TWELVE CALLINGS TO THE ETHNOMATHEMATICIANS OF THE WORLD

DOZE CHAMADOS AOS ETNOMATEMÁTICOS DO MUNDO

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ABSTRACT

This theoretical reflection presents the description of three stages of analysis related to the ethnomathematics program: 1) A first attempt to establish the number of people and study groups who are currently investigating ethnomathematics, 2) A case study of a mathematics classroom, which aims to answer the question proposed by Ubiratan D'Ambrosio 28 years ago about how to learn ethnomathematics in a classroom. This intervention is named *mathematics class with an ethnomathematical approach*, and 3) A reflection on some sensitive questions regarding the culture of the ethnomathematics program and cultural identity. These three stages are the basis for the elaboration of the 12 callings to the ethnomathematicians of the world and for building a manifesto of political struggle of current ethnomathematicians and those in training.

Keywords: Academic Community; Didactic Proposal; Ethnomathematics Program; Mathematics Education; Manifest.

RESUMO

Esta reflexão teórica apresenta a descrição de três etapas de análise em relação ao programa etnomatemática: 1) Uma primeira tentativa de estabelecer o número de pessoas e de grupos de estudo que estão atualmente investigando Etnomatemática. 2) Um estudo de caso de uma sala de aula de matemática que visa responder à pergunta proposta por Ubiratan D'Ambrosio há 28 anos sobre como aprender Etnomatemática em uma sala de aula. Essa intervenção é denominada de *aula de matemática com um foco etnomatemático* e 3) Uma reflexão sobre algumas questões sensíveis a respeito da cultura do programa etnomatemática e da identidade cultural. Essas três etapas são a base para os 12 chamados para os etnomatemáticos do mundo e para a elaboração de um manifesto de luta política dos etnomatemáticos atuais e daqueles em treinamento.

Palavras-chave: Comunidade Acadêmica; Proposta Didática; Programa Etnomatemática; Educação Matemática; Manifesto.

1. Introduction

On May 5, 2015, at the *XIV Conferência Interamericana de Educação Matemática - CIAEM* (Interamerican Conference on Mathematics Education) in Tuxtla, Mexico, a meeting among 16 ethnomathematics researchers was organized to discuss some questions about the current state of art of the ethnomathematics program. The questions discussed were: 1) How do you see the development of ethnomathematics program in the world and particularly in Latin America?, Are we progressing or are we stagnant?, What does research in this field involve? 2) What are the biggest challenges faced by the ethnomathematics program? 3) What is the role of ethnomathematics program regarding economic globalization and neoliberalism? The answers to these questions are discussed in Aroca (2016) and led this author to the writing of this paper.

Before listing the 12 callings, it was necessary to create the basis for its elaboration by beginning with a presentation of the ethnomathematicians of the world. This list also includes some critics of ethnomathematics[1]. This task sounds very ambitious as it runs in the inevitable risk of excluding individuals, study groups, or networks. But, by providing the names of researchers or networks, it is possible to make contacts as well as find and specify information regarding ethnomathematics.

This inventory was based on information gathered from various sources such as networks, study groups, and researchers. Such a survey of the state of the art of ethnomathematics in the world offers a glimpse of how the ethnomathematical movement really is and how it allows investigators and educators to: a) integrate more investigation, b) meet more researchers, c) make contacts, and d) strengthen or develop networks and collaborations. The inventory of this movement also argues against the position that ethnomathematics is just as a fleeting fashion program. Hence, ethnomathematics provides Mathematics Education with an environment that relates mathematical knowledge, teachers, and students with the local mathematical knowledge that circulates in the schools sociocultural contexts. It is an additional alternative in relation to the various sociocultural positions applied in educational settings.

2. Three Macro Issues before the Discussion of the 12 Callings

There are three macro issues that need to be analyzed before starting the discussion of the 12 callings to the ethnomathematicians of the world.

2.1. Ethnomathematics of the World

The ethnomathematics program grows differently in various continents. For example, in the Americas and, particularly, in Latin America, there are more organizations and greater growth in investigations in ethnomathematics than in the rest of the world. Americas have the largest number of ethnomathematical networks. For example, in addition to the *International Study Group on Ethnomathematics* (ISGEm) and *North American Study Group on Ethnomathematics* (NASGEm) in the United States, there is the *Red Latinoamericana de Etnomatemática*[2] (RELAET) founded in Colombia and the *Associação Brasileira de Etnomatemática*[3] (ABEm) in Brazil.

According to current information from RELAET (December, 2015), there are 11 countries in Latin America with national coordinators. Yet, it should be noted here that such coordination efforts are of differing extent in each country. In countries with no

[1]The main researchers who have criticized ethnomathematics program are listed under Call no. 7 in the *Final Considerations* section of this article.
[2]Latin American Network of Ethnomathematics.
[3]Brazilian Association of Ethnomathematics.

national coordinators there are also researchers and study groups investigating ethnomathematics. It is important to highlight that it is not possible to determine how many ethnomathematical researchers are in these countries due to the high number of groups and networks responsible for the development and dissemination of investigations in this research field. For example, there are countries like Brazil and Colombia in which there is a high number of research and groups investigating ethnomathematics. In fact, there are ethnomathematics researchers in the Americas who are not linked to any of the four networks described.

Regarding the collected data, the African continent also has a significant growth in investigations of ethnomathematics. An unquestionable pioneer was Paulus Gerdes (2007a, 2011), who increased the number of doctoral theses in ethnomathematics that have been made in this continent. Gerdes (1995, 1999) also demonstrated the relationship between ethnomathematics, mathematics education, and its historical and epistemological development. There is a high number of researches, investigations, and projects carried out in Africa (Gerdes & Djebbar, 2011; Gerdes, 1999, 2007b, 2007c, 2011). For example, some researchers on ethnomathematics in Africa are: in Angola, Alfredo Capitango de Lúcio and Domingos Dias, who is the Coordinator of the RELAET in that country; in Mozambique, Marcos Cherinda and Abdulcarimo Ismael from the Pedagogical University of Maputo; in Zimbabwe, Sylvia Madusise, and in Ghana, Jorge Appiah.

The view of the ethnomathematics program in Europe is different because its results are *measured* in terms of the modern science culture and whether or not projects have a scientific nature. Despite this scenario, there are study groups and researchers investigating ethnomathematics. They are: 1) Portugal: Mônica Borges Mesquita, Alexandre Pais, Teresa Vergani, Darlinda Moreira, Joana Latas, Filipe Sousa, Cecília Costa, and Pedro Palhares; 2) Greece: Charoula Stratoupoulus, 3) Belgium: Karen François and Rik Pinxten; 4) Germany: Ursula Verdugo Rohrer and Gert Schubring, 5) Italy: Franco Favilli; 6) Spain: Maria Luisa Oliveras, who leads the research group on Ethnomathematics and teacher training; Veronica Albanese, Nuria Gorgorió, and Javier Diez-Palomar; 7) Denmark: Ole Skovsmose; 8) France: André Cauty, Karine Chemla, Eric Vandendriessche, Agathe Keller, Alexandre Mopondi-Bendeko, and Fiancée-Gernavey Bantaba, and 9) Switzerland: Anahy Gajardo.

It may not be possible to complete an extensive survey of research in Asia due to language barriers, because not everybody publishes the results of their research in English. Thus, there are local or regional experiences written in the native language that are oftentimes unknown by the academic world in other continents. Yet, some ethnomathematics researchers in Asia are: 1) Japan: Takuya Baba and Mitsuhiro Kimura from the Hiroshima University; 2) Philippines: Willy Alangui; 3) Israel: Igor Verner, Khayriah Massarwe, and Daoud Bshouty from the Technion - Israel Institute of Technology; 4) In Nepal there is an ethnomodeling research group whose main partner is Daniel Orey. The coordinator of this group is Toyanath Sharma, http://www.abi.edu.np/. There also Bal Luitel and Amrit Poudel from Kathmandu University, and Ramesh Neupane; and 5) Turkey: Ahmet Küçük. From the Memories of *ICME12* it is possible to present the following researchers: 6) Korea: Ho Kyung Ko; 7) Singapore: Charlie Carroll; 8) China: Chang-jun Zhou, Yu-hong Shen, and Qi-xiang Yang, who work in the Dehong Teachers' College, and Cai Rang Xiawu from the Northwest University for Nationalities; Shen Yu-hong and Yang Qi-xiang, who work in the Dehong Teachers' College, Yunnan. It also important to highlight that the *Southeast Asia Ethnomathematics Seminar* was held in 2008 in Malaysia. The University Putra Malaysia (UPM) also offers both a *Master of Science in Ethnomathematics* and a *PhD in Ethnomathematics.*

In Oceania, some researchers investigating ethnomathematics are: 1) Australia: Kay Owens, who is a member of *The Glen Lean Ethnomathematics Centre* (GLEC), Cris Edmonds-Wathen, and Alan Bishop; 2) New Zealand: Bill Barton, Tony Trinick, Tamsin Meaney, Uenuku Fairhall, and Don Rubinstein, who is working with teachers in Micronesia and was the leader of a major project funded by the University of Hawaii that has produced many pedagogical materials, and 3) Papua New Guinea: Patricia Paraide, Charly Muke, Vagi Bino, and Serongke Sondo. It is important to emphasize that a recent book written by Owens, in 2015, entitled *Visuospatial Reasoning: An Ecocultural Perspective for Space, Geometry and Measurement Education*, offers more references of ethnomathematics research in this continent. For example, there are a number of investigations on navigation and wayfaring from across the islands in Micronesia such as Marshall Islands; in Polynesia such as New Zealand, Hawaii, and Tahiti; and in Melanesia such as Solomon Islands and Papua New Guinea.

This growth in research on ethnomathematics will impact our communities because more questionings will arise. For example, *What has been the real impact of ethnomathematics in the mathematics education in Latin America?, What understanding do educators and particularly those professionals who coordinate and administer teacher education programs have about the ethnomathematics progra*m? In this context, consider the exceptional case of Peru, as there is a national education policy promulgated by the *Ministry of Education*[4] (MOE), in 2013, that includes ethnomathematics in the school curricula. Yet, moving from theories to practice has not been easy, but there is an important theoretical advancement in mathematics education provided by the publication of book entitled *Matemáticas en Educación Intercultural Bilingüe: Orientaciones Pedagógicas* (Mathematics in Intercultural Bilingual Education: Pedagogical Orientations), in 2013, that includes the ethnomathematics perspective in the issues of intercultural bilingual education. Thus, the impact of the ethnomathematics program on communities constitutes one of its challenges.

On the other hand, it is important to emphasize here that an excellent analysis of the history of ethnomathematics program that helps to supplement these information is presented by Rosa & Orey (2014), who described 20 historical fragments of ethnomathematics program not only related to the Americas, but also around the world. This document is essential to develop a broad understanding of the origins of the ethnomathematics program.

2.2. A Mathematics Class from an Ethnomathematical Approach

Among the main challenges faced by ethnomathematics and considering D'Ambrosio's and the nine ethnomathematicians' responses that were analyzed on this topic (Aroca, 2016), it is necessary to highlight their conceptual framework and conceptions about this program and its dimensions. However, among these challenges, there is a gap that

[4]In Brazil, there is also an inclusion of Ethnomathematics in a national policy. For example, *the National Curricular Parameters for Mathematics* (1997) and some educational laws such as Law no. 10639 (2003) on racial ethnic education also address an ethnomathematical perspective in the school curricula.

emerges, which is not discussed in the literature regarding ethnomathematics program that is mainly related to the issues of *how*, *what*, and *why* students learn mathematics in the classrooms. In this context, suppose that a teacher who is interested in the Ethnomathematics Program decides to apply his/her theoretical framework in the classroom, then, the question that arises is: W*hat is his/her teaching commitment towards learning*? Thus, the main goal of any ethnomathematician, and as a mathematics educator, is that his/her students learn mathematics, whether by their own choice, by the curriculum, by the community or because mathematics emerges in the classroom.

When D'Ambrosio (1988) was asked if ethnomathematics can be taught, he said: "Ethnomathematics is not taught, you live it and you do it" (p. 3) because it is a lived program that makes sense in the context in which it occurs. Therefore, the intention is not to teach ethnomathematics in the classrooms rather is to live it and learn it. Thus, a teacher should ask him/herself: "when I enter in a 1st grade class (or 2nd, or 3rd) how can I learn ethnomathematics? With this attitude, he/she is beginning a process that will open a new dimension as a professional and as a human being" (D'Ambrosio, 1988, p. 3).

Today, 28 years later, this response can be equated with the aforementioned question: *What is your teaching posture about learning?* This question has been answered from different approaches such as language, adult practices, community of practices, and student practices in the classroom (Assunção & Borges, 2012; Ávila, 2014; García, 2014; Latas & Moreira, 2013; Owens, 2014; Sánchez, 2014; Wager, 2012). Since the answer to this question is very complex and cannot be answered from a single point of view, I propose an alternative, which is related to the *mathematics class from an ethnomathematical approach* that becomes the first[5] challenge of the ethnomathematicians.

2.2.1. The Relation between Ethnomathematics and Mathematics Education

Other questions emerge regarding to the relation between ethnomathematics and mathematics education: a) *Is ethnomathematics program another way of doing mathematics education?*, b|) *Is ethnomathematics a subsidiary program of mathematics education?*, and c) *Is mathematics education currently conceived as an obstacle to the comprehension of the ethnomathematics program?*

I believe that D' Ambrosio's approach to ethnomathematics gives us some answers to these questions. For example, he states that "Ethnomathematics is considered as a subarea of History of Mathematics and Mathematics Education, with a very natural relation with Anthropology and Cognitive Science. The political dimension of Ethnomathematics is evident" (D'Ambrosio, 2011, p. 9).

In Aroca (2016), D'Ambrosio raised the following issues: 1*) It is necessary for schools to teach mathematics practiced by the dominant culture because this enables young people to enter in the system. But, at the same time, it is necessary that schools recognize and value knowledge developed by local cultures* and 2) *Considering this approach as a didactic strategy, it is very convenient to develop a parallel and*

[5]These challenges are not organized hierarchically since this is simply the order they appear in this manuscript.

comparative education. In my opinion, these arguments provide a basis for answering the questions raised above. Thus, it is prudent that ethnomathematicians assume a position regarding the relation between ethnomathematics program and mathematics education. But, in addition to this, there is a more complex topic that can be depicted by questions: a) *How does ethnomathematicians know that students learn mathematics and which mathematics are they learning?,* b) *What kind of mathematics is taught and why?*, and *c) What kind of control is assumed to be in a mathematics class mediated by an ethnomathematical approach?*

This context allows for the presentation of the proposed approach named *mathematics class with an ethnomathematical approach*[6] that is constantly changing, open to criticism and modifications, and which is one of many that exist in the methodological diversity of the ethnomathematics program. So, in this regard, ethnomathematics program is conceived as a sociocultural approach to mathematics education. This example gives an idea of the development of this approach in the *Semillero*[7] *Mathematical Diversity Program* in the Universidad del Atlántico, in Barranquilla, Colombia. Basically, prospective mathematics teachers in teacher education program work with this approach that has three general and essential stages.

2.2.1.1. First Differentiating Stage

This first stage is related to the conduction of fieldwork in a community of practice, which can last several months. It is when ethnomathematical practices of the community emerge, it is known, classified, and interpreted. Thus, this stage does not start in the classroom, but outside of the school. This is the most important and time consuming stage of this work because ethnomathematicians should be deeply involved in this practice. In this context, the skeletal system of the ethnomathematics program is found out of the classroom, in the world of students and teachers, and in their social, geographical, and spatial experiences. However, the muscular system of the ethnomathematics program is developed in the classroom and this system is investigated systematically. Therefore, to conduct research in ethnomathematics means to do the fieldwork and extracurricular activities since they are part of its methodological procedures. In this methodological approach, the use of qualitative research is strongly recommended because of the demands of the context in which the practices emerge and are developed (Creswell, 1998; Denzin & Lincoln, 1994; Flick, 2002; Vasilachis, 2006).

2.2.1.2. The Choice of a School where Students and Teachers Recognize or are Familiar with the Chosen Ethnomathematics

This second stage relates to the choice of schools to recognize the socio-geographical experiences of students and teachers. Something interesting happens here because the chosen ethnomathematics necessary for the pedagogical work with the students may or may not be similar in the same community or town, which may not allow to the development of a parallel and comparative relation of the same mathematics content in

[6]The sequence of creation of this approach can be traced in Aroca (2008a, 2008b, 2008c, 2009, 2010, 2013a, 2013b, 2014, 2015); Rey & Aroca (2011); Ortega, Millán & Aroca (2012), Correa, Medina & Aroca (2013).
[7]Semillero is a group of university students led by a research professor. In our case, these students are studying to be mathematics teachers.

the curriculum. This analysis depends on the socio-geographical space as well as on the skills of the teachers on knowing and interpreting this ethnomathematics.

2.2.1.3. The data transposition from ethnographic work and the parallel teaching process and comparative results in the classrooms

Before the development of the *Theory of Didactic Situations* (TDS) by Brousseau, there were proposals for activities in which manipulative materials were brought to the students in order to help them to mathematize mathematical content. Generally, these materials were not linked to the students' reality as well as this connection was not investigated by the mathematics teachers. For example, the ideas of Freudenthal and other authors from the school of *Active Pedagogy* are related to the concept in which students work with contextualized activities and materials in order to learn mathematical content.

Mathematics class with ethnomathematical approach is not a program to be applied in classrooms like Cuisenaire rods or logic blocks or other ostensible didactic material necessary for students to help students to learn mathematics. This approach is not based on the masterful sequence needed to obtain *application problems* by using ethnomathematics.

This approach ensures that students assume comparisons between ethnomathematics and academic mathematics in which learning is based, thus it is necessary that students and teachers take control of this process. If students, at the end of this process, are able to compare academic mathematics, which belongs to a globalizing culture, with ethnomathematics that is part of our reality, including *pure mathematics* and the critics of ethnomathematics program, that is where learning is supported.

There is a tension between the main interests of the *TDS* and the *Objectification Theory* (OT). The focus of *OT* is on promoting the constitution of the human being and on their knowledge while the focus of *TSD*[8] is the learning of academic mathematics. The focus of these theories is different and their units of analysis are distinct. If we locate the didactic posture of the ethnomathematics program in the tension between academic mathematics that belongs to a globalized culture and ethnomathematics that belongs to the local culture, then *mathematics class from an ethnomathematical approach* should *move tensions* between *OT*[9] and *TSD*[10].

In synthesis, it is important to search for a parallel and comparative learning between academic mathematics and ethnomathematics without assuming any instrumental role because students need to be empowered by both academic mathematics as well as the foundations of local mathematical practices chosen for their own environment. This

[8]It is necessary to recall that both Guy Brousseau (2006) and Bruno D'Amore (2003) have written about ethnomathematics. So, it is interesting not only know the criticism of the ethnomathematics program, but also to understand how didactic specialists perceive the ethnomathematics program.

[9]There are different approaches in mathematics education, but *TDS* and *OT* were chosen because of their trajectory, results, and tensions (Jurado, 2007; Radford, 2011).

[10]One of the main criticisms of *OT* researchers to *TSD* is that it does not contemplate the historical cultural individual who belongs to a specific culture and develops his/her own knowledge. *TDS* considers ideal individuals who should learn mathematical content imposed by the system so they can acquire academic mathematical knowledge.

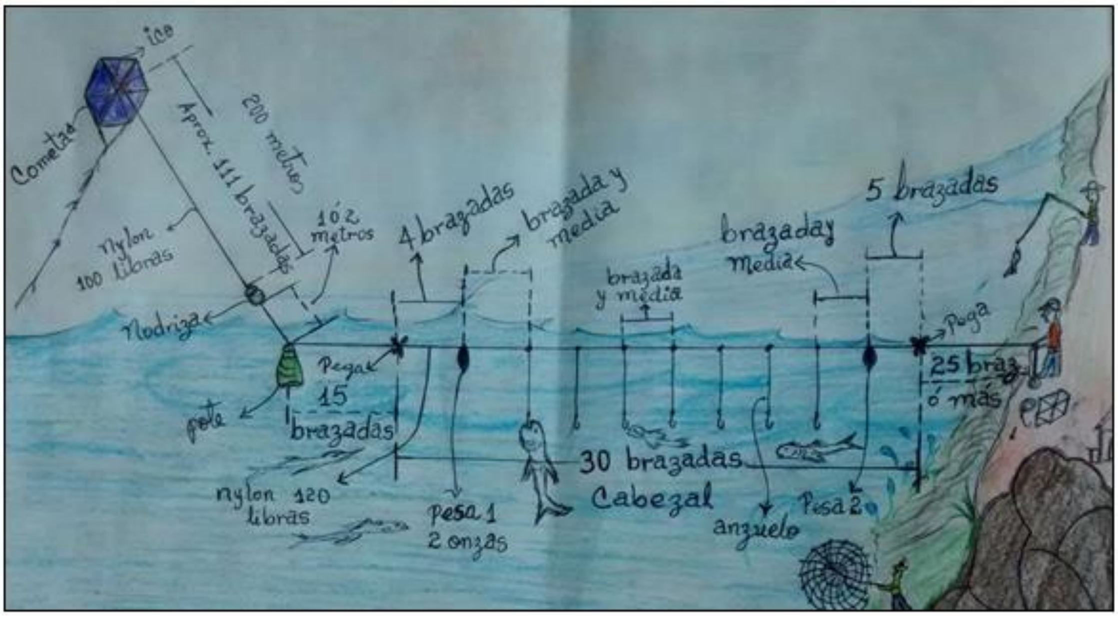
approach implies in a transformation of the traditional way of teaching mathematics in the classrooms.

For example, a mathematics teacher decides to develop a workshop related to basket weaving to work with geometric concepts and shapes. Thus, this teacher brings strips of any kind of fiber such as cotton, straw, or cane in order to perform a detailed analysis of the logic design of baskets. Then, if the goal of the class is the empowerment of the students by using ethnomathematics developed by the local culture, it is denied the opportunity to empower students in the academic mathematics, which is part of the globalized culture.

Thus, it is necessary that the teacher answers some questions that arise from this workshop: a) What is the mathematical knowledge to be developed in this class? b) How is the class going to be organized? c) What are the problematic situations that can be exemplified and developed in the class? d) How is the teacher going to take control of this activity in order to facilitate students' communication, elaboration of conjectures, and the validation of the results? and e) How is the teacher going to mediate students' comparison between ethnomathematics and academic mathematics?

There are several investigations that have been developed at the *Semillero Project*. One of these investigations is related to the understanding of two sets of unconventional measurement system used in artisanal fishing kites in Bocas de Ceniza, Barranquilla, Colombia, and their potential use in mathematics education[11]. This investigation is part of the project named *a mathematics class from an ethnomathematical approach*.

Figure 1 shows a fishing tackle with kites, which is essentially based on the strokes implicitly measured in yards. This example constitutes the first set of empirical measurement system used by the fishermen in Bocas de Ceniza.



[11]This potential is related to the discussion of the type of control used in mathematics classes by the teacher such as: a) planning, development, and evaluation, b) the role students assume when they compare ethnomathematics and academic mathematics, c) the kinds of mathematics activities applied in the classroom, and d) the evaluation system.

Figure 1[12]: Fishing tackle according to strokes implicitly in yards

The second set of unconventional measurement system found in fishing with kite is related to the design of six types (Figure 2) of kites that are used by the fishermen according to the intensity of the winds.

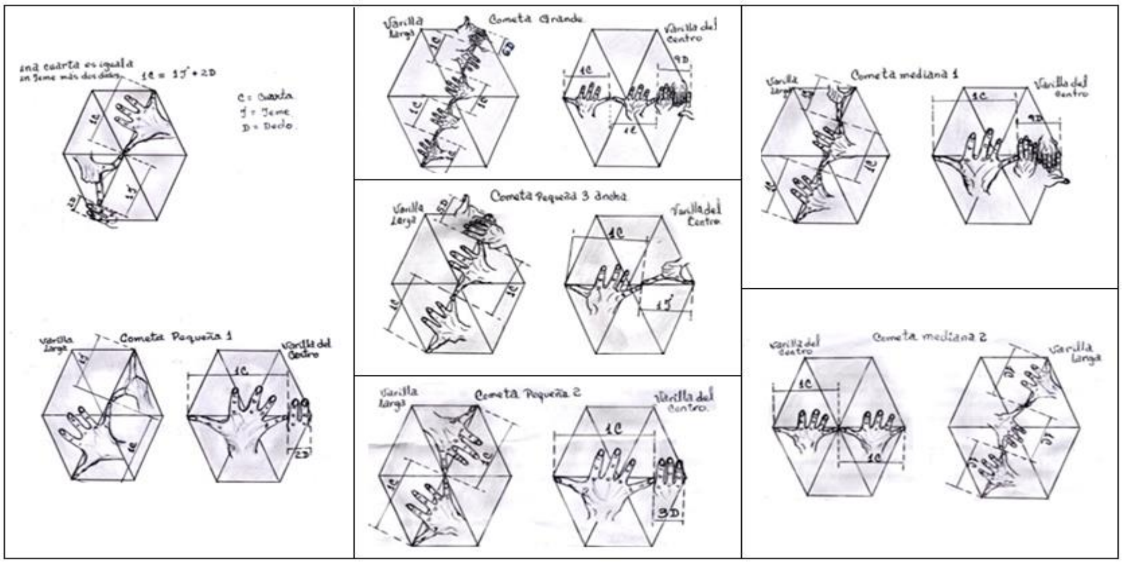


Figure 2: Six types of kites used in the fishing during the year

These measures are based on quarters, handspan, and fingers, which are used based on the season and on the types of winds that occur during the year (Figure 3).

Figure 3: Measures of a medium kite that is used for normal wind

In this project, researchers used diverse techniques and instruments to collect data in order to recreate the *natural situation* (Vasilachis, 2006). Then, interviews and participant observation were conducted and data analysis was developed. This methodological procedure led to a generation of teaching resources such as the one showed in Figure 2.

It is important to describe here the relation between kites and variables involved in this practice. Fishermen use different sizes of kites depending on the different kind of

[12]The drawings are usually made by students in training. In this case, the drawings were made by Camilo Rodriguez under the supervision of some fishermen.

weather[13] throughout the year[14]. For example, there is good weather in January, February, March, September, October, November, and December because these months have strong wind that favors the work of the fishermen during the day and the night.

For this weather condition, fishermen use *small kite* (*sk*) with the following rod dimensions: long stick (*LS*) measures a *cuarta*[15] (*c*) (Figure 4) plus a *jeme*[16] (*j*) (Figure 5), then, *LS = 1c + 1j* and the central stick (*CS*) measures a *cuarta* (*c*) plus *dos dedos*[17] (*d*), then, *CS = 1c + 2d*.

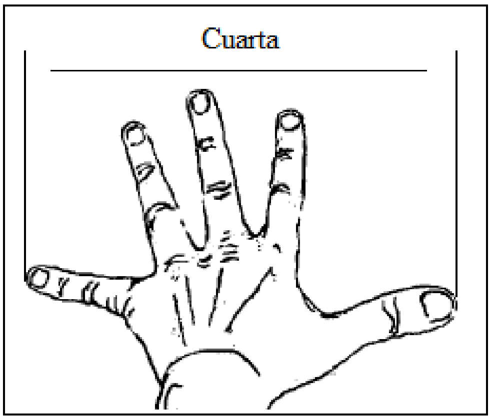


Figura 4: Cuarta, handspan, great span

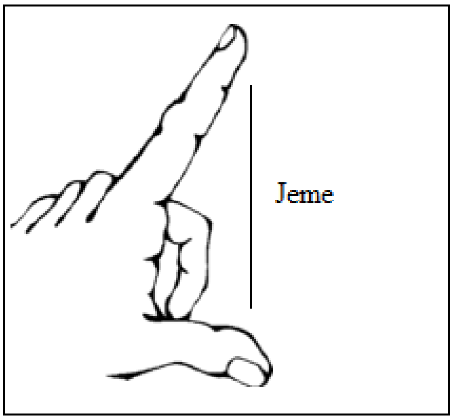


Figura 5: Jeme, little span

Figure 6 shows the measures of the long and the central sticks in a small kite used by the fishermen.

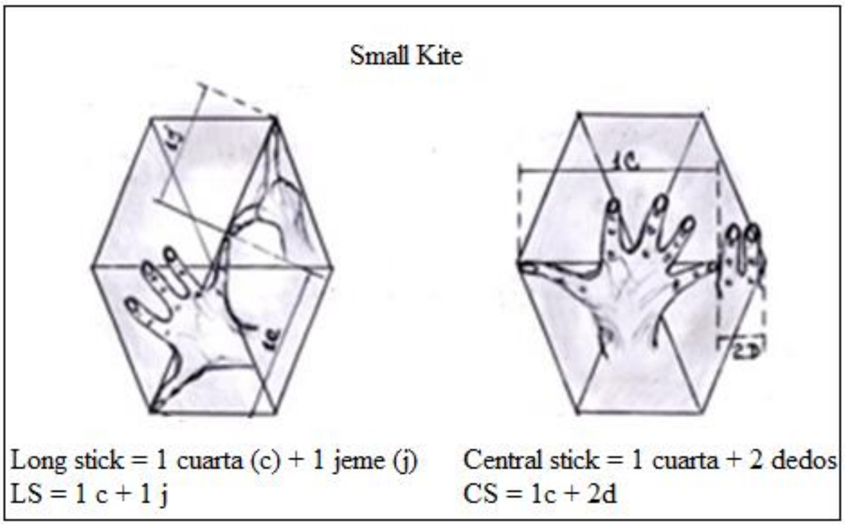


Figure 6: Measures of the long and central sticks in a small kite

Therefore, the measurement of each stick is determined by the sum of *cuartas*, *jemes*, and *dedos* (fingers). This approach is used as a way to symbolize data representation,

[13]It is not easy to define weather, but it is related to good, regular, and bad atmospheric conditions for fishing with kites. These conditions are wind direction, rain, summer, and shortage of fish abundance.

[15]*Cuarta* (handspan, great span) is approximately the distance from the tip of the thumb to the tip of the little finger, when the hand is fully extended.
[16]*Jeme* (little span) is approximately the distance between the tip of the thumb to the tip of the index finger.
[17]The translation of the Spanish expression *dos dedos* to English is two fingers.

which allows researchers to control variables, but this is equivalent to the verbal generalizations made by the fishermen.

However, it is important to acknowledge and be conscious that these generalizations may generate obstacles for the seventh grade students, because, according to the mathematics curriculum in Colombia, students develop mathematical generalizations in the eighth grade. According to this context, teachers must be aware of the limits of the implementation of the transposition of this practice in the classrooms.

By finishing the ethnographic work developed with the teacher-advisor and mathematics teachers in the teacher education program, this investigation was moved to the classroom. Contacts were made, institutional permissions were requested, and this pedagogical intervention was linked to a teacher in the school. It is always wise to expose the teacher in the school to the methodological procedures of the intervention, otherwise, there is a risk that this lack of communication may generate educational obstacles to the development of this proposal. Thus, it is important that this teacher understands that he/she can also learn from this approach by implementing it and practicing it in the classrooms. The minimization of these obstacles is one of the biggest challenges of this approach.

The class always starts with a test[18] and at its end there was an application of a complete re-test to analyze the conceptual change regarding to the proposed mathematical content. Three mathematical concepts were studied in this class: length, distance, estimation, relations, and associated concepts. The *length* is related to the *dimension* of a *body interpreted* in a straight line; the dimension is related to a *magnitude* that helps to know or define a *physical phenomenon*; and the magnitude is related to the property of the bodies that can be measured, thus leading to the *distance*.

After the test, there is an exhibition of the ethnomathematics identified in these practices by using different materials; such as videos, projectors, photos, speakers, and manipulatives, in order to socialize collected information. Hence, the analysis of the information related to ethnomathematics determines which academic mathematical themes or concepts can be used in a parallel and comparative relation and, therefore, the selection grade level. Then, it is necessary to identify topics in the Colombian mathematics curriculum that are related to the ethnomathematical perspective in the classroom. This approach allowed for the confrontation of the tension between academic mathematics of a globalizing culture and ethnomathematics of a local culture.

The metric system and the two sets of unconventional measurement system used in artisanal fishing kites in Bocas de Ceniza were chosen to be developed with the students. The academic definitions of mathematical concepts were never given to students because they were motivated to come up with these conceptions during the class. Figure 7 shows the results of the discussion about the concepts of length and distance elaborated by the members of group no. 5 during class.

[18]The questions asked were: 1) What is measurement?, 2) What is an estimation?, 3) How is it measured?, 4) How can you measure it?, 5) What is a measurement system?, 6) What do you understand by measurement unit?, 7) What is the length?, and 8) What is the distance?

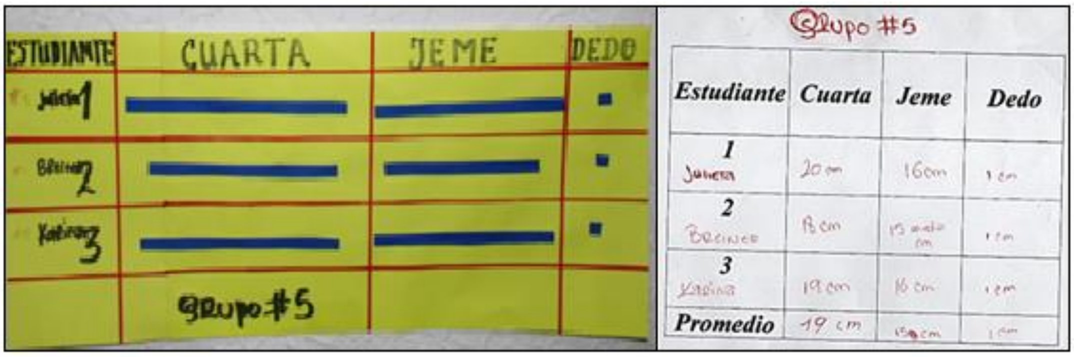


Figure 7: Illustrative tables that show lengths (left) and distances (right) elaborated by group no. 5

The mathematical content used in both tables implied that 3 students in the working groups got involved in cognitive conflicts that allow them to reflect on the concepts of length and distance. A cognitive conflict occurs when a *mental model*[19] developed by a student faces the representation of other models or mental models that analyze the same mathematical content. Thus, the mental model that was operated by most students in the groups offered a similar treatment to the length and the distance as it was established in the test. The results from the initial activities of the test also show that students only used measurement units from the metric system.

For example, figure 7 plays the role of a new mental image in which it was intended to destabilize this mental model. This change could be verified by checking the students' answers in the re-test, which showed that the treatments for the length and distance were not the same, yet they tended to be valid. In this regard, the tension between ethnomathematics and academic mathematics can be considered as a tension between mental models that produce cognitive conflicts, which are invaluable to promote learning.

The idea presented here is not to instrumentalize ethnomathematics based on academic mathematics rather to allow students to take on the fisherman role in some of its facets. In this activity, students use *cuartas*, *jemes*, and *dedos* (fingers) to construct their kites and then they discuss about the mathematical knowledge related to this practice. This is a moment of great interest because students start the comparison process in which their subjectivities have the appropriate conditions to emerge. Figure 8 shows students using their hands and the unconventional measurement system, used by the fishermen, in the construction of their kites.

[19]A mental model is initially a changing image that is becoming stable from the stimuli as well as it tends to remain stable until the emergence of new stimuli or images of an object, situation, or process. Thus, the stimulus precedes the mental image and its successive transformations tend to stabilize the mental model (D' Amore, 2006).

Figure 8: students using their hands and the unconventional measurement system in the construction of their kites

At the end of the class, students were asked to respond individually to a questionnaire that must be delivered in the next class. The questions were: 1) *Do you believe that the procedure used by fishermen for the construction of small-scale fishing tackle and the elaboration of the kites, is mathematical? Justify your answer*, 2) *What is the best process of teaching and learning mathematics: using the textbook or applying mathematics found outside of the classroom? Justify your answer*, 3) *Do you know any other ethnomathematical practice different from that used by the fishermen from Bocas de Ceniza? Explain your answer. If you want to draw pictures. Use any resource you want to give the explanation.*

In general, a *mathematics class from an ethnomathematical approach* has the following structure:

1. Fieldwork to develop forms of knowledge about the practice and ethnomathematics involved. It employs significant time. It is necessary training in the development of qualitative research.
2. Analysis of ethnographic information and its relation to the national mathematics curriculum content. This approach begins to address the tension between academic mathematics of a globalizing culture and ethnomathematics of a local culture.
3. Linking of a school professor in the planning of the intervention in the classroom as well as the allocation of functions such as teacher-adviser, training teachers and teacher.
4. Organization of work in the classrooms:
    - 4.1.1. Applying a test. Identification of notions of mathematical concepts.
    - 4.1.2. Recursive explanation of ethnomathematics.
    - 4.1.3. Development of problematic situations.
    - 4.1.4. Students' comparisons
    - 4.1.5. Discussion with the teacher-adviser, training teachers, and teacher.
    - 4.1.6. Application of the retest.
    - 4.1.7. Application of the survey about the importance and the scope of the ethnomathematics program.
5. Delivery of the final report to the mathematics teachers of the school, after it has been revised, supported, and approved by the university.
6. Implementation of re-retest three months later[20].

[20]The application of this test means that researchers may be able to search for mental models that students created around the mathematical concepts developed during the conduction of the project.

It is important to recall that this article presents three macro themes that are the basis of the elaboration of the 12 callings to the ethnomathematicians of the world, yet other themes are surely missing in this study, because of issues of extension. These three themes are: 1) A first attempt to establish the number of people and study groups who are currently investigating Ethnomathematics, 2) A case study of a mathematics classroom, which aims to answer the question proposed by Ubiratan D'Ambrosio, and 3) The theme comes next is about a reflection on some sensitive questions regarding the culture of the ethnomathematics program and cultural identity by (re)thinking about the relationship between Ethnomathematics, culture and indigenous communities. This topic is very sensitive at least in Latin America and even more so in some countries than in others.

3. The 12 Callings

The elaboration of the 12 callings to the ethnomathemacians of the world includes the following questions: 1) *What do we understand by culture and cultural identity* and 2) *What is the place of ethnomathematics reality:* a) *Where is it?* b) *Who is an ethnomathematician?* c) *What are his/her assumptions?*

3.1. What do we Understand by Culture and Cultural Identity?

If it were possible to organize ethnomathematics research chronologically and to investigate all the first investigations of this program, this verification might show that the majority of these studies were related to the indigenous communities. Research conducted around the world show how ethnomathematics research developed from the study of indigenous people because this program is closely related to anthropology. For example, in Latin America, these investigations help to preserve, restore, and strengthen the cultural identity of the members of these cultural groups, particularly, to value mathematical knowledge and practices that were useful in these communities.

Therefore, it is necessary that ethnomathematicians assume a critical position towards concepts regarding culture, cultural identity, colonization, and decolonization in investigations in this program. In this context, D'Ambrosio (2011) states that:

> Recognizing that individuals of a nation, a community, and a group share their knowledge, such as language, explanations systems, myths and cults, culinary and customs, and have their compatibilized and subordinate behavior to values systems agreed by the group, we say that these individuals belong to a culture. The sharing knowledge and compatible behavior are synthesized characteristics of a culture. Thus, we talk about the culture of the family, the tribe, the community, the unionization, the profession, and the nation[21] (p. 19).

This assertion implies that cultural identity also depends on the rhythm of the time or temporality as well as on the social, technological, cultural, and political changes. Cultural identity does not mean being stuck in the past or just gazing into the past. In D'Ambrosio’s (2011) point of view, a dynamic interaction that is always present in the encounters of individuals prevents the possibility of talking precisely about cultures because they are in incessant transformation in a cultural dynamics.

So, mathematical knowledge developed in an indigenous or practice community has a paradox: it gives *identity* to these communities, but at the same time it is a dynamic process over time. This discussion about identity is not easy because words such as colonization and decolonization come into play. According to this context, Samanamud (2010) states that a:

> (...) decolonization project that escapes from proposals that recover the identity and its own legacy, because these ideas reduce culture to conceptual-objective by ignoring the symbolic mythical plane, then we must decolonize who we were, what we are, and how to establish ourselves, which leads us, as a duty, to rethink education and its civilizational dimension (p. 67).

This author also states the following:

> But, if you believe that the affirmation of identity represents at the same time its recovery, and that recovery also means a creation, then, we are in a complex movement of decolonization. It is not only a claim, but it is a recovering, but in the recovery there are also elements of creation: therefore, it has to produce its own knowledge from culture, all of this in a direction that allows us to go beyond the modern capitalist western civilization (Samanamud, 2010, p. 75).

In general, the challenge is that the ethnomathematician can harmonize in their own mental model or teamwork the concepts of culture, cultural identity, colonization, and decolonization. This harmonization enables the outline of the objectives of the investigations that are less paternalistic when they are assumed to be connected to indigenous communities or communities of practice such as carpenters, masons, fishermen, children in certain age range, etc.

3.2. What is the Place of Ethnomathematical Reality: Where is it? Who is an ethnomathematician? and What are his/her assumptions?

It is important to briefly discuss the three questions regarding the place of ethnomathematical reality.

3.2.1. Where is it?

One of my students asked me some years ago: where is ethnomathematics? And I, as a good teacher who does not want to look bad in from of my *disciples* said: in the culture! This response was perhaps influenced by an article I had read entitled *The Locus of Mathematical Reality: an anthropological footnote*, written by Leslie White in 1947. This article was reprinted in Spanish in the book entitled *Sigma: el mundo de las matemáticas* (Sigma: the world of mathematics), written by James Newman in 1994. Let us recall part of what White (1947) concluded in his article.

> Thus we see that there is no mystery about mathematical reality. We need not search for mathematical *truths* in the divine mind or in the structure of the universe. Mathematics is a kind of primate behavior as languages, musical systems and penal codes are. Mathematical concepts are man-made just as ethical values, traffic rules, and bird

> cages are man-made. But this does not invalidate the belief that mathematical propositions lie outside us and have an objective reality. They do lie outside us. They existed before we were born. As we grow up we find them in the world about us. But this objectivity exists only for the individual. The locus of mathematical reality is cultural tradition, i.e., the continuum of symbolic behavior. This theory illuminates also the phenomena of novelty and progress in mathematics. Ideas interact with each other in the nervous systems of men and thus form new syntheses. If the owners of these nervous systems are aware of what has taken place they call it invention as Hadamard does, or *creation*, to use Poincare's term. If they do not understand what has happened, they call it a *discovery* and believe they have found something in the external world. Mathematical concepts are independent of the individual mind but lie wholly within the mind of the species, i.e., culture. Mathematical invention and discovery are merely two aspects of an event that takes place simultaneously in the cultural tradition and in one or more nervous systems. Of these two factors, culture is the more significant; the determinants of mathematical evolution lie here. The human nervous system is merely the catalyst which makes the cultural process possible (p. 303).

Ethnomathematical practices can be created in relation to the need to survive social exclusion, either by a by a state or people. An ethnomathematical focus can lead to the creation of learning communities that develop mathematical practices that could lead us to the emergence of ethnomathematics. So, only people belonging to cultural traditions, with continuous symbolic behavior, would be more likely to expand this accumulation of symbolic technology by having more stimulation around them and that their nervous systems could be sensitive to them. Creating mathematics was like lightning that would illuminate the dark sea.

Thus, many researchers and scholars locate ethnomathematics within the idea of culture. But, this claim may be an obstacle to the understanding of this program. If they are radical, they would claim that everything is located within culture because it is not easy to explain culture in detail. Then, its concept could have been appropriated by something more general. For example, students create many mental models of culture, general ideas, such that sometimes it is strange to say that mathematics is everywhere and therefore ethnomathematics is also everywhere. Explaining ethnomathematics in function of culture is more complex than to explain it in terms of practice, which is inside of a cultural tradition. Models, conceptualizations, and theories about culture overwhelm us, but this shows how complex it is to conceptualize ethnomathematics.

In this context, giving ethnomathematics a place in the reality of practices and not in culture, it is likely to confuse ethnomathematics with mathematics in everyday life since it is not understandable that culture is reflected in practice. This deals with how people conceive some things for culture and others for daily life. However, the meaning of the daily life is also an obstacle as well as cultural identity, since they are still generic representations. What does *everyday* mean?

The workshop was developed with students, where they were asked questions related to *what culture is*, *what mathematics is*, *when something is mathematical*, and *what daily life is*. While in regards to the answers about culture the word *every* has a high frequency, in everyday life it appears the *same* through the world of life, family, friends, neighborhood, neighbors, and activities that are performed. From this point of view, ethnomathematics is best understood through the analysis of its function in specific and concrete cases, in practices, and therefore its place in reality. Cultural traditions and socio-geographical experiences of the people involved in these practices converged. But, practice is not a passive action, because it also imposes problems for people to solve. So, there was a dialectical discourse that was created between practice conditions, cultural traditions, and the socio-geographical experience of people.

Practices appear, disappear, and are transformed, but not necessarily for all people in this process. For example, the practices developed by the members of the fishing community from Bocas de Ceniza may come to an end because of the construction of a huge port for merchant ships. Fishermen in this community had a meeting with representants of this construction project. Apparently they were indemnified and they were given an eviction date. *Can they continue fishing with kites?* As told by the fishermen themselves, this perspective is uncertain.

This example shows that there are variables that can generate, transform, promote, or eliminate ethnomathematical procedures that are not dependent on the people involved in the development of these practices. Ethnomathematical practices can be created in relation to the need to survive social exclusion by a state or people who lead to the creation of communities that develop mathematical practices that lead us to the emergence of ethnomathematics.

3.2.2. Who are the Ethnomathematicians?

A simple answer to this question could be that they are the union set of the professional lives of Ubiratan D'Ambrosio and Paulus Gerdes. This set is the combination of three elements: academic training in mathematics, the development of theoretical skills, and methodological abilities for the fieldwork, which originate six considerations:

1) Ethnomathematicians must have an academic training in mathematics and mathematics education, otherwise they may experience obstacles in understanding the scope and pedagogical implications of the ethnomathematics program. This is paradoxical, because sometimes what is considered mathematical knowledge ends up being people’s own appropriation of it. Understanding academic mathematics involves knowing its values, methods, languages, symbols, organization, and rigor. This means having to put this training in connection to the ethnomathematics program.

2) Ethnomathematicians must reflect about the role of the ethnomathematics program, not only theoretically, but also about its essence, because the natural, social, and cultural contexts stress this discussion. An elementary exercise is to answer the following question: What do I understand by the ethnomathematics program? and then compare this answer with answers from the academic community.

3) Perhaps the greatest methodological ideal is that ethnomathematicians do fieldwork in order to interact with the members of the communities, to know them, or *think like them*, if this is possible. Fieldwork allows researchers to

develop a better analytical perspective of these communities instead of simply being theoretical or critical.

4) Ethnomathematicians must develop a basis in methodological training in qualitative research in order to know *others* and value different knowledge systems regarding its distinct ways of thinking, doing, and communicating mathematical ideas.

5) It is necessary to conceptualize culture, identity, practice, community, and tradition because they depend on the sociocultural context of each ethnomathematician. These themes involve sensitive issues when formally linked to ethnomathematics program.

6) Ethnomathematicians cannot think that members of cultural groups or communities of practices, particularly indigenous communities, are the *others* who are *needy* of necessary truths to solve problems. Ethnomathematicians, by their own practice, are agents of other cultural group who need time and *praxis* to understand cultural practices they want to study. So, ethnomathematical research is not explicit because there is a challenge to understand the natural contexts where ethnomathematics develops without the presence of the investigators. However, D'Ambrosio (2011) warns that "research in ethnomathematics must be done with great rigor, but the subordination of that rigor with to a language and to a standardized methodology, even though with interdisciplinary nature, can be deleterious to the ethnomathematics program" (p. 18).

This methodological process must have a flexible research design from different qualitative research traditions or schools. (Creswell, 1998; Denzin & Lincoln, 1994; Flick, 2002; Vasilachis (2006). These references may guide the construction of theories from natural contexts in which there is the development of the ways of doing, thinking, and communicating mathematical practices elaborated by the members of the communities or cultural groups. By knowing these methodological traditions it is possible to choose research techniques or tools that are more relevant for each context. It is important to emphasize here that it is the context that guides the research design, not the opposite.

3.2.3. What are their Assumptions?

When mathematics educators assume an ethnomathematical position, they also assume a political position, because their research should promote the preservation of the dignity of the members of all cultures. This political position rejects a colonialist approach in both teacher education and research. It is necessary that teacher education programs question a system that imposes only one way of thinking mathematically, which produces widespread educational failure that causes suffering to children and adolescents. The political position in mathematics education through ethnomathematics assumes a respect for the knowledge produced in different contexts, which depends on the historical and cultural process of the creation of mathematical practices by the members of the communities.

Researchers and educators must be aware that many mathematical knowledge systems and, consequently, mathematics diversity are at risk of extinction when neoliberal policies increasingly reduce the solution of these practices to mere instrumentation and to use of techniques to only perform calculations based on trade and commerce. In this regard, D'Ambrosio (2011) states that it is important to avoid that myths, religions, folklores, medical practices, traditional clothes, and scientific and mathematical knowledges developed by the members of distinct cultural groups are considered as curiosity and reasons for mockery. This is also a type of symbolic violence conveyed through language even in the classrooms (Skovsmose, 2015). The extensive work of Paulus Gerdes in Mozambique is an important example that shows how ethnomathematics can be used politically in search for cultural empowerment of the members of cultural groups in different countries.

4. Final considerations: Describing the Twelve Callings

The 12 callings are considered as the essential elements for a *Manifest for an Ethnomathematics Program* in the political struggle for the ethnomathematicians in the world.

Calling No. 1: Impact your community in relation to mathematics education with an ethnomathematical focus. Build and validate learning from the academic and local mathematics.

Calling No. 2: Make efforts to include an ethnomathematics program in initial training programs for mathematics teachers in your country and intend to increase the sensitivity of mathematics teachers in all educational levels.

Calling No. 3: Impact national policies regarding mathematics teaching. First, start at your school, and then your region, department, province, or state. Search for allies or support, then move on to a national level.

Calling No. 4: Link to academic networks of investigation and divulgation, including potential benefits of contacting and including other ethnomathematicians in your country and develop collaborations, which helps to accomplish calling No. 2.

Calling No. 5: Make your work visible by any audiovisual or written means; share them publicly on the Internet. Disclose and share your own experiences or results, this may lead to critical feedback and to receiving further contributions.

Calling No. 6: Seek and create ongoing training in ethnomathematics theories and subsidiary theories. The analysis of other ethnomathematics publications in journals with a good system of blind peer evaluations, discussions in conferences, critical self-evaluation, and other research can lead to a broader vision of the ethnomathematics program. However, because the ethnomathematics program is multidisciplinary, you must not only expand your understanding of the results of this program, but also seek training in other disciplines according to your research interests.

Calling No. 7: Read criticisms on ethnomathematics and take them into account for a better implementation of readings, design of learning activities, formulation of problem situations, approach to research objectives, and conduction of fieldwork, among others.

The main critics are: Milroy (1992), Dowling (1993), Vithal & Skovsmose (1997), Rowlands & Carson (2002), Domite & Country (2009), Country (2011), Pais (2011, 2013), Knijnik et al (2012), Country (2013) and Skovsmose (2015). However, none of these critics have analyzed what can happen in the classroom, especially on academic and local mathematics learning.

Calling No. 8: Valorize critics of mathematicians and mathematics educators who distrust the ethnomathematics program, because these criticisms paradoxically strengthen the ethnomathematical discourse.

Calling No. 9: Defend the rights of people to decent, inclusive, and respectful mathematics education in relation to the history and local cultures, find allies within these locations, but bear in mind that these people are part of a globalizing culture and the development of academic mathematical knowledge brings them harm as well as benefits that can be availed according to their permanence and transcendence with such knowledge.

Calling No. 10: Build up rigorous qualitative research designs which are flexible in diverse contexts and that seek to develop theories from data in natural situations. Ethnomathematicians must develop a greater responsibility in rebuilding mathematics history of our own people; this is why the potential obstacle in this process is the same subjectivity and beliefs of the ethnomathematicians, who should be aware that they themselves are the main enemies in the written systematization of mathematical tradition.

Calling No. 11: As a didactic strategy, it is appropriate to create parallel and comparative curricula where students are responsible for this comparison; they must know the word ethnomathematics, and the teacher must organize the class from an ethnomathematical approach, and consciously, from a validated theory perspective. If you want to know how you learn ethnomathematics in the classroom, then we must investigate successful student practices as well as those developed by their own community.

Calling No. 12: View the socio-geographical experience of students and sociocultural environment surrounding them, learning ethnomathematics scenarios of other ways of doing, thinking and communicating mathematically.

Finally, a total of 12 calls were described here, which became a modest manifest of ideals that come together to create an overall mission to accomplish these both personally and collectively. Particularly, to ensure that other ethnomathematicians know, analyze, refute, complement, or validate them, many are already part of their performance as mathematics educators. According to this context, a great deal of political struggle is underway!

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