Ethnomathematics

Ethnomathematics as a line of study and research in mathematics education investigates the roots of mathematical ideas and practices, starting from the way individuals behave in different cultural groups. Ethnomathematical studies attempt to identify mathematical practices that begin with the knowledge of the others in their own terms and rationality. In this regard, ethnomathematics studies the cultural roots of mathematical knowledge starting from various ways in which members of distinct cultural groups mathematize. As well, the study of ethnomathematics considers the historical evolution of mathematical knowledge with the acknowledgment of all social and cultural factors that mold this development.

When the focus of a study is the pedagogy of mathematics, the attention must be centered both around the legitimization of student knowledge, that grows from experiences built in their own unique ways and around the study of pedagogical possibilities of how to work with the learning process that occurs outside and inside of the school environment. Indeed, a discussion of educational aspects of ethnomathematics helps teachers to establish cultural models of beliefs, thought and behavior, in the sense of contemplating potentials of the pedagogical work that takes into account the previous knowledge of students as well as the mathematical learning that is meaningful and empowering.

In an increasingly globalized and interdependent world, it is fundamental that teachers and educators are given experience that allows them to understand that the diversity of ideas and thoughts that come into contact either through communications, business, education, and science
are greatly influenced by the way in which individuals who belong to different cultural groups learn mathematics. This pedagogical approach is not often reflected in the traditional mathematics classroom, yet high equitable expectations along with personalized connections in mathematics instruction are essential for success for all students.

The Etymological Root of Ethnomathematics

D’Ambrosio (1993) applied to name this program by using the etymology of Greek roots, *ethno*, *mathema*, and *tics* to explain what he understands to be ethnomathematics. He said that ethnomathematics is defined as the mathematics practiced by the members of distinct cultural groups, which are identified as indigenous societies, groups of workers, professional classes, and groups of children of a certain age group, etc. (D’Ambrosio, 1985).

Ethnomathematics is interested with the motives by which specific cultures (*ethno* vs. *ethnic*) developed over history, the techniques and the ideas (*tics* = *technē*) to learn how to work with measuring, calculating, inferring, comparing, classifying, which allow for the ability to model natural and social environments and contexts in which we have come to explain and understand these phenomena (*mathema*).

This program of study represents a methodology for ongoing research and analysis of the processes that transmit, diffuse, and institutionalize mathematical knowledge (ideas, processes, and practices) that originate from diverse cultural groups through history. Ethnomathematics is identified with the history of specific cultural groups (D’Ambrosio, 1990).

Important Facts for the Development of an Ethnomathematics Program

According to Rosa and Orey (2013), six important facts were essential to the development of Program Ethnomathematics program:

1. In 1973, Zaslavsky published her book *Africa Counts: Number and Patterns in African Culture*, which explores the history and practice of mathematical activities of the members of distinct cultural groups in Africa.

3. In 1977, the term ethnomathematics was first used by D'Ambrosio in a lecture given at the *Annual Meeting of the American Association for the Advancement of Science* in Denver, USA.

4. The consolidation of the ethnomathematics term culminated with the opening lecture entitled *Socio-Cultural Bases of Mathematics Education* given by D'Ambrosio at ICME 5, in Australia in 1984, which officially established the ethnomathematics program as a research field.

5. In 1985, D'Ambrosio writes his seminal work entitled *Ethnomathematics and its Place in the History and Pedagogy of Mathematics*, which represents the first comprehensive, theoretical treatment in English of Ethnomathematics Program. These ideas have stimulated the development of this field of research.

6. In the same year of 1985, the *International Study Group on Ethnomathematics - ISGEm* launched the ethnomathematics program internationally.

In the last three decades, the amount of research, investigations, thesis, and dissertations that dealt with theoretical and practical aspects of ethnomathematics. At the same time numerous article, book chapters, and books were written about the relationship between culture, mathematics, and mathematics education. During these decades, studies involving ethnomathematics were discussed and debated in a succession of local, regional, national, and international meetings, seminars, conferences, and congresses.

Collaborating on the international expansion of ethnomathematics as a program, five international conferences have been held in different countries and continents:
1) The *First International Conference on Ethnomathematics (ICEm-1)* was held in Granada, Spain, in September 1998. The theme of the conference was *Research, Curriculum Development, and Teacher Education.*

2) The *Second International Conference on Ethnomathematics (ICEm-2)* was held in Ouro Preto, Minas Gerais, Brazil, in August 2002. The theme of the conference was *A Methodology for Ethnomathematics.*

3) The *Third International Conference on Ethnomathematics (ICEm-3)* was held in Auckland, New Zealand, in February 2006. The theme of the conference was *Cultural Connections and Mathematical Manipulations.*

4) The *Fourth International Conference on Ethnomathematics (ICEm-4)* was held in Towson, Maryland, United States, in July 2010.

5) The *Fifth International Conference on Ethnomathematics (ICEm-5)* was held in Maputo, Mozambique, in July 2014.

6) The *Sixth International Conference on Ethnomathematics (ICEm-6)* will be held in Barranquilla, Colombia, in 2018.

**Characterization of ICEm-5**

The ICEm-5 was held at the Faculty of Natural Science and Mathematics located at the Lhanguene Campus of the Pedagogical University in Maputo, Mozambique, from July 7th to July 11th, 2014. The conference was jointly hosted and organized by the International Study Group on Ethnomathematics (ISGEm), the Southern African Study Group on Ethnomathematics (SASGEm), the Mozambican Study Group on Ethnomathematics (MOSGEm), and the Faculty of Natural Sciences and Mathematics of the Universidade Pedagógica.

The ICEm-5 had representatives of 21 countries. There were 45 participants among students, educators, investigators, and researchers who had opportunities to discuss ideas and share their research topic on ethnomathematics. Presentations were accepted and presented in English, Portuguese, and Spanish.

During ICEm-5, there were 11 plenary sessions, 16 parallel sessions composed by 39 communications. These presentations had representatives from Angola: 1, Angola/Portugal: 1,
Australia: 2, Brazil: 2, Chile: 1, Chile/Mexico: 1, Colombia: 1, Colombia/Denmark: 1, Costa Rica: 1, Greece: 1, Mozambique: 10, New Zealand: 4, Nigeria: 1, Papua New Guinea: 1, Portugal: 1, Saint Thomas and Prince: 1, South Africa: 1, Spain: 4, United Arab Emirates: 1, United States of America: 8, and Zimbabwe: 1.

**ICEm-5 Committees**

The conference has the following committees:

1) *International Programme Committee*

   Arthur B. Powell (USA)
   Bal Chandra Luitel (Nepal)
   Bill Barton (New Zealand)
   Hilbert Blanco Alvarez (Colombia)
   Iran Abreu Mendes (Brazil)
   Kalifa Traoré (Burkina Faso)
   Lawrence Shirley (USA)
   Maria do Carmo Santos Domite (Brazil)
   Maria Luisa Oliveras (Spain)
   Noor Aishkin Adam (Malaysia)
   Pedro Palhares (Portugal)
   Sibusiso Moyo (Zambia, South Africa)
   Swapna Mukhopadhyaya (India, USA)

2) *Regional Southern Africa Mobilization Committee*

   Domingos Paidiameu (Angola)
   Mogege Mosimege (South Africa)
   Ramira Patel (Swaziland)
   Sibusiso Moyo (Zambia, South Africa)
3) **International Proceedings Publication Committee**
   Daniel Clark Orey (Brazil)
   Maria Luisa Oliveras (Spain)
   Milton Rosa (Brazil)

4) **Local Organizing Committee (LOC)**
   Abdulcarimo Ismael (Coordinator of the Southern Africa Study Group on Ethnomathematics)
   Evaristo Uaila (Coordinator of the Mozambican Study Group on Ethnomathematics)
   Marcos Cherinda (Chair, Faculty of Natural Science and Mathematics, Universidade Pedagógica)
   Paulus Gerdes (President of the International Study Group on Ethnomathematics)

5) **Members of the LOC**
   Emília Nhalevilo (Director of Research Center of Mozambican Studies and Ethnoscience)
   Carlos Lauchande (Head of the Department of Mathematics, Universidade Pedagógica)
   Sarifa Fagilde (Director of International Relations Office, Universidade Pedagógica)
   Arlinda Johane (Secretary of the Faculty of Natural Science and Mathematics)
   Alda Duvane (Secretary of Post-Graduate Course, Faculty of Natural Science and Mathematics)

**Thematic Topics**
ICEm5 did not focus on a unifying thematic theme; instead, the submissions of the papers were related to one or more thematic topics that guided the activities of the conference. During ICEm5 there were 50 presentations in which 11 were plenary sessions and 39 were communications.

1) Ethnomathematics and cultural anthropology/ethnology (14 papers – 28%).
II) Ethnomathematics and history of mathematics (1 paper – 2%).
III) Ethnomathematics and mathematics education (18 papers – 36%).
IV) Ethnomathematics and teacher education (8 papers – 16%).
V) Ethnomathematics and mathematics (1 paper – 2%).
VI) Ethnomathematics and mathematical games (2 papers – 4%).
VII) Ethnomathematics and philosophy (6 papers – 12%).
VIII) Ethnomathematics and music (No paper – 0%).

Relevant Aspects to Consider: Discussing and Debating about Ethnomathematics

Ethnomathematics grew out of the history of mathematics, mathematics education, and issues of mathematics in anthropology, sociology, economic, environmental issues, and political science. It recognizes that all cultural groups do activities that involve mathematical thinking, even if the mathematics may not look like the Eurocentric academic mathematics that students learn in school. In order to allow the ethnomathematics community to discuss important issues related to ethnomathematics, five countries were represented in the 11 plenary sessions:

1. Swapna Mukhopadhyay from the United State. Her speech was entitled *Making Ethnomathematics Visible through Culturally Relevant Pedagogy and Funds of Knowledge*.
2. Lawrence Shirley from the United States. His speech was entitled *Mathematics of Students’ Culture: A Goal of Localized Ethnomathematics*.
3. Paulus Gerdes from the Mozambique. His speech was entitled *African History as a Source of Inspiration for the Discovery of New Mathematical Ideas*.
4. Hilbert Blanco-Álvarez and Maria Luisa Oliveras from Spain. Their speech was entitled *Obstáculos para Integrar la Etnomatemática en el Aula de Clase de Matemáticas*.
5. Nirma Naresh from the United States. Her speech was entitled *The Role of Critical Ethnomathematics Curriculum in Transforming and Empowering Learners*.
6. Maria Luisa Oliveras from Spain. Her speech was entitled *Etnomatemática: el Vértice Matemático del Posmodernismo Poliédrico*.
7. Milton Rosa and Daniel Clark Orey from Brazil. Their speech was entitled *Emic (local), Etic (Global) and Dialogical (Glocal) Knowledges in Ethnomodeling Research.*

8. A. J (Sandy) Dawson from the United States. His speech was entitled *Mathematics and Culture in Micronesia.*

9. Arthur B. Powell from the United States. His speech was entitled *Potential Contribution of Language Learning for Ethnomathematics.*

10. Maria Helena Gavarrete from Costa Rica. Her speech was entitled *Elementos del Conocimiento Matemático Cultural en la Tradición Indígena de Costa Rica.*

11. Marcos Cherinda from Mozambique. His speech was entitled *Didactical Transposition of Mathematical Ideas: From Woven Patterns to School Mathematical Concepts.*

Ethnomathematics may be considered as basic as the counting terms in various languages or the use of symmetries in craft products, or as complex and controversial as oppressed societies using mathematics to encourage open-minded thinking to challenge the authorities. In order to debate these important issues related to ethnomathematics, 39 communications were also presented. They helped participants to understand the growing field of ethnomathematics and its significance to mathematics education as well as the need to find ways to enrich lessons by demonstrating mathematical ideas, procedures, and practices developed by or from other cultural groups, often doing some global education and teaching about world issues along the way. It is important to highlight that in these presentations there as a predominance of topics related to ethnomathematics and cultural anthropology, mathematics education, teacher education, and philosophy. On the other hand, topics related to the connection between ethnomathematics and history of mathematics, games, and mathematics need to be discussed and debated in future research and investigations.

According to this context, it is necessary to reflect on the growth of the field of ethnomathematics and some key questions surrounding this program as well as its significance for Mathematics Education. Reflecting on the activities of conference, some questions emerged:

1. Did new concepts emerge from the presentations, discussions, and debates?
2. What are the challenges that now face the ethnomathematics community?
3. Are there critiques to the ethnomathematics as a program?
4. How can ethnomathematics research help the pedagogy of ethnomathematics?

The presentations showed that it is necessary to debate about issues regarding Mathematics Education, classroom knowledge, and knowledge of a specific cultural group. However, the discussions surrounding these issues do not imply that ethnomathematics is only an instrument to improve mathematical education because it has a role in helping us to clarify the nature of mathematical knowledge and of knowledge in general. In so doing, it is necessary to shift the research from theoretical issues toward educational and practical issues.

_The International Proceedings Publication Committee of ICEm-5_
Daniel Clark Orey
Maria Luisa Oliveras
Milton Rosa
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participants and one group of three. Word or story problems created, were then analyzed using Marks (1994) three-points of consideration for word problem construction. Marks three-points for consideration were intended for teachers and not students. The premise of the research was that students have the ability to write word or story problems that are grounded in ethnomathematics that have educational value and could be used by teachers. The presentation will disseminate the research findings and what mathematics teachers can do to provide students opportunities to explore word or story problems grounded ethnomathematics.

Keywords: Ethnomathematics; Word Problems; Writing.

References

Science Trail: A Pathway of Scientific Education in Príncipe Island
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Learning Science is not an exclusive process of the school context, as there are many non-formal and even informal contexts, in which Science can be learned, which points out to an integrated
approach of these training contexts (Osborne & Dillon, 2007; Rodrigues, 2011). Also some (ethno)mathematical educators and curricular guidelines for teaching and learning mathematics equally recognize students’ outside school experiences, namely in non-formal and informal environments/contexts (e.g. Bishop, 2005; Gerdes, 2007; Moreira, 2008; NCTM, 2007).

Moreover, there are cultural contexts with multidisciplinary potentialities which, when recognized and legitimated, enhance a holistic view of Science (Gerdes, 2007). To boost outside school learning as a mean to promote connections with previous knowledge and their contexts, the teacher should consider them when organizing learning experiences for students, and therefore, integrating non-formal education contexts in classroom activities (Faria & Chagas, 2012; Rodrigues, 2005, 2011). The existence of partners of Mathematics of Planet Earth 2013 in São Tomé and Príncipe, the recognition of Príncipe as a Biosphere Reserve of UNESCO in 2012 and the validation of the General Theory of Relativity grounded in observations of the astronomical expedition leaded by Arthur Eddington in Príncipe in 1919 were the combined reasons that led a multidisciplinary team of teachers of Príncipe’s High School to promote learning experiences in a non-formal context focusing the mentioned events in order to appreciate the cultural context of the island. The theoretical framework of this paper assumes an integrated vision of formal and non-formal educational contexts. In this way, the pathway of scientific education in Príncipe Island - Science Trail - provides the contact with nature and assumes the exploration of scientific matters, integrated in a historical and cultural Principean context. In particular, some of those contexts proved to be facilitators in the process of building bridges with mathematical concepts, enhancing connections between Culture and Mathematics. One component of young people’s mathematical development is the ability to use their learning in real contexts (NCTM, 2007), and Mathematical Trails arise with the potential to establish connections with the context (Shoaf et al., 2004). However, the selection of contexts must be deliberate and made with criteria. Sometimes, contexts are presented as belonging to the students’ world; when, in fact, they belong to the adults’, contexts which hide their complexity or become artificial examples do not allow an effective transfer of knowledge (Boaler, 1993, Gilbert, 2013).

An evaluation of the Science Trail, based on questionnaires and the gathering of documents, was made, in order to assess the impact of this initiative in the participants. Their
feedback points out to the continuation of this initiative and the recognition of its educational potentialities.

Keywords: Formal and Non-formal Contexts; Scientific Education, Interdisciplinary; Culture and Mathematics.

References
Didactical Transposition of Mathematical Ideas: From Woven Patterns to School Mathematical Concepts

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The presentation demonstrates a process of extracting mathematical ideas embedded in woven basketry techniques in order to stimulate the introduction of mathematical concepts of the school mathematics program. The demonstration includes examples of concepts such as sequences and series, matrixes, combinations, and assembling of geometric solids by exploration of that technique, using cardboard strips. The essential thinking supporting that didactic transposition (Chevallard, 1989) of mathematical ideas from a non-schooled artisan activity to mathematics learning process in the classroom, stays in the theoretical framework of Ethnomathematics, in which it is established a pedagogical premise that children may learn better and feel themselves confident in doing mathematics when they participate in the process of generating mathematical ideas (Gerdes, 1996) while (re)producing artifacts of their own socio-cultural environment. The research was conducted with application of Gerdes’ approach, starting from reasoning on why… how… and what if… questions related to the existence and gestalt of such artifacts when one is manipulating them either physically or mentally. In order be able to transpose the mathematical ideas from the woven basketry to mathematical concepts to be learned in a classroom setting I developed an apparatus using cardboard strips (Cherinda, 2002), which I called “weaving board” (WB). The research started by a pilot study involving case studies aiming to observe closely what happened with individual learners when engaged in WB-activities. The main study was conducted in two parts. The first part was a quasi-experimental study involving two groups –
