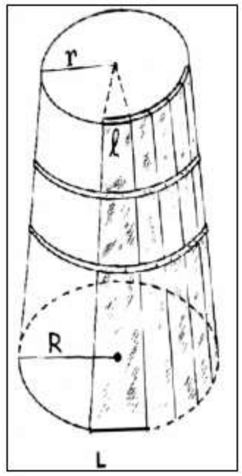

Figure 4 - Wine barrel shaped like a truncated cone (Bassanezi 2002, p. 48)

In order to determine the volume of the wine barrel, wine producers approximate the volume of the barrel by applying a procedure named average cylinder (BASSANEZI, 2002) which is given by formula I:

$$V \cong \pi \bullet r_m^{\ 2} \bullet H$$

They also apply the average radius procedure, which is given by formula II:

$$r_m = \frac{r+R}{2}$$

By replacing formula II into formula I, formula III is given by:

$$V \cong \pi \bullet \left(\frac{r+R}{2}\right)^2 \bullet H$$

Figure 4 also shows that the fitting angle β between the two wooden staves is obtained by considering that:

- R is the radius of the base of the wine barrel.
- L is the width of the wooden stave of the wine barrel in its base.
- All juxtaposed wooden staves form a circumference at the base of the wine barrel.

In this process, it is possible to observe that the scheme used in figure 3 is an orthogonal projection of one of the wine barrel wooden staves as shown in figure 5.

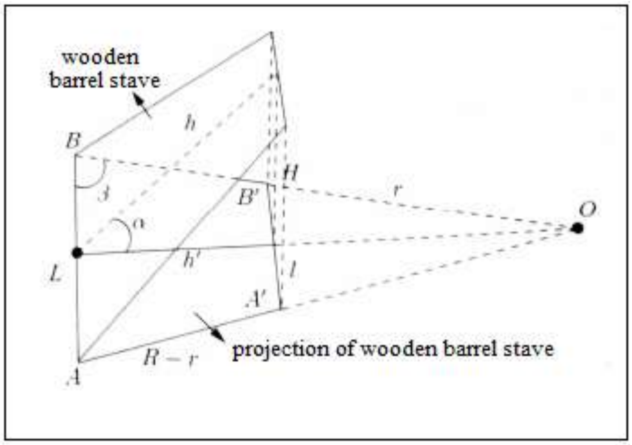

Figure 5: Orthogonal projection of a wine barrel wooden slate (Bassanezi 2002, p. 49)

According to etic approach by developing a mathematical modeling process used in academic mathematics, the volume of the truncated cone is given by the formula:

$$V = \frac{1}{3} \bullet \pi \bullet H \bullet \left(R^2 + rR + r^2\right)$$

In the emic approach by developing an ethnomodeling process used by wine producers; the volume of the wine barrel is given by the formula:

$$V \cong \pi \bullet \left(\frac{r+R}{2}\right)^2 \bullet H$$

This model, investigated an ethnomathematics perspective as the cultivation of vines and production of wine barrels with strong links to the history and culture of people in that particular region of Brazil. The process of the construction of the wine barrel is an excellent example and certainly typifies any connection between ethnomathematics and mathematical modeling (D'Ambrosio, 2002) through ethnomodeling. Thus, this method presents us with an approximated calculation for the area of the volume of the wine barrel as employed by this specific cultural group.

Some Considerations about the ethnomodeling of the Wine Barrel Construction

An emic observation of this mathematical practice sought to understand it for constructing wine barrels from the perspective of internal dynamics and relationships as influenced within the culture of wine producers. On the other hand, an etic perspective provides a cross-cultural contrast and comparative perspective by using aspects of academic mathematics that translate this practice in order to create a new understanding of those from a different cultural background. This approach is necessary to comprehend and explain this mathematical practice as a whole from the point of view of that from the outside.

In this context, the emic viewpoint clarifies intrinsic cultural distinctions while the etic perspective seeks objectivity as an outside observer across cultures. This is the dialectical approach, which concerns the stability of relationships between these two different cultural approaches. In our point of view both perspectives are essential to understand human behaviors (Pike, 1996), especially, social and cultural behaviors that help to shape mathematical ideas, procedures, and practices developed by the members of distinct cultural groups.

Finally, one of the latest trends in Mathematics Education points to a need to integrate the teaching of this science with other knowledge areas in an interdisciplinary fashion at all levels of education. In order for this process to be successful as well as the mathematics to be valued, contents we consider unique and valuable creations can use ethnomodeling in order to link the theory into practice, and by including a dialogical approach.

Final Considerations

Today, numerous and diverse mathematical knowledge systems and traditions are at risk of becoming extinct because of rapidly changing natural and socio-cultural environments fueled by a fast pacing economic, social, environmental, political, and cultural changes occurring on a global scale. Many ancient and local mathematical practices disappear because of the intrusion or imposition of “foreign” etic knowledge value systems and technologies and come to from the development of concepts that promise short-term gains or solutions to problems faced by cultural groups without considering the emic knowledge, values or contexts to solve these very same problems. Not unlike the loss of global tropical rainforests, the tragedy of the impending disappearance of indigenous and local knowledge is most obvious when a diversity of skills, technologies, and cultural artifacts, problem solving strategies and techniques, and expertise are lost to all of us before being archived, understood and/or saved.

Defined in that manner, the usefulness of both emic and etic distinctions are evident. Like all human beings, researchers, educators, and teachers have been enculturated to some particular cultural worldview; we all therefore need a means of distinguishing between the answers we derive as enculturated members of “my” group and the answers we derive as observers of “our” group. Culture is a lens, shaping reality; it can be considered a blueprint, specifying a plan of action, by utilizing the research provided by both approaches, we gain a more complete understanding of the cultural groups of interest for all of us.

Bibliographical References

Ascher, M. (2002). Mathematics elsewhere: An exploration of ideas across cultures. Princeton, NJ: Princeton University Press.

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

Berry, J. W. (1990). Imposed etics, emies and derived emics: Their conceptual and operational status in cross-cultural psychology. In T. N. Headland & M. Harris (Eds.). Emics and etics: The insider-outsider debate (pp. 84-89). Newbury Park, CA: Sage.

Berry, J. W. (1999). Emics and etics: A symbiotic conception. Culture & Psychology, 5, 165-171.

Craig, E. (1998). Routledge encyclopedia of philosophy: Questions to sociobiology. New York, NY: Routledge.

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

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

D'Ambrosio, U. (2001). What is ethnomathematics and how can it help children in schools? Teaching Children Mathematics, 7(6), 308-310.

Eglash, R. (1999). African fractals: Modern computing and indigenous design. New Brunswick, NJ: Rutgers University Press.

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.

Lett, J. (1996). Emic-etic distinctions. In D. Levinson & M. Ember (Eds.). Encyclopedia of Cultural Anthropology (pp. 382-383). New York, NY: Henry Holt and Company.

Lovelace, G. (1984). Cultural beliefs and the management of agro-ecosystems. In T. Rambo & P. E. T. Sajise (Eds.). An introduction to human ecology research on agricultural systems in South East Asia (pp. 194-205). Honolulu, HI: East–West Centre.

Martin, J. N., & Nakayama, T. K. (2007). Intercultural communication in contexts. Boston, MA: McGraw-Hill.

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

Pike, K. L. Emic and etic standpoints for the description of behavior. Glendale, IL: Summer Institute of Linguistics, 1954.

Pike, K. L. (1996). With heart and mind: A personal synthesis of scholarship and devotion. Duncanville, TX: Adult Learning Systems.

Pollak, R., & Watkins, S. (1993). Cultural and economic approaches to fertility: Proper marriage or mésalliance? Population and Development Review, 19, 467-496.

Rosa, M. (2010). A mixed-methods study to understand the perceptions of high school leader about English language learners (ELL): The case of mathematics. (Doctorate dissertation). College of Education. California State University, Sacramento.

Rosa, M., & Orey, D. C. (2003). Vinho e queijo: Etnomatemática e modelagem! [Wine and cheese: ethnomathematics and modeling!]. 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 ethnomathematics as a program: delineating a path toward pedagogical action]. BOLEMA, 19(26), 19-48.

Rosa, M., & Orey, D. (2009). Symmetrical freedom quilts: The ethnomathematics of ways of communication, liberation, and art. Revista Latinoamericana de Etnomatemática, 2(2), 52-75.

Rosa, M., & Orey, D. C. (2010a). Ethnomodeling as a pedagogical tool for the ethnomathematics program. Revista Latinoamericana de Etnomatemática, 3(2), 14-23.

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

Urton, G. (1997). The social life of numbers: A Quechua ontology of numbers and philosophy of arithmetic. Austin, TX: University of Texas Press.