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Maputo – Mozambique

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 = techné*) 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.

2. In 1976, D'Ambrosio organized and chaired the section entitled *Why Teach Mathematics? For the Topic Group: Objectives and Goals of Mathematics Education* during the Third International Congress of Mathematics Education - ICME-3, in Karlsruhe, Germany. In this section, D'Ambrosio proposed a discussion about the cultural roots of mathematics in the context of Mathematics Education.
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 Aishikin 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.

I) 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 is 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

SUMMARY

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I - ETHNOMATHEMATICS AND CULTURAL ANTHROPOLOGY/ETHNOLOGY

Mathematics and Culture in Micronesia

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Wheatley and Frieze's book, *Walking Out Walking On*, provides the conceptual framework for an examination of Project MACIMISE, a National Science Foundation funded project that focused on the languages and cultural practices of nine Pacific islands and the state of Hawai‘i. MACIMISE, pronounced as if spelled 'maximize', is a 5-year Project. The Project's task is the development of elementary school mathematics curriculum units sensitive to local mathematical thought and experience. There were twenty-one participants (who call themselves the *Macimisers*) in the Project. The participants were educated in ethnographic and anthropological research strategies to enable them to retrieve/uncover cultural practices extant in the communities where they lived. This academics work was accomplished partially via distance learning when the participants were registered in advanced degree programs at the University of Hawai‘i—Mānoa. In this paper, the Project is analyzed in terms of the concepts (*scaling across, start anywhere—follow it everywhere, intervention to friendship,* the *art of hosting* and the use of *circle)* advanced by Wheatley and Frieze.

Keywords: Indigenous Mathematics; Distance Learning; Mathematics Curriculum Development.

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Intellectual Property in Ethnomathematics

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Beginning from the reflections about a methodology used in a research project with an indigenous Colombian community, this paper outlines some methodological possibilities for ethnomathematical research. Issues like intellectual property and social relevance are discussed in order to propose a broader concept of "academic instance", trough the acknowledgement and legitimation of alternative scenarios of generation, transmission and transformation for mathematical knowledge. This paper has four sections: a) preliminaries about the indigenous community, b) description of the research process and its products (for their very nature, it will be written in a plural third person style), c) individual thoughts, treating the harmony between the ethnomathematical methodology and its theoretical, humanistic and political foundations, d) an epilogue or a review about the experience, to discuss the spirit which aims the analysis made.

Keywords: Intellectual Property; Ethnomathematics; Indigenous.

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Validación de Conocimiento en Sistemas de Representación del Mundo Indígena Precolombino

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Se presenta un planteamiento vinculado al análisis de los diseños decorativos en artefactos (Huxley, 1955) de la época precolombina en el que se proponen algunas premisas sobre relaciones con conocimientos astronómicos. En las investigaciones realizadas en artefactos y diseños indígenas precolombinos, se sugiere que, algunos diseños tenían como propósito esencial, guardar información que era considerada relevante para estos pueblos. Estas informaciones las encontramos durante la época precolombina, durante el periodo de la conquista y en no pocos casos prevalece hasta la actualidad. Muchos diseños precolombinos constituyen un lenguaje particular, que puede ser interpretado, cuando se descubren los códigos de los sistemas matemáticos codificados. Es decir, cuando se logra tener acceso a la información que el diseño guarda en su interior. En algunos casos, incluso, cabe la posibilidad de realizar una interpretación de carácter mítico, que nos remite a una información matemática codificada y, que la encontramos como una suerte de palimpsesto o, como una estructura de capas concéntricas, que asemeja a las capas de una cebolla. ¿Qué tipo de información se guardaba en los diseños? Es difícil decirlo de manera exhaustiva, sin embargo, se pueden seguir ciertos indicios, ciertas pistas, que puedan ayudar a leer las primeras páginas de ese gran y enigmático libro. Algunos grupos étnicos precolombinos, guardaban información astronómica en diversos soportes: la historia mítica, los libros, las telas, los altos y bajos relieves, entre otros. Algunos de estos conocimientos astronómicos han sido interpretados y validados siguiendo complejos

sistemas de códigos (Jaén, 1996, 2006). Por ejemplo, el códice de Dresde (s.f.), es un libro que exhibe un calendario del planeta Venus, realizado por el pueblo maya. Fue así como aprendimos que mayas y aztecas tenían un sistema de numeración en base 20, o que utilizaban el concepto del cero y que llevaban un riguroso calendario de Venus. Esos conocimientos ya conocidos, ya validados, pueden dar origen, o revelar, otros conocimientos que se expresan bajo otras formas de representación, o en otro tipo de soporte. Se plantea que estos sistemas de representación expresan gráficamente, el conocimiento etnomatemático, precolombino.

Palabras-clave: Etnomatemática; Artefactos; Diseños Precolombinos; Astronomía.

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Da Etnomatemática a Matemática. Um Estudo sobre o Grupo Étnico Herero/Helelo do Sul de Angola (Subgrupo Mucubal e Muhimba)

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Embasado na teoria do programa etnomatemática, nosso estudo refere-se ao cotidiano do grupo étnico Herero ou Helelo – em especial, os subgrupos Mucubal e Muhimbas–, localizado no sul de Angola. Os subgrupos Mucubal e Himbas são povos que mostram de forma viva a sua cultura nômade – ainda nos dias de hoje – e constituem/perpetuam a riqueza cultural da região sul de Angola, na Província do Namibe. A pesquisa, ora apresentada, busca mostrar os estudos feitos de um ponto de vista histórico/antropológico. O movimento de expansão das línguas nacionais em todo território de Angola, nos desperta a atenção em trabalharmos na exploração dos saberes/fazeres desta cultura e de registro dos modos de vida dos mais velhos, bem como aprender a matemática que envolve fatos, estratégias e a compreensão/apreensão de conceitos (D'Ambrosio, 2005). Durante a evolução do processo de ensino e de aprendizagem, é comum em quase todos os níveis, existir um maior aproveitamento teórico das disciplinas. Segundo Sabba (2004), a matemática é considerada de difícil compreensão, por vezes, sem significado e sem uso no cotidiano, portanto, é importante chamar a atenção para as relações que não existem aparentemente, mas que são extremamente valiosas para a apreensão do conhecimento, a fim de manter-se em constante reconstrução, atualização e principalmente criação de novos ideais e modos de perceber o mundo que nos cerca. Para tanto, é preciso tornar a apreensão dos conhecimentos matemáticos uma atividade mais prazerosa para os mais jovens e mostrar como há matemática em diversas relações, esta pesquisa buscará por meio dos jogos existentes na cultura Herero, explicitarem os conceitos de geometria e de contagem utilizados pelos jovens nesta atividade lúdica, mostrando como se dá a construção do raciocínio matemático aí e como considerá-lo em sala de aula. Nesse contexto, envolvendo os estudos etnomatemáticos, contextualizará de que modos e de que maneira é possível cruzar os conceitos dos povos com os conhecimentos da matemática escolarizada. A pesquisa está apoiada nos referencias teóricos de Ubiratan D'Ambrosio, Maria do Carmo Santos Domite, Claudia Sabba, Paulus Gerdes entre outros.

Palavras-chave: Etnomatemática; Cultura do Povo Helelo/Herero; Processos de Ensino e Aprendizagem.

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El Sistema de Comunicación Numérico Gestual de los Calibradores del Tiempo de los Ómnibus de la Ciudad de Cali, Colombia

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En Colombia, en sus principales ciudades el oficio de controlar los tiempos de las rutas de transporte urbano, comúnmente llamado *calibración*. Este oficio es ejercido por hombres adultos y generalmente con poco grado de escolaridad. Esta actividad tiene procesos únicos que la caracterizan como una etnomatemática que podría aportar a la educación matemática, sea por el sistema de comunicación numérico gestual que emplea, sea por las concepciones y algoritmos (mentales o escritos) empleados al sumar y restar. El análisis contempló cuatro momentos: 1) Análisis de la planilla donde se consignan los datos (Figura 1). Variables manejadas en intervalos pequeños de tiempo: nombre de la empresa, rutas, número del ómnibus, tiempo de pasada, diferencia de tiempos, número del teléfono móvil, entre otros datos, 2) El cálculo digital empleado en el sistema de comunicación numérico gestual, ver una pequeña muestra de esta comunicación en la Figura 2, 3) El empleo de algoritmos de suma que ante nuestros ojos, parecen de sustracción. Dos de estos algoritmos se pueden ver a continuación: $\begin{array}{r|l} 18 & \\ 22 & 4 \end{array}$ y $\begin{array}{r|l} 56 & \\ 04 & 8 \end{array}$.

En el primero, el sustraendo (18), se ubica en la parte superior, el minuendo (22) debajo, y la diferencia (4), a un lado. En otro algoritmo, cuando los tiempos pertenecen a horas diferentes, el algoritmo toma otros significados y forma operacional. 4. El análisis de los cálculos mentales que los calibradores emplean. Parte de esto se puede notar en el siguiente diálogo. *Investigador:* ¿Cómo calculas la diferencia entre 47 minutos de una hora y 06 minutos de la siguiente?. *Héctor responde*: "Da 19…10 para 57 y 9 pa' 06, no son 10-10[1] , sino 10-9, porque 10.

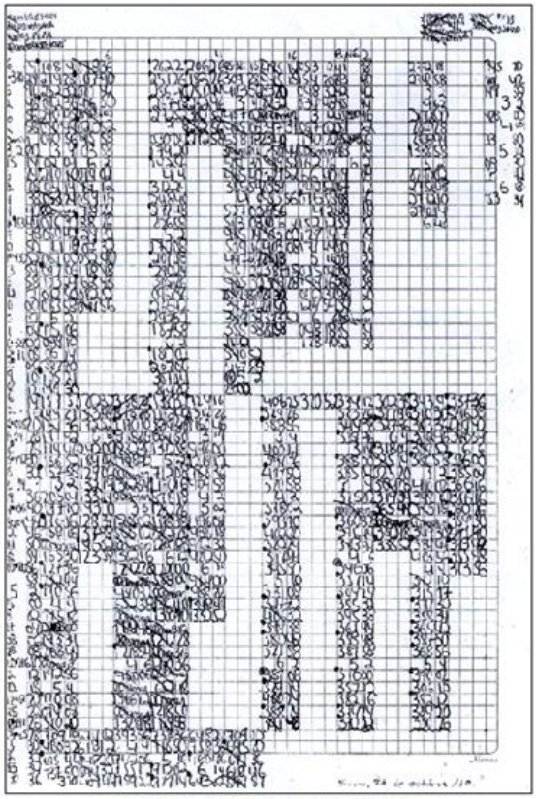

Figura 1: Anotaciones de un Calibrador

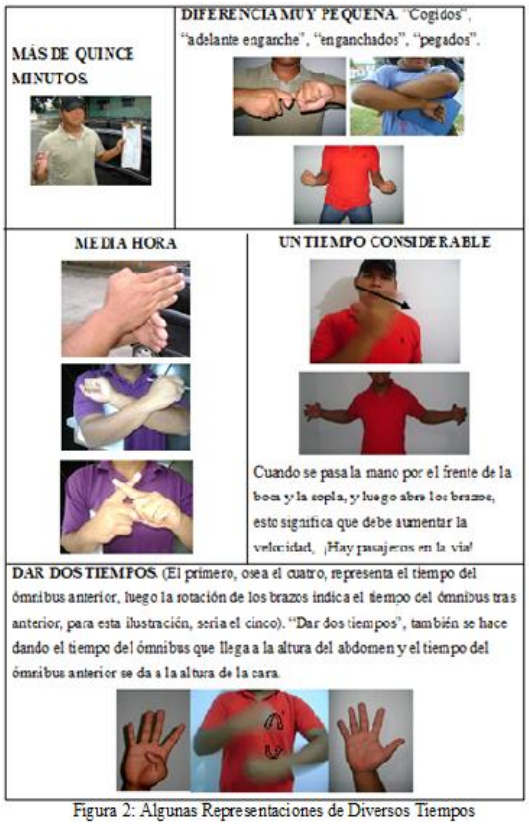

Figura 2: Algunas Representaciones de Diversos Tiempos

Palabras-Clave: Medición del Tiempo; Calibración; Cálculos Aritméticos Distintos.

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Os Saberes Matemáticos de Jovens e Adultos Privados de Liberdade

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Este artigo é um recorte da pesquisa qualitativa da primeira autora mestranda em educação na Universidade Federal do Rio de Janeiro, sob a orientação da segunda autora. Tem como objetivo promover uma reflexão sobre a descrição (etnografia) e análise (etnologia) de alguns saberes/fazeres matemáticos construídos/adquiridos por jovens e adultos em contexto de privação de liberdade. Para tal, elegemos na pesquisa, a abordagem do tipo etnográfica, que nos tem permitido uma imersão no cotidiano do aluno preso. Neste contexto a autora exerce sua prática docente, lecionando matemática para turmas de Jovens e Adultos. A realidade do sistema prisional brasileiro e a ausência de itens básicos fez com que esses sujeitos construíssem/adquirissem saberes/fazeres que são manifestos como *mentefatos* e *artefatos* que atendem suas necessidades no tempo e espaço em que estão inseridos. O local da pesquisa é uma escola estadual de educação básica localizada no interior de uma unidade prisional na cidade do Rio de Janeiro.

Palavras-chave: Educação de Jovens e Adultos em Contexto de Privação de Liberdade; Saberes Matemáticos; Etnografia.

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Os Saberes Matemáticos dos Caçadores *Nyaneka-nkhumbi* do Sul de Angola, Visão Etnomatemática

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Sabemos que os conhecimentos matemáticos não são exclusivos da escola, mas que todas as culturas geram matemática. O grupo étnico *Nyaneka-nkhumbi* é um dos grupos linguísticos do sul de Angola, com saberes e saberes fazeres etnomatemáticos ricos e inéditos (Dias & Costa, 2011). Com o presente trabalho em etnomatemática, pretendemos contribuir no campo da pesquisa em educação matemática, a valorização e divulgação de conhecimentos evidentes na cultura dos *Nyaneka-nkhumbi*, não só, é a nossa pretensão também mostrar os conhecimentos matemáticos escondidos nas armadilhas do grupo étnico *Nyaneka-nkhumbi*. Falar de armadilhas é dizer o conjunto de instrumentos usados frequentemente pelos caçadores para apanharem presas como pássaros e/ou animais diversos. Vamos aflorar em particular conhecimentos matemáticos sobre as armadilhas identificáveis nas práticas culturais do grupo étnico *Nyaneka-nkhumbi* alicerçados em estudos desenvolvidos por vários autores da linha de pesquisa de Gerdes, D'Ambrósio, Palhares e tantos outros que são apologistas do estudo etnomatemático.

Este trabalho está estruturado da seguinte maneira: Uma breve introdução, práticas matemáticas do grupo étnico *Nyaneka-nkhumbi*, conhecimentos matemáticos escondidos em armadilhas do grupo étnico *Nyaneka-nkhumbi* e conclusões e considerações finais. As técnicas utilizadas para obtermos os dados de pesquisa foram: Observação, entrevistas informais aos praticantes e ex-praticantes de caça informal, tiragem de fotografias às armadilhas nas localidades onde se verifica a prática de artefactos (armadilhas) e notas de campo. Este estudo está integrado num projecto de doutoramento que visa a aplicação educativa dos conhecimentos matemáticos informais do grupo étnico *Nyaneka-nkhumbi*, no campo educativo através de tarefas que possam ser usadas na sala de aula de crianças da educação básica quer de Angola quer de Portugal (Dias, Costa & Palhares, 2013).

Palavras-chave: Educação matemática; Etnomatemática; Práticas Matemáticas Informais.

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Elementos del Conocimiento Matemático Cultural en la Tradición Indígena de Costa Rica

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Se presentan resultados de investigación sobre etnomatemáticas indígenas realizadas en Costa Rica que forma parte de la de la tesis doctoral titulada ‘Modelo de aplicación de etnomatemáticas

en la formación de profesores para contextos indígenas en Costa Rica' (Gavarrete, 2012). D'Ambrosio (2007) establece que la Etnomatemática es concebida como "las distintas formas de conocer", y a partir de esta idea se genera una propuesta de caracterización que consiste en el Conocimiento Matemático Cultural Indígena, en el cual dichas maneras de conocer, comprender, representar, entender, clasificar y explicar los fenómenos de la realidad física y de la realidad mítica están presentes en la dinámica social y son prioritariamente heredadas a través de la tradición oral. El conocimiento matemático cultural indígena es un conocimiento holístico, que tiene un sistema referencial que recurre a metáforas sobre la realidad, por la carencia de grafía y que posee un cuerpo jerarquizado de axiomas sobre los cuales se constituye la manera de comprensión de la realidad. Que posee para su manifestación social un cuerpo jerarquizado de cargos tradicionales y un conjunto de prácticas rituales para la pervivencia de dicho conocimiento. Este conocimiento tiene como pilares fundamentales los elementos de la cosmovisión (Panikkar, 2006), es decir, que su punto de partida es el conocimiento del mito, que rige de forma normativa todas las otras áreas de conocimiento, de manera que las vías de supervivencia y las vías de trascendencia se definen y se consolidan a partir de unos axiomas vernáculos. Estos axiomas definen unos algoritmos para las prácticas rituales y para las prácticas sociales que implican para su consumación la aplicación de conocimiento identificado como matemático, tanto por la investigadora, como por los participantes del estudio. El conocimiento matemático cultural indígena constituye una herramienta que permite poner de manifiesto características de las etnomatemáticas indígenas, donde confluyen elementos del entorno físico y mítico, tangible e intangible y que forman parte de los conocimientos compartidos en los grupos indígenas costarricenses, como por ejemplo: 1) En las formas de organización social, como por ejemplo la estructura clánica que prevalece en la mayoría de las comunidades indígenas y que es de carácter matrilineal, 2) En la rigurosa secuencia para realizar determinados rituales, que podría entenderse como un algoritmo con estructuras de orden contextualmente fundamentado en una estructura axiomática que está constituido por la tradición mítica, 3) En la lógica referencial clasificatoria manifestada en la oralidad, pues existe diversidad de palabras utilizadas para realizar los conteos según la forma: plana, alargada, redonda, humana, entre otras. También en la clasificación nominal de los cuantificadores indefinidos, pues no hay una sola manera de decir

"algunos", "varios" o "muchos" y también en los pronombres interrogativos, pues existen distintas maneras de preguntar "¿Cuántos?", según la forma que tenga el objeto y 4) El carácter animista del mundo indígena implica que los sistemas de representación utilizan un sistema referencial metafórico, donde se recurre a lo físico para referir lo abstracto. En la investigación de Gavarrete (2012) se estudió el conocimiento matemático cultural indígena de tres grupos étnicos distintos en Costa Rica: Ngäbes, Bribris y Cabécares, con la finalidad de proponer mecanismos de acción educativa atinentes y coherentes con su visión de mundo y su lógica particular. Esta propuesta se materializó en un curso de formación de profesores en el cual se propició el respeto por las raíces ancestrales de los indígenas, así como la equidad de oportunidades en su formación para evitar la exclusión que han sufrido históricamente dentro del panorama globalizado de la educación matemática mundial, pues la investigación sobre las ideas que subyacen en las prácticas sociales, a través del estudio de las diversidades culturales, étnicas y lingüísticas proporciona a los docentes herramientas para conducir la enseñanza de manera contextualizada y a promover el respeto por la valía del propio conocimiento matemático cultural, con lo cual se propicien nuevas vías en el aprendizaje significativo de los estudiantes.

Palabras-clave: Conocimiento Matemático; Etnomatemáticas Indígenas; Cosmovisión.

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Técnicas para Interpretación Etnomatemática de Signos Culturales Históricos: Estudio de Dos Caos

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La investigación tiene el propósito de interpretar, desde el punto de vista de las etnomatemáticas, las expresiones de pensamientos representados en las pinturas del arte rupestre andaluz y canario, signos culturales ancestrales hallados en dos cuevas que fueron asentamientos de grupos humanos y que se han conservado en España.

Photo 1: Geometry in Canarian rock art

Photo 2: Cultural signs in Andalusian caves

Para ello se definen tres objetivos: 1) Caracterizar las Etnomatemáticas, en general y en el sentido en que se utilizarán aquí. 2) Contextualizar y describir las pinturas halladas, e interpretar los pensamientos o mensajes representados en ellas mediante signos identificados como matemáticos. 3) Aportar nuevas técnicas que permitan crear una metodología etnológica apropiada para el análisis y la interpretación etnomatemática de signos culturales históricos, es decir elementos representativos de las culturas ancestrales de grupos humanos no pervivientes. La primera parte del trabajo consiste en explicitar los fundamentos: el concepto de etnomatemáticas, las investigaciones históricas y antropológicas existentes, (Oliveras, 1996, 2006). Una segunda parte se dedica a. contextualizar y describir el objeto de estudio, y siguiendo los fundamentos a identificar elementos de contenido etnomatemático. En la tercera parte se reflexiona sobre las técnicas utilizadas para el análisis y la interpretación etnomatemática, tratando de agrupar en un solo modelo las técnicas aplicadas en cada uno de los dos ejemplos, tomadas en parte de otras investigaciones previas (Bolaños, J., Fernández-Oliveras, A. & Oliveras, 2014) y en parte elaboradas para este estudio.

Palabras-clave: Técnicas de Interpretación Etnomatemática; Métodos de Investigación, Antropología Cultural.

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An Ethnomathematical Study of the Cultural Artifact of Symmetrical Freedom Quilts: Facts and Myths Related to the *Underground Railroad*

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Symmetry is a fundamental concept pervading culture, arts, design, and science. In popular terms, symmetry is often viewed as a kind of balance between various parts of an object. In art and design, symmetry means a kind of balance in which the corresponding parts are not necessarily alike but only similar. In this context, quilts often have a visual balance as well as produce pleasing effects. Since quilts may be considered as cultural artifacts as well as artistic and mathematical manifestations and expressions of the daily life of the slaves in the United States, who were part of a particular cultural group. Symmetrical freedom quilts were the physical traces of people who made community around the creation of the quilts that expressed their shared behaviors, knowledge, and values. Figure 1 shows the Shoo Fly Symmetrical Freedom Quilt.

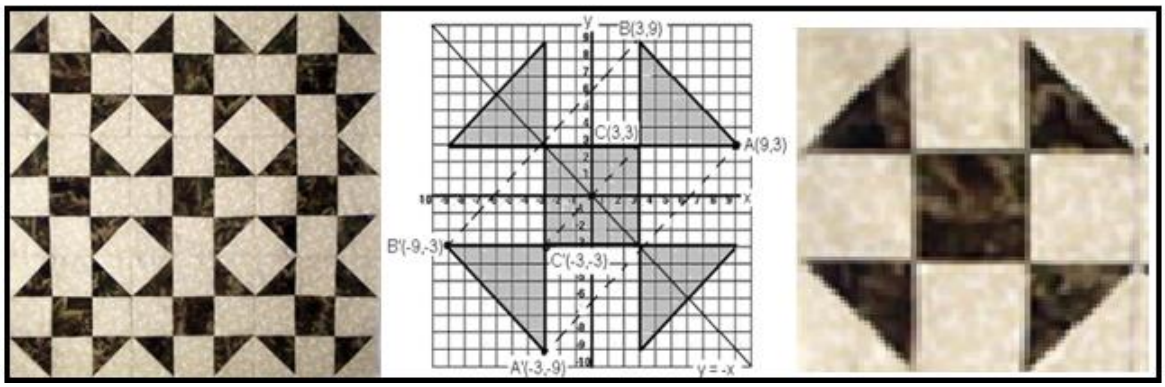

Figure 1: Shoo Fly Symmetrical Freedom Quilt.

The story of symmetrical freedom quilts offers a mixture of fact and myth. Its oral tradition may not give us absolutely accurate information but it often reflects a greater truth of pride of the

members of specific cultural group (slaves) and their hopes for their future. Maybe there was no special role symmetrical freedom quilts played in the Underground Railroad in the slavery time in the United States while there are some debates to prove that quilts were used as directional codes in helping slaves to run to freedom. In so doing, the purpose of this presentation is to explore the symmetrical patterns found in a specific kind of quilts, called symmetrical freedom quilts and to explore the connections between mathematics, ethnomathematics, modeling, and the tactile craft and art of quilting of this resilient group of people.

Keywords: Symmetrical Freedom Quilts; Underground Railroad; Ethnomathematics; Cultural Artifacts, Geometrical Quilts; Mathematical Modeling.

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A Etnomatemática nos Lenços dos Namorados

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Os estudos sobre Etnomatemática realizados em Portugal são ainda muito poucos e esta pode ser uma vertente importante no sucesso da matemática em Portugal (Palhares, 2008). Desta forma, é importante efetuar investigações que façam a ligação entre as transformações geométricas e elementos da cultura que nos rodeiam (Gerdes, 2012). É o caso dos lenços dos namorados de

Vila Verde, que futuramente podem permitir a sua utilização nas salas de aula. O concelho de Vila Verde está localizado no distrito de Braga, situado no coração minhoto do território português. Vila Verde apresenta características rurais e é o exemplo vivo na tradição dos bordados, que vem enaltecendo e valorizando cada vez mais. Na época à qual remonta a origem dos lenços dos namorados, estes eram usados como prova de amor e de comprometimento que as raparigas bordavam e davam aos seus namorados. Os lenços dos namorados apresentam características muito particulares, onde o tema do Amor é a essência e se refletem promessas de amor (Aliança Artesanal, 2002). Realizou-se uma recolha de informações da tradição dos lenços dos namorados em Vila Verde, incluindo conversas com pessoas intimamente ligadas a esta tradição e recolha fotográfica do maior número possível de lenços dos namorados. A intenção foi perceber o tipo de simetrias presentes nos lenços dos namorados, globalmente ou após truncatura, e verificar a relação da presença de simetrias com os métodos de construção ou a função a que se destinam. Os lenços dos namorados sofreram cortes para ser possível considerar, em cada um, o maior número de simetrias possíveis. Foram identificados um total de vinte e cinco lenços dos namorados com duas simetrias, sendo que dezoito apresentam a transformação identidade e reflexão segundo um eixo na diagonal e sete apresentam a transformação identidade e reflexão segundo um eixo vertical. Com a presença de quatro simetrias existem doze lenços dos namorados, sendo que em três deles verifica-se rotações de 90^0, 180^0, 270^0 e 360^o e nos restantes nove, foi possível identificar a transformação identidade, rotação de 180^o e reflexão segundo dois eixos. Com oito simetrias foram encontrados treze lenços dos namorados, são considerados os mais perfeitos, pois apresentam as simetrias do quadrado.

Palavras-chave: Lenços de Namorados; Simetria.

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African History as a Source of Inspiration for the Discovery of New Mathematical Ideas

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Throughout history, African peoples have conceived diverse, fruitful mathematical ideas. A rich variety of geometries, frequently interwoven with artistic, symbolic, educational, architectonic, and other cultural manifestations, has been developed. The 'sona' drawings in the sand of the Cokwe in Angola and the 'mpango' mat decorations of the Makwe in Mozambique are two examples of such geometric traditions. The presenter will explain briefly how the analysis and reconstruction of geometric considerations in these and related traditions led to the invention of new mathematical concepts, like mirror patterns, mirror curves, Lunda-designs, Liki-designs and various types of matrices – in particular, cycle matrices with attractive visual properties – and to the exploration of these ideas. This line of research contributes to an understanding, awareness, and appreciation of the scientific potential of these and other African traditions and practices – so often repressed in the colonial past, so often underestimated in the present. These traditions and practices become a source of inspiration for future, scientific development.

Keywords: African History; Mathematical Ideas; Cultural Manifestations.

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History of a Ph.D. Thesis in Ethnomathematics

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The document is about the history of the development of the author's PhD thesis. At the beginning, by understanding Ethnomathematics as the study of mathematical practices of specific cultural groups, the research focuses on the mathematical practices of a craft environment; a specified methodology is created as an instrument for the analysis of braid crafts. Then an ethnographical and afterwards an ethnomathematical study of some example of braids are made. The braids come from two different crafts: one employing llama wool from the region of Salta (North of Argentina) and the other employing untreated leather from the region of Buenos Aires (Albanese, Oliveras & Perales, 2014). The experience of the field work provides the evidence to distinguish that in the first braid crafts the generated mathematical modelization can be considered as a situated interpretation since the craftsmen themselves manage it, but in the second braid crafts the modelization is not situated as the craftsmen did not know it. A following ethnographic study provides the way these craftsmen think mathematically their own practice (Albanese & Perales, 2014). The reflection above is the key for the development of the following part of the PhD work. A new review of the ethnomathematical framework leads the author to re-conceptualize Ethnomathematics as the way of social thinking and to understand the quantitative, relational and special aspects of reality making the author sensitive to the deep epistemological changes about the conception of mathematics as a social and cultural construct that taking an ethnomathematics perspective involves (Albanese, Santillán & Oliveras, 2014). Then we decided to construct and conduct a workshop addressed to teacher-education with the objective of making the participants aware of their conceptions about the nature of mathematics through the direct and creative experience of a consensual modelization of braid crafts. Finally we recognize in the ethnomathematical perspective three dimensions that enable us to analyze the observations of a group of pre-service and in-service teachers after their participation in the workshop. These observations are considered as evidence of their epistemological conceptions about mathematics.

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Key words: Ethnomathematics; Ethnography; Conceptions about Mathematics.

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Artesanías de trenzado y Etnomatemática.

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Presentamos la primera parte de un trabajo doctoral en desarrollo. La investigación tiene el propósito de estudiar las ideas matemáticas involucradas en la realización de unas artesanías de trenzado, esto es, una forma de tejer hilos cuyo producto son trenzas y cordeles. Para ello se definen dos objetivos: 1) describir algunas artesanías de trenzado e identificar las matemáticas implícitas en ellas; 2) elaborar una metodología etnográfica y etnomatemática apropiada para conseguir el propósito inicial y que se ajuste al objeto de estudio. Una primera parte del trabajo consiste entonces en crear la metodología que denominamos MOMET, constituida por un Método Etnográfico (MET) y una MOdelización Matemática (MOM). El MET se compone de unos factores que permiten la descripción etnográfica de un ejemplar de trenzado que se

considera como una unidad de análisis. Estos factores son: la caracterización, la utilidad, el material, la modalidad de tejido y el diseño. El MOM se aplica a nivel del factor de diseño: a partir de la manera activa de realizar la acción de trenzar se definen unas fases de actuación que se modelizan matemáticamente, primero con grafos y después con permutaciones (Oliveras & Albanese, 2012). La realización del trabajo de campo etnográfico en el entorno artesanal argentino proporciona los datos constituidos por unos ejemplares de trenzas y cordeles y las respectivas informaciones a propósito de los factores del MET relativos a esos ejemplares. A tal efecto se elabora el análisis etnomatemático, basado en el MOM, de algunos ejemplares elegidos entre los recolectados. Esto proporciona una modelización matemática de la actividad de trenzar que podemos observar es -por lo menos en parte- compartida por un grupo de artesanos que utilizan herramientas de la matemática académica formal para organizar y comunicarse en su labor artesanal (Albanese, Oliveras & Perales, 2014).

Palabras-clave: Etnomatemática; Modelización Matemática; Trenzado Artesanal.

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II – ETHNOMATHEMATICS AND HISTORY OF MATHEMATICS

Division of Loaves and Teaching Egyptian Fractions

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The ancient Egyptian developed a notation for unit fractions, but represented all other fractions, with the exception of 2/3, as sums of distinct unit fractions. The Rhind Papyrus dating from 1650 BC gives us an idea how this practice may have arisen. The first 6 problems from the Papyrus involve dividing a given number of loaves of bread among a given number of people. For example if 5 loaves are to be divided among 8 recipients, four of the loaves may be split into halves and the remaining loaf into eighths with each person receiving 1/2 + 1/8 loaves of bread. This equal division model for representing a rational number has a distinctly different visual representation from the traditional parts-of-a-whole model taught in schools. In conjunction with teaching about Egyptian fractions, we have presented this model to students at the middle school and community college levels as well as to pre-service elementary teachers. Because there are an infinite number of ways to represent any proper fraction as the sum of unit fractions, the task of dividing the loaves provides an opportunity to look at alternative solutions, justify them using the properties of rational numbers, and consider the merits of each proposed solution relative to the real-world context (e.g. which method will produce the fewest crumbs). Contemporary applications for unit fractions and sums of unit fractions will also be discussed.

Keywords: Egyptian Fractions; Teaching Rational Numbers.

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III – ETHNOMATHEMATICS AND MATHEMATICS EDUCATION

Study of the Curricular Orientations of the Intercultural Bilingual Program in Chile: A Surfacing Analysis in Terms of Mathematics and the Mapuche Culture

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The objective of this research, is analyze the discourse in the "Orientaciones para la Contextualización de los Planes y Programas para la Educación Intercultural Bilingüe" to build a conceptual scheme, about the mathematical teaching and learning process that the Ministry of Education of Chile proposes for the Educational Institutions with high concentration of Mapuche students. The curricular document covers the first levels of Elementary School (6-9 years old) and proposes an education based on respect and comprehension of the knowledge of the indigenous people and their ways of conceiving teaching and learning. This document is currently available from 2005 up to date (2014). To achieve the objective, the analytical processes used in this research, are structured according to the Ground Theory using the MAXQDA 10 software. We proceeded to catalog the unit of analysis through the Open, Axial and Selective Coding. Conclusions indicate that there are three key categories: a) Mathematics of the Mapuche: The Mathematical Elements developed in the Curricular Document are inferior in number than ones described in literature about the Mapuche People. The depth in which the elements are addressed is faint and they are based on translation of concepts and tools, from Spanish to the Mapuche Language. Its connection with cosmogony and worldview of the people is scarce, b) Context: Concerning the contextualization of the didactic activities proposed by the curricular document, this attaches the meaningful elements to the people in accordance with mathematics and their use in a rural environment. Therefore, the mathematical activities that are to be developed propose problem resolution, in the predominant field of agriculture and animal breeding. The suggested way, in which the activities are to be developed, has a strong emphasis in teamwork over individual work, and c) Mapuche Language: This category expresses the

importance of mathematical learning from the oral essence of their activities. The terms of the Mapuche language that are present in the curricular document come from three different sources. The first one, the cognitive processes of the Mapuche people (ways of conceiving knowledge). Second, the resources (songs and games) that mediate the mathematical learning. The third one, the mathematical objects, in which translations of numerical phrases, terms in Mapuche language (not explicit in Spanish) are presented, which have a main relationship with quantification elements. In conclusion, the curricular document reaches its greatest potential when the teacher who uses it has the following characteristics: to know the mathematical aspects that are innate to the people and work in the rural and bilingual school (Spanish, Mapuche Language). Finally, two lines of action were examined: first, is the rescue of cultural mathematical knowledge; and second the integration of this cultural knowledge to the didactic processes of teaching and learning that potentiates instruction to the educators who do not possess the necessary tools to develop professionally in the Mapuche People context.

Keywords: Curriculum; Ethnomathematics; Mapuche People; Mathematical Teaching-learning.

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Qué está Realmente Arriba, Abajo, por Encima y por Debajo

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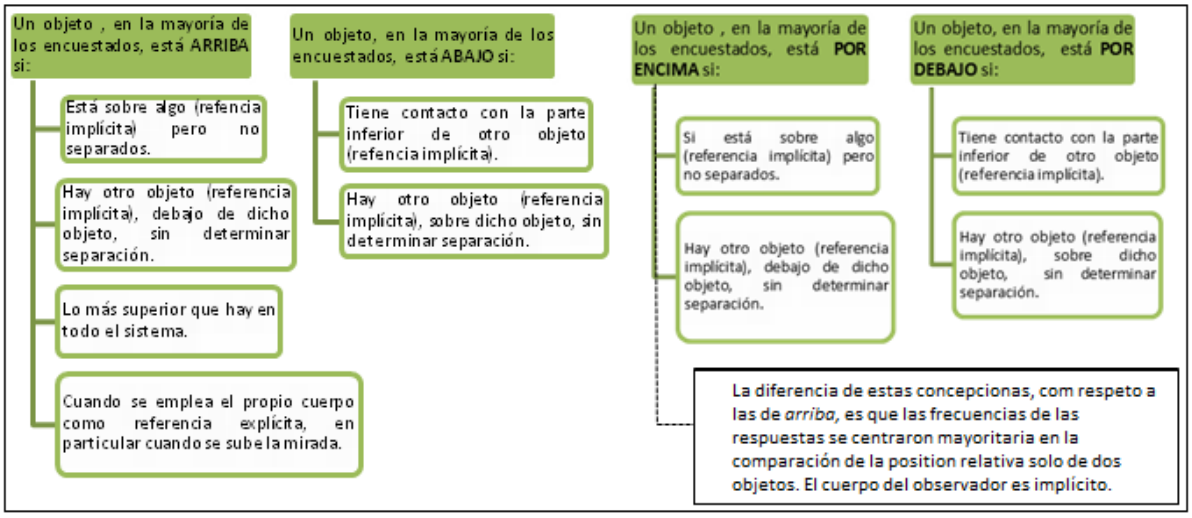
En el desarrollo del pensamiento espacial preescolar, las imágenes visuales (de un mundo estático) tienen como objetivo, entre otros, "desarrollar" nociones del espacio "euclidiano" como son las nociones de orientación *arriba* y *abajo* y las nociones de situación *por encima* y *por debajo*. Al analizar varios textos escolares de preescolar de América latina, se concluyó que muchas de estas actividades son obstáculos didácticos para que los niños puedan crear nociones espaciales más acorde con la realidad. Estas nociones no se conceptualizan en contextos escolares sino que implícitamente se hacen en el entorno cultural próximo de cada persona, son nociones etnomatemáticas y no euclidianas que son activas en cualquier contexto cultural. La investigación no solo analizó textos escolares, sino que abordó grupos culturales como niños y profesores de preescolar, estudiantes y profesores universitarios y adultos mayores no escolarizados. Por lo pronto, al ser esta una investigación doctoral en desarrollo, se cuentan con resultados parciales como los que muestra la Figura 1. Dicha Figura muestra las concepciones de Arriba, Abajo, Por Encima y Por debajo, de 45 estudiantes de quinto semestre de Licenciatura en Matemáticas de una Universidad Pública al norte de Colombia. Figura 1. Resultados parciales sobre concepciones de *arriba-abajo* y *por encima – por debajo. 45 estudiantes universitarios.*



En síntesis, podríamos considerar que bastaría con definir un Marco Referencial y un lenguaje, Levinson (2003), Tenbrink (2011), Barton (2008), para definir la posición relativa de los objetos, y probablemente no tendríamos objeción alguna al respecto, la cuestión de fondo es cuáles son las concepciones que tienen diversos grupos culturales (campesinos, pescadores, niños en cierto

rango de edad, profesores universitarios, profesores de preescolar, campesinos y adultos mayores) sobre dichos conceptos espaciales. En propósito general de la investigación es más complejo aún, se trata de analizar las concepciones que manejan dichos grupos culturales en torno a: arriba - abajo, por debajo - por encima, delante de - detrás de - al lado de, dentro-fuera-en el borde, izquierda-derecha, grande-pequeño-mediano, a-hasta-desde-aquí. A este conjunto de palabras las llamaremos *nociones espaciales*. Este análisis puede implicar un aporte significativo al diseño de situaciones didácticas para el desarrollo del pensamiento espacial en libros de textos de preescolar y a una mejor conceptualización de estas nociones que son transversales en todos los ciclos de formación matemática (tanto escolar como sociocultural) de una persona.

Palabras-clave: Concepciones Espaciales; Grupos Culturales; Orientación y Situación.

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Teaching Geometry in Upper Secondary School through Ethnomathematical Ideas and 'Drama in Education' Techniques

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The relationship between Ethnomathematics and Mathematics Education is appeared in the classic paper of Renuka Vithal and Ole Skovsmose "The end of innocence: a critique of Ethnomathematics" (1997, p. 135) as the fourth strand of the research on Ethnomathematics; a strand considered 'still an under-researched area' that was informed from the other strands (historical anthropology, cultural anthropology, mathematics in everyday contexts). While at this time the research on mathematics education, strongly affected by Ubiratan D' Ambrosio (1985) and Alan Bishop (1988), was on the first steps of exploring sociocultural issues and not accepted by a large number of mathematics education researchers, today 'it has become routine to tentatively suggest that people should no longer be willing to think of mathematics and mathematics education as far removed from culture, politics, and controversy' (Appelbaum & Stathopoulou, 2014). Although originally ethnomathematical research started with the study of mathematics/ mathematics practices in non-western cultures today affects the research in Western contexts, too. Much more, Ethnomathematics is a posture that informs perspectives of mathematics education. For example, in the current trend of almost all of the curricula that project the need of meaningful mathematics teaching in the classroom Ethnomathematical research can radically contribute bringing in the classroom the connection of mathematics knowledge with culture and context expending so not only students' mathematical experience but as well as their image about what constitutes mathematical knowledge. Furthermore students, through this kind of approaches, become familiarized to accept not only the formal/academic knowledge but also every kind of knowledge that 'works' in a particular context developing in this way a respect for others knowledge and culture. In this paper we — an ethnomathematician researcher and a mathematics educator and researcher — are discussing our experience of incorporating ethnomathematical ideas in mathematics teaching in an upper secondary class of Geometry. The research is constituted of three steps: 1) An original ethnomathematical research. The research was conducted in the village Pyrgi of Chios Island (Greece); a research on the spot studying the traditional practice of constructing 'xysta' — geometrical figures on houses' facades—and the mathematical ideas explicit or implicit appeared in this practice, 2) The incorporation of mathematical ideas for designing a WebQuest. A WebQuest was developed in the framework of an interdisciplinary project for teaching geometrical notions, 3) The

development of a new interdisciplinary project including Drama in Education techniques. The main aims of the project were for the students: a) to realize through drama that mathematics is a human activity connected to all cultures and human activities, b) to understand mathematics' notions such as symmetry and pattern, by investigating mathematical ideas that are incorporated in *Xysta*, c) to communicate maths through drama, and d) to identify, explore and implement Literacy skills into Drama. In this research using the 4th strand of Ethnomathematics, informed also of the 3rd (mathematics in everyday contexts; here mathematics of a professional group) students had the opportunity to negotiate mathematical notions in a meaningful environment and at the same time to see mathematics as a cultural construction.

Keywords: Ethnomathematics; Interdisciplinarity; Geometrical Notions; Upper Secondary School; WebQuest; Drama in Education.

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Análise da Resolução de Problemas Envolvendo Raciocínio Proporcional Baseados em Contextos Piscatórios de Portugal

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Desde os tempos remotos que os seres humanos, em particular os mercadores, utilizavam conhecimentos matemáticos que lhes permitia resolver problemas ligados às trocas comerciais, e que os menos hábeis no contexto dos negócios e da matemática, julgavam não ter solução ou serem de difícil resolução. Os problemas que envolvessem raciocínio proporcional eram considerados de média ou elevada complexidade. No entanto, os mercadores há muitos séculos atrás, sem escolarização formal, resolviam engenhosamente problemas de relativa complexidade. Ainda hoje, algumas atividades profissionais, apesar da sua baixa escolarização, têm uma relação muito próxima com problemas que envolvam raciocínio proporcional. É o exemplo de comunidades piscatórias que utilizam conhecimentos matemáticos informais no seu quotidiano, mas que por vezes se torna difícil transpô-los para a sala de aula e vice-versa. Também em contextos escolares que não nos piscatórios, os alunos revelam dificuldades na resolução de problemas sobre raciocínio proporcional (Lesh, Post, Behr, 1988). Este trabalho tratando-se de uma investigação de natureza qualitativa e com a Etnomatemática como pano de fundo, foi desenvolvido em duas comunidades piscatórias (Câmara de Lobos - Madeira e Caxinas) recolhendo informação sobre elementos matemáticos utilizados no seu quotidiano (construção de barco). Em fase posterior teve lugar a aplicação de tarefas no contexto do raciocínio proporcional em duas escolas com alunos (10-12 anos) de contextos distintos: alunos da comunidade piscatória de Caxinas e alunos de contexto mais citadino de Vila Nova de Famalicão. Os dados serão apresentados de forma descritiva e interpretativa, nomeadamente as estratégias de

resolução e as dificuldades dos alunos. Apresentar-se-á também uma breve análise sobre a possível influência/interferência da matemática escolar no desempenho de alunos destes dois contextos sociais tão distintos, perante as mesmas tarefas matemáticas.

Palavras-chave: Raciocínio proporcional; Comunidade Piscatória.

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Etnomatemática Associada a Física no Trabalho Artesanal de Pedreiro. Caso da Cidade de Chimoio

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Ultimamente, a cidade de Chimoio tem conhecido um grande crescimento no ramo de construção civil, o que se traduz em muitas pessoas, com baixo nível de escolaridade, a procurarem trabalho nas obras de singulares bem como em pequenas empreitadas. Este fenómeno fez com que se levanta uma questão sobre os conhecimentos matemáticos e físicos que estes pedreiros artesão usam no seu dia-a-dia, dai, surgiu a seguinte questão: Quais os saberes matemáticos e físicos utilizados empiricamente pelos pedreiros em contextos profissionais? Este trabalho se enquadra na "Etnomatemática" tratada por D'Ambrósio, o qual atribui uma atenção especial à Matemática praticada por grupos sócio-culturais. Trata-se de algumas práticas culturais no uso da Matemática ao tempo em que se traz alguns elementos didáctico-cognitivos relacionados à

pesquisa de grupos populares verificando sua relação com a Matemática (BORGES, 2004). Para colecta de dados privilegiou-se o inquérito com perguntas fechadas e abertas. A pesquisa revela uma percepção nítida da ligação estreita existe entre grupos culturais e grupos profissionais específicos, que se nutrem pela relação antropológica do trabalho humano centrado no fazer matemático e físico. Dos 40 pedreiros artesanais envolvidos na pesquisa quanto ao seu nível de formação na área de obras ou construção civil, foi constatado que apenas 5% têm formação nesta área, INEFP, os restantes 95% referiram que adquiriram a profissão na sequência do seu trabalho como servente. Este facto confirma a ideia de D'Ambrósio (2001), o qual advoga que "o acúmulo de conhecimentos compartilhados pelos indivíduos de um grupo tem como consequência compatibilizar o comportamento desses indivíduos e, acumulados, esses conhecimentos compartilhados e comportamentos compatibilizados constituem a cultura do grupo. No que refere a noção de conceitos físicos ligados à construção civil, como é o caso da dilatação térmica, os pedreiros mostraram-se muito desligados da realidade científica, o que significa que quase todos praticam este conceito de forma empírica. Dos inquiridos 4% responderam positivamente ao questionário quanto aos conceitos de dilatação térmica e 96% assinalaram "não". A mesma questão, feita de outra maneira evidenciando os efeitos negativos da dilatação térmica numa obra, teve as seguintes respostas: "*aquecimento",* "*subida de temperatura", "por causa de calor".* Tendo em conta os 83% correspondentes a estes dizeres, conclui-se que os informantes têm noção de dilatação térmica. No computo geral os dados recolhidos mostram quem há uma necessidade de se partir de conhecimentos práticos e de experiências empíricas que vários grupos sociais e culturais têm para a construção de novos conhecimentos científicos e/ou harmonização dos já existes. Foi notório que este grupo específico tem muita bagagem, habilidades e relíquias por se aproveitar. Entretanto, há que se capitalizar e fazer-se o registo destes conhecimentos.

Palavra-chave: Entnomatemática; Física; Pedreiro Artenasal**.**

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Students in the Republic of the Maldives Creating Ethnomathematics Word Problems

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Far to often, students are engaged with word problems for extra credit or as challenge problems. While many students are required to respond to word problems that have no cultural significance or relate to the student. Research indicates that such a practice is not beneficial for student success (Barlow & Cates, 2007; Gerofsky, 1999; Marks, 1994; Ronhovde, 2009). One way to address this phenomenon is ethnomathematics. Ethnomathematics is the relationship between culture and mathematics (D'Ambrosio, 1985). Meaningful word problems instead of routine exercises are beneficial for students (Martinez, 2001; Amit and Klass-Tsirulnikov, 2005). Each student's lived experience is rich in mathematical symbolism (Presmeg, 1998). Word problems allow students to use problem solving strategies, rather then, memorized techniques to solve routine problems (Xin, 2007). Word problems encourage students to think mathematically and develop reasoning skills rather than rely on prescribed formulas (Martinez, 2001). Students who write in mathematics have an opportunity to communicate their mathematical thinking to other students and the teacher (Miller, 1991; Winograd and Higgins, 1994). Students who write word problems tend to be better problem solvers (Rudnitsky, Etheredge, Freeman, and Gilbert, 1995) and are extremely motivated to solve word problems (Brown, 1993). A study was designed to explore a group of participants' ability to write word or story problems that are grounded in ethnomathematics. The study took place on the island of Kuda Hudaa in the Republic of the Maldives. Participants were to write two word or story problems, one for multiplication and the other division. Participants completed the task in groups of two – eight groups of two

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.

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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.

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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 –

experimental and control – with purpose to access the learners' performance in learning of mathematics due to an intervention with the WB on the topic "sequences and series" (Figure 1).

Figure 1: A learner helping another in WB-activities

Although there was no significant difference between the two groups of learners, the experimental one became aware of having started the mathematics lesson in a "strange" manner that seemed to be an artwork lesson but then ending up with a reasonable understanding of the concepts of sequence and series by doing their own mathematics. The second part of the main study was an action research, where teachers and I collaboratively developed further WB-activities, related to school mathematics program. The exploration of woven patterns based on the basketry techniques resulted in a production of different woven geometrical shapes in two as well as in three dimensions.

Keywords: Didactical Transposition; Mathematical Ideas vs. Mathematical Concepts.

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Emic (Local), Etic (Global), and Dialogical (Glocal) Knowledge in Research in Ethnomodeling

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Mathematics used outside of the school may be considered as a process of modelling rather than a mere process of manipulation of numbers and procedures. The application of ethnomathematical techniques and the tools of modelling allow us to see a different reality and give us insight into mathematics done in a holistic manner. Using this perspective, the pedagogical approach that connects the cultural aspects of mathematics with its academic aspects is named ethnomodeling, which is a process of translation and elaboration of problems and questions taken from systems that are part of any given cultural group. Today, numerous diverse mathematical knowledge systems are at risk of becoming extinct because of the rapidly changing natural and cultural environments and fast pacing economic, social, environmental, political, and cultural changes occurring on a global scale. In this context, many local mathematical practices may disappear only because of intrusion by foreign technologies or resulting of the development concepts that promise short-term gains or solutions to problems faced by cultural groups without being capable of sustaining them. Defined in that manner, the usefulness of the emic and etic distinction is evident. Like all human beings, researchers, educators, and teachers have been enculturated to some particular cultural worldview, and they therefore need a means of

distinguishing between the answers they derive as enculturated individuals and the answers they derive as observers. Defining emics and etics in epistemological terms provides a reliable means of making that distinction. Culture is a lens, shaping reality, and a blueprint, specifying a plan of action. At the same time, a culture is unique to a specific group of people. By utilizing the research provided by both approaches, we gain a more complete understanding of the cultural groups of interest. An alternative goal for ethnomodeling research must be the acquisition of both emic and etic knowledge. Emic knowledge is essential for an intuitive and empathic understanding of mathematical ideas of a culture and it is essential for conducting effective ethnographic fieldwork. Etic knowledge, on the other hand, is essential for cross-cultural comparison, the essential components of ethnology, because such comparisons that necessarily demand the use of standard units and categories. Furthermore, emic knowledge is a valuable source of inspiration for etic hypotheses. Finally, we define *ethnomodeling* as the study of mathematical phenomena within a culture because it is a social construction and culturally bound.

Keywords: Ethnomodeling; Mathematical Modeling; Ethnomathematics; Emic; Etic; Dialogical.

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Senderos Norteados por un Curso de Multiculturalidad y Etnomatemática

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Una experiencia de aula suele trazar muchos senderos, incluyendo aquellos que no conducen a nada. No obstante, en este documento se reporta una experiencia exitosa debida a un curso centrado en la multiculturalidad y la Etnomatemática. El curso (Oliveras, 2009) fue desarrollado en Venezuela en las aulas de la Universidad Pedagógica Experimental Libertador (UPEL) y se materializó mediante un foro que, posteriormente, se complementó con visitas a escuelas ubicadas en poblaciones indígenas donde se desarrolla un Programa de Educación Intercultural Bilingüe (PEIB) de esa Universidad. En el mismo se colocaron en escena varios aspectos teórico-referenciales concomitantes al tema, generando reflexiones y debates requeridos para consensuar conclusiones respecto a la multiculturalidad, la interculturalidad y la consideración y sentido de la Matemática en diferentes culturas. Desde allí se abrieron espacios propiciatorios para la investigación en Etnomatemática y la Formación de Profesores, teniendo lugar el reconocimiento, la identificación, la valorización y la descripción de prácticas matemáticas que acontecen fuera de la escuela. También se elaboraron proyectos, siguiendo a Oliveras (2005), que emergieron luego de concretar las posibilidades que brinda la Etnomatemática como perspectiva que impulsa la diversidad educativa y social. Los proyectos se sustentaron en conocimientos matemáticos implicados en labores propias de los grupos de la región, destacando los siguientes: construcción de cestas indígenas; caracterización de casas típicas de una colonia de extranjeros; diseño y construcción de un instrumento musical, y elaboración de muebles típicos de una población particular (Martínez Padrón y Oliveras, 2014). Además de los productos anteriores, se: (a) concretaron cursos de capacitación en Etnomatemática dirigidos a docentes indígenas, incluyendo uno de formación a ser insertado en el PEIB; (b) desarrollaron trabajos de maestría y tesis doctorales; (c) elaboraron proyectos de investigación puestos en escena en

grupos socioculturales diferenciados; y (d) publicaron varios artículos científicos que abordan estas experiencias.

Palabras-Clave: Educación Matemática; Etnomatemática; Grupos Socioculturales; Multiculturalidad.

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Chocalhos Africanos de Dança e a Exploração de Poliedros

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Apresentar-se-á uma visão panorâmica da pesquisa, realizada desde 1997, sobre poliedros entrecruzados em práticas culturais africanas, em particular, na fabricação de chocalhos de dança. Esta apresentação servirá para reflectir sobre alguns métodos de investigação em etnomatemática. Sugerir-se-ão possibilidades para explorar as ideias incorporadas no entrecruzamento de poliedros na educação matemática e na formação de professores. Indicar-se-ão conexões com outras áreas da matemática, como a teoria de nós.

Palavras-chave: Chocalhos Africanos; Entrecruzamento de Poliedros; Etnomatemática.

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State-of-the-art of Ethnomathematics in Chile

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This text is part of a project of the Latin-American Network of Ethnomathematics, RELAET. The general goal of this organization is to explore the current situation of Ethnomathematics in Latin-American as *research and training areas*. This text presents a diagnosis of the development of Ethnomathematics in Chile, and it also shows that Ethnomathematics is a research and training area of emergent development in the country. The recollection and organization of data analysis was conducted with five a priori categories, which refer to different areas where experiences of training and/or research in Ethnomathematics have been developed and the mathematics and cross-cultural activities proposed by Bishop (1999). The five a priori categories are: a) *Educational policies* include laws and decrees related to the inclusion of ethnomathematics into the school system and educational resources developed by the ministry of education, b) *National research* conducted around Ethnomathematics. It includes articles, research and outreach, and postgraduate thesis, c) *Teacher training* in primary education, mathematics education (secondary) and bilingual intercultural education. It includes modules or courses in teacher training curricula and undergraduate thesis related to ethnomathematics, d) *Academia meetings* where ethnomathematics has been incorporated in the last years (2013-2014), and e) *Academia networks* which provide space for the development of ethnomathematics in Chile. The analysis of publications from the first four categories was based on the given subject areas and the referenced sociocultural groups. In this way, *five emerging subject*

categories were identified: Rescue of Cultural Mathematical Knowledge (CMK) (Gavarrete, 2012) of ethnic sociocultural groups (22%); Rescue of CMK of non-ethnic sociocultural groups (5%); Source for rescue of CMK of ethnic sociocultural groups (9%); Ethnomathematics, curriculum and teaching (25%); Contextualizing the School Mathematical knowledge in the culture (38%). In relation to the sociocultural groups the conclusion was as follows: 35% of publications refer to the Mapuche people, 27% to the Aymara people, 15% to the Lican Antai people, 13% to sociocultural groups non-ethnic (workers, farmers, youth and adults, etc.); and 9% does not refer to any specific sociocultural group. The analysis of academia network shows that in Chile the Latin-American Network of Educational Ethnomathematics (RELAET) and the Interuniversity Network of Education and Interculturality (RIEDI) are existent organizations. Regarding to Ethnomathematics as *training area* the conclusion was that experiences of ethnomathematics training have been included into the undergraduate studies of Primary Intercultural Education. And in regards to Ethnomathematics as *research area*, it is observed that this has been focused on areas related to ethnomathematics, curricula and teaching. Most of the works refer to the Mapuche people. The main challenge to the development of Ethnomathematics in Chile are to study the CMK of the sociocultural groups, both ethnic and non-ethnic, to include ethnomathematics into the teacher training programs for Primary Education and Mathematics Education; and also to develop strategies to achieve such inclusion.

Keywords: Ethnomathematics; Chile; Training; Research; Cultural Mathematical Knowledge.

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Impact of Local Language Creole on the Teaching and Learning of Two-dimensional Geometry at the Upper-primary level in Mauritius

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The research reported in this article shows the impact of local language Creole as means of instruction on the performance of two-dimensional geometry tasks at the upper primary level in Mauritius. A quasi-experimental design involving two independent variables: language of teaching (English and Creole) and types of teaching strategies (traditional classroom teaching from textbook and inquiry-based teaching with manipulatives) was conducted in four primary schools. The upper-primary level pupils from the schools were clustered into four randomly matched groups and the experimental teaching on 2D geometry was conducted by the researcher himself. A multiple-choice questionnaire with questions on 2D geometry was administered to all the surveyed pupils as posttest and retention test. It was found that the use of the local language Creole had significantly improved the pupils' two-dimensional geometrical skills at van Hiele levels 1 and 2 (recognition and analysis levels) in both posttest and retention test. The utilization of inquiry-based teaching with manipulatives when combined with the use of Creole had prompted the acquisition of geometric skills like visual, logical, applied and even verbal. This paper discusses from examples how this occurred.

Keywords: Mauritius; Primary School Geometry; Geometry Investigating; Language and Mathematics; Creole.

Los Números Mapuches en el Currículo de la Lengua Mapuzugun en la Educación Básica de Chile

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Este trabajo es parte de una investigación en desarrollo sobre el Sistema de Numeración, de la cultura Mapuche de Chile. Presentamos el uso cotidiano de los números mapuche, utilizados por el Programa de Lengua Mapuzugun. Actualmente, el sistema educativo en Chile se define como un Sistema Intercultural y Bilingüe, desde el inicio de la democracia en 1990. Desde este momento se comienza a valorar la existencia de las culturas originarias y el reconocimiento a su integridad y desarrollo, respetando sus costumbres, valores y cosmovisión. El año 2009 se aprobó la Ley General de Educación (LGE), la que establece un nuevo sector de aprendizaje para la educación general básica, la "lengua indígena", que introduce las bases curriculares específicas y programas de estudio correspondientes. En este póster presentamos el análisis morfo-matemático (De Bengoechea, 2009) de los números mapuches utilizados por el Programa de Estudios de la Lengua Mapuzugun (Lengua del pueblo Mapuche), en los niveles de educación básica (primaria). Éste nos ha permitido describir el uso del sistema de numeración mapuche como parte de su tradición oral (Ministerio de Educación, 2011) y algunos posibles conflictos o ventajas al no considerar este conocimiento de origen como un conocimiento previo para el aprendizaje de la matemática escolar en los primeros años de la educación obligatoria. Sin embargo, este conocimiento no es abordado desde el punto de vista de la lingüística en Mapuzugun ni como parte de la matemática viva del pueblo mapuche, siendo un componente importante de la cultura (Oliveras. 1996). Junto a este avance en la educación intercultural bilingüe, el Ministerio de Educación retira, el año 2009, la unidad didáctica "Sistemas numéricos en la historia y actuales" del programa de estudio de matemática en la educación básica. Esta unidad didáctica permitía, en ese momento, el estudio de la numeración mapuche y su incorporación en los libros de textos de los estudiantes que entrega el Ministerio de educación. Este trabajo es una contribución a la valorización de los conocimientos matemáticos del pueblo

mapuche (D'Ambrosio, 2000) y un comienzo en la búsqueda de herramientas teóricas, que permitan la articulación dialógica entre el conocimiento matemático de origen del estudiante mapuche y la matemática escolar en los primeros años de la educación obligatoria. Si la etnomatemática mapuche es parte de la práctica matemática de los estudiantes mapuches fuera de la escuela, es necesario observar esta práctica dentro de la escuela, lo que permite reconocerla como una práctica válida que refuerza la auto-respeto (D´Ambrosio, 2000) y el desarrollo identitario del estudiante mapuche. Estas visiones nos permiten proyectar una educación etnomatemática crítica e intercultural que contribuya a la educación intercultural bilingüe.

Palabras-clave: Métodos de Investigación; Antropología Cultural; Educación Cultural.

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Making Ethnomathematics Visible through Culturally Responsive Pedagogy and Funds of Knowledge

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Ethnomathematics provides a philosophical and epistemological framework for talking about the relationship between mathematical activities and forms of life, a relationship that is largely negated in school mathematics. While ethnomathematics has evolved steadily as a global movement, both as research and activism, since its formulation by D'Ambrosio in 1985, it remains somewhat under-theorized in relation to aligned developments in humanistic education. Further, despite many pioneering efforts, the impact of the ethnomathematical perspective on school mathematics remains limited and unsystematic. In this paper I will discuss an approach of foregrounding ethnomathematics as an integral part of school mathematics, drawing, in particular, on the approaches of culturally responsive pedagogy (Gay) and funds of knowledge (Moll).

Keywords: Culturally Responsive Mathematics; Funds of Knowledge; School Mathematics.

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Cultural Villages as Contexts for Mediating Culture and Mathematics Education in the South African Curriculum

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Some mathematics educational reform policies indicate that learners should be getting an education which is connected to their cultures. However, teaching in schools rarely brings the interconnection between mathematics and culture in pedagogically informed ways. Connections are often done superficially because of teachers' inexperience in ways of connecting. Also, the curriculum in schools lacks content and specific strategies that enable the making of the connections explicit in the context of teaching. The study from which this paper emerges worked with three mathematics teachers in an attempt to teach mathematics in ways that connect key concepts with culture. Through mathematizing culturally-based activities performed at a cultural village, two Grade 9 mathematics topics in the South African curriculum were indigenised. A teaching unit on the indigenised topics was designed and implemented in five Grade 9 classes at the same school. The paper demonstrates that the experience of designing, implementing, and reflecting on the intervention study had some positive contribution to the participating teachers' pedagogical repertoire. I argue that cultural villages can be used as contexts for mediating culture and mathematics education.

Keywords: Cultural Villages; Culture; Mathematics Education, South African Curriculum.

Re-introducing Ethnomathematical Practices into the Classroom: Linguistic Issues

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For over 100 years, the Māori language and knowledge was excluded from schools by a range of colonial education policies based on assimilation and integration. As a consequence of this and other state policies, by the 1970s Māori was considered an endangered language, with much of the traditional knowledge eroded and/or restricted to a few domains. In the wider political context, the change in status affecting the Māori language galvanised groups in the late 1970s to demand greater use of Māori in the government and other public institutions controlled by the government, most notably, education (Trinick, 2013). Eventually, the state was compelled to respond to the community demands, and implement policies to support the revitalisation of the language and traditional practices. These policies included state funding of Māori language immersion schooling, and funding to support the implementation of state mandated mathematics curriculum. The reintroduction of the Māori language and knowledge into domains such as schooling, in conjunction with the desire to teach subjects such as mathematics in the medium of Māori, led to rapid expansion of the lexicon to keep up with the demands from Māori immersion schools. However, the process of linguistic modernisation of the Māori language and the introduction of traditional practices in subjects such as mathematics has since raised a number of conflicting tensions and linguistic and cultural issues (Trinick & May, 2013). This paper explores the linguistic and pedagogical tensions and at times conflicting ideologies that have influenced the lexication of the mathematics terminology and the selection of ethnomathematical activities. Two dichotomous ideologies have been in competition with each other in the mathematical language modernisation process. The linguistic purists supported a return to more 'authentic' language to express both traditional ethnomathematical and contemporary mathematical ideas, while a group of pragmatists favoured the use of transliterations (phonologically adapted terms) in similar ways to other Indigenous groups around the globe who have modernized their language. Because of the endangered status of the language, puristic ideologies eventually won over. An additional tension included the question of standardisation of the mathematical language for national purposes that conflicted with the maintenance of the local

tribal dialects. There was a strong belief among Māori mathematics educators in the need to standardise the terms. The goal was to facilitate consistency and common interpretation of terms across the country. At the community level, many tribes continue to hold strong views that curriculum areas such as mathematics should reflect their own dialects and own cultural traditions. Successful modernisation of the Māori language on the one hand, thus has to be responsive to the universal needs of language efficiency, while, on the other hand, trying to accommodate the particular demands of localising ideologies such as dialects. The sociolinguistic beliefs such as linguistic purism (Harlow, 1993), which influenced the technical approach to modernising the language may have created particular pedagogical issues, such as a lack of intertranslatability between Māori and English at the higher levels of mathematics study. Additionally, many teachers in the Year (Grade)1-13 schools were L2 speakers of the Māori language, simultaneously learning the language, the traditional knowledge and the craft of teaching. Cumulatively, these issues raise several pedagogical issues that are discussed in this paper.

Keywords: Ethnomathematics; Modernising Indigenous Language; Sociolinguistic Issues.

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IV – ETHNOMATHEMATICS AND TEACHER EDUCATION

La Capacitación en Etnomatemática en la Trayectoria de la Formación de Maestros. Un Caso en Argentina

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Desde hace aproximadamente 5 años en la provincia del Chaco, en el norte argentino, se trabaja en vista de comprender, reflexionar e insertar en los ámbitos académicos a la Etnomatemática, con la intención de no considerarla una mera curiosidad académica, sino más bien profundizar en sus aplicaciones educativas. El Instituto de Educación Superior Juan Mantovani propende acciones de capacitación en vista a la formación docente en el nivel primario, para que los futuros maestros conozcan este nuevo campo de conocimiento. Se inició un primer acercamiento con el propósito de socializar experiencias de investigación etnomatemáticas a partir de la cultura montenegrina (Santillán & Zachman, 2009). El segundo acercamiento de la comunidad estudiantil con la etnomatemática ha sido desde el espacio curricular "Proyecto Integrador Interdisciplinar de Ciencias Sociales", donde se tomó como ejemplo la posibilidad de interdisciplinar historia, antropología, y etnomatemática (Santillán, 2011). Finalmente en el 2013, con el mismo grupo de estudiantes, se realizó una capacitación de "Los Signos Culturales y las Matemáticas", donde se fomentó el trabajo en pequeños grupos de corte investigativo sobre las matemáticas presentes en algunos signos culturales de la provincia del Chaco. La base de estas acciones formativas ha consistido en entender a la Etnomatemática como una manera de incluir a los otros, considerados como tal porque procedentes de diversas culturas (pueblos originarios u otros países de inmigración) o microculturas (cuales los gremios de trabajadores o bailarines), en el interés de comunicarse, compartir y sacar partidos a experiencias, propuestas y

proyectos comunes (Albanese, Santillán & Oliveras, 2014), con la idea de que toda forma de encuentro es un hecho educativo y los caminos a recorrer juntos son itinerarios en situación que es preciso aprender a acompañar.

Palabras-clave: Etnomatemática; Formación Docente.

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Microproyectos Curriculares Centrados en Etnomatemáticas com Elemento Formador de Maestros

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La experiencia docente que presentamos está íntimamente ligada a la investigación, considerada como parte de la acción de formar a los profesores, y tiene el propósito de introducir las etnomatemáticas como elemento formativo en los estudios universitarios de Grado en Maestro de Educación Infantil. En los nuevos planes de estudios, adaptados al Espacio Europeo de Educación Superior y con validez en todo el continente europeo, se ha introducido la realización de un Trabajo Fin de Grado (TFG) en su último semestre de formación, en el cual debe demostrarse la formación global recibida en todas las materias. Hemos planificado un modelo de TFG en el que los/as estudiantes, interrelacionen conocimientos, prácticas profesionales de aula e investigación. Dicho tipo de TFG se fundamenta en el Modelo Didáctico Emergente de Oliveras (Oliveras, 1996). Se caracteriza por el trabajo teórico de introducción en las etnomatemáticas, consideradas una alternativa epistemológica que incluye el conocimiento matemático infantil como válido, y por la elaboración de Microproyectos curriculares centrados en etnomatemáticas, como elemento formador de maestros. Para ello se definen tres objetivos: 1) Desarrollar en los maestros en formación una epistemología que acepte *multimatemáticas* (Oliveras, 2006) y les permita identificar las relaciones de la matemática escolar con los signos culturales propios de las culturas de los niños presentes en el aula, 2) Aportar nuevos ejemplos de la técnica didáctica globalizada denominada *Microproyecto*, (Oliveras, 1996, 2005), que consoliden una metodología adecuada para la educación infantil intercultural, 3) Introducir la investigación como elemento de formación profesional, formativo por sus características y por su objeto de estudio: la propia acción educativa en matemáticas. Este trabajo consiste en presentar el Modelo Didáctico Emergente como mediador de la introducción de las etnomatemáticas en la formación de maestros, seguido de describir y contextualizar cuatro TFG consistentes en la fundamentación y elaboración de distintos Microproyectos etnomatemáticos.

*Palabras-clave***:** Formación de Profesores; Microproyectos Curriculares; Educación Intercultural.

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Obstacles to Integrate Ethnomathematics in Mathematics Classrooms

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This paper present partial results of the doctoral research "*The Training of Teachers who Teach Math using Ethnomathematics: Elements for Reflection*", its general objective is to identify elements for the design of teacher training programs since ethnomathematics. Specifically, this exposes the study of the veracity of two conjectures: teachers do not recognize mathematical extracurricular activities as math, and 2, this position obstructs the use of this knowledge in the classroom. A qualitative methodology for case studies was used. The case is a training course for teachers from ethnomathematics made in Tumaco, Colombia between July and October 2012. The empirical material was a group interview recorded in audio and were transcribed and analyzed with the theoretical model "MEDIPSA" which in its epistemological component includes the Wittgenstein's philosophy of mathematics. The findings, according to our conjectures, indicate that there is an obstacle between extracurricular math and school math because teachers doubt the mathematical value of extracurricular math. This conclusion gives us lights to outline the first element to consider in teacher training, which has to do with the epistemic openness to what is mathematics.

Keywords: Mathematics Teacher Training; Ethnoeducation; Curriculum; Extracurricular Mathematics; Cultural Diversity.

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Bringing Ethnomathematics to Elementary Schools in Papua New Guinea

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After 40 years of ethnomathematics research in PNG and policies encouraging ethnomathematics in schools, it was time to look at professional learning for teachers so they could effectively implement the policies. We designed a set of interlinked principles, used them in workshops for Elementary School teachers (Pre-Elementary, Grades 1 and 2), and revised the principles to take account of needs. We developed a manual and a website to use in the workshops and afterwards. We are continuing this research through several phases of a design-based research. Early evaluation data suggest that this is a very worthwhile technology-enhanced professional learning based on an appropriate set of principles.

Keywords: Papua New Guinea; Ethnomathematics in Schools; Elementary Teacher Education; Language and Mathematics; Inquiry Learning; Design-based Research.

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Mathematics of Students' Culture: A Goal of Localized Ethnomathematics

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Ethnomathematics is the mathematics of cultural groups, but often those cultural groups are "others" and "elsewhere". However, it is also valuable to look inward to see the interaction of mathematics and one's own culture. An assignment in a graduate course offers this opportunity to students. The assignment is to find an area of the student's personal "culture" (sometimes

defined rather broadly) and find its use of mathematics. Students are asked to write about (a) the cultural area; (b) how they are personally tied to it; and (c) how and where it uses mathematics. In addition to the paper, students make an oral presentation. Thus, all students learn (often surprising) aspects of their classmates' non-professional life, and the presenter digs into areas of family and heritage that may not have been reviewed before. Since all students are classroom mathematics teachers, finding their own cultural mathematics is not only enlightening for themselves, but also offers opportunities to include new mathematics applications in their teaching. This paper is a report on more than a decade of using this assignment, including student examples.

Keywords: Ethnomathematics; Teacher Education; Classroom; Personal Culture.

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Etnomatemáticas Indígenas y Formación Docente: el Modelo MOCEMEI

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Se describen resultados de la tesis doctoral titulada 'Modelo de aplicación de etnomatemáticas en la formación de profesores para contextos indígenas en Costa Rica' (Gavarrete, 2012). Dicho trabajo plantea la importancia de impulsar la difusión de los aspectos relacionados con la herencia del conocimiento cultural indígena que tiene relación con el conocimiento matemático, para propiciar la dignificación del conocimiento ancestral; a través de una adecuada formación profesional que contribuya a reforzar las identidades culturales desde el entorno escolar. Uno de los propósitos del estudio fue caracterizar las Etnomatemáticas a través del Conocimiento Matemático Cultural de tres grupos indígenas de Costa Rica: Ngäbes, Bribris y Cabécares. Otro de los propósitos fue proponer un Modelo de un Curso de Etnomatemáticas para la Formación de Profesores que trabajan en Entornos Indígenas, a partir de sus propias Etnomatemáticas: el modelo MOCEMEI. La investigación tuvo un diseño metodológico compuesto por cuatro estudios base que respaldaron empíricamente la formulación del modelo, y un estudio final que describió y evaluó la implementación del MOCEMEI. En esta investigación (Gavarrete, 2012) se plantean de una serie de premisas y conjeturas que señalan la preeminencia de una visión monocultural de corte eurocentrista que impera en la educación matemática de Costa Rica y en la formación profesional de esta disciplina; y a la vez, plantea la necesidad de motivar procesos de reflexión sobre la matemática en las culturas, así como también la necesidad de promover la aplicación de etnomatemáticas en los procesos de formación de profesores con la finalidad de

exaltar la acción pedagógica y combatir la exclusión promovida por un currículo monocultural. Se defiende que la Etnomatemática y la Etnodidáctica (Oliveras, 1996) son alternativas para combatir la exclusión, en este caso atendiendo la interculturalidad como parte importante en el proceso de la formación de profesores. Tejiendo un entramado de teoría y hallazgos del trabajo etnográfico, en la investigación (Gavarrete, 2012) se plantea una propuesta didáctica multicultural y transdisciplinar que integra las dimensiones del Programa de Etnomatemáticas (D'Ambrosio, 2008), así como los elementos teóricos acerca de enculturación matemática (Bishop, 1999), y que se materializa a través de microproyectos para la educación intercultural (Oliveras, 2005). Algunos resultados relevantes de la investigación son la caracterización de las Etnomatemáticas Indígenas de Costa Rica a través de indicadores del Conocimiento Matemático Cultural en el lenguaje, la cosmovisión y las prácticas sociales. Otros resultados relevantes se obtienen a partir de estudios diagnósticos en los cuales se logró determinar los aspectos a tener en cuenta para la formación en didáctica de las matemáticas de los profesores que trabajan en entornos indígenas. El MOCEMEI promueve formar al docente indígena como un investigador de su propio proceso de enculturación, pues la investigación sobre las ideas que subyacen en las prácticas de sus propias culturas, a través del estudio de las diversidades culturales, étnicas y lingüísticas les proporcionan herramientas para conducir la enseñanza a partir de los hallazgos y contribuir con un entendimiento mutuo y el respeto por la valía del propio conocimiento matemático cultural, dando mérito a sus propios saberes y propiciando actividades contextualizadas con tareas que integren las etnomatemáticas occidentales y los resultados del proceso de enculturación y orientándolos a una propuesta curricular donde los materiales de enseñanza estén situados en una estructura epistemológica que relacione los contextos locales, nacionales e internacionales y propicie nuevas vías en el aprendizaje significativo en los estudiantes. De la aplicación y evaluación del MOCEMEI se concluyó que es una propuesta atinente, de alcance nacional en Costa Rica y que puede replicarse en otros entornos pedagógicos específicos para proponer estrategias de acción educativa que no amenace las raíces ancestrales de los contextos indígenas en Costa Rica, y a la vez, no los limite o excluya dentro del panorama globalizado de la Educación Matemática mundial.

Palabras-clave: Formación de Profesores; Etnomatemáticas Indígenas; Diversidad Sociocultural.

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Etnomatemáticas de Signos Culturales: su Incidencia en la Formación Docente

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Presentamos resultados de dos investigaciones que han sido realizadas con maestros de primaria en Argentina y Costa Rica, en las cuales se propuso aplicar la etnomatemática como herramienta para la formación docente. Se discutieron diversas formas de hacer y entender las etnomatemáticas de dos grupos culturales distintos: el gremio de los bailarines de danzas folclóricas (Argentina) y el pueblo originario Cabécar (Costa Rica). En ambos países se organizó un curso para la formación docente, que propició la investigación en el entorno a través del

desarrollo de Microproyectos Curriculares basados en Etnomatemáticas sobre un signo cultural (Oliveras, 1996). La organización del curso consideró propuestas didácticas tanto para maestros en formación inicial como para maestros en formación permanente que participaron en su implementación. Los signos culturales elegidos para estudiar fueron la "chacarera" (Argentina) y el sistema de numeración oral en lengua cabécar (Costa Rica); ambos fueron abordados desde sus etnomatemáticas con la finalidad de proponer acciones didácticas pertinentes al aula de educación primaria. Algunos resultados de los microproyectos desarrollados en ambos países fueron discutidos y relacionados o diferenciados de la matemática académico-formal, propiciando una formación didáctico-matemática a partir de un proceso reflexivo-investigativo en los maestros participantes. Por ejemplo, la danza folclórica de la "chacarera" se aborda desde la geometría, y permite reflexionar sobre otras formas de distinción del rombo respecto al cuadrado, a partir de las formas y secuencia del baile (Albanese y Perales, en prensa); mientras que el sistema de numeración oral en lengua cabécar se aborda desde el sentido numérico y es un sistema de numeración oral de base quinaria que utiliza clasificadores numerales y una metáfora numérica para representar al número cinco (Gavarrete, 2012). En ambos países, la experiencia de investigación que se ha promovido en los maestros ha impactado en su formación profesional, pues se ha reflexionado sobre la universalidad del conocimiento matemático y sus aplicaciones didácticas, al promover la creatividad docente que facilite desarrollar el currículo de matemáticas en conexión con el entorno sociocultural.

Palabras-clave: Etnomatemática; Formación Docente; Signo Cultural, Microproyectos.

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The Role of Critical Ethnomathematics Curriculum in Transforming and Empowering Learners

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The foundation of ethomathematics rests in its "openness to acknowledging as mathematical knowledge and mathematical practices elements of people's lives outside the academy" (Mukhopadhyay, Powell & Frankenstien, 2009, p. 75). Although there are several contexts in which mathematical ideas develop and are discussed, mathematics education has mostly been associated with the institutional context. The problem is that usually in the school setting, mathematical knowledge is presented as a "prized body of knowledge"(Millroy, p. 50), stripped of its rich cultural and historical connotations, and far removed from the "lives and ways of living of the social majorities in the world" (Fasheh, 2000, p. 5). When thinking about mathematics, seldom does one think about culture, context, history, or diversity. Many preservice teachers (PSTs) believe that there is no place for such constructs in their future mathematics classrooms. Mathematics educators, in particular ethnomathematicians (e.g., Civil, 2002; Mukhopadhyay et. al., 2009) oppose this view and argue for countering the narrow vision of mathematics that confines it to the school walls. Although a teacher educator and a researcher might hold such perceptions about the teaching and learning of mathematics, it is necessary to begin such processes at the teacher education level "as it is necessary to [change] teacher attitudes I as well (Presmeg, 1998, p. 325). The constructs of ethnomathematics and the critical ethnomathematics curriculum (Mukhopadhyay et. al.,) lend themselves well to this cause. In this session I focus on a strand of ethnomathematics research that specifically explores the relationship between ethnomathematics and multicultural mathematics education. This strand is of special interest to mathematics educators and helps address questions such as: *What are the*

implications of ethnomathematics for the theories and practices of the mathematics education? How can we add to and use this research base to advocate the ideals of culturally relevant mathematics education? Teacher education programs have begun to address some of these questions by designing and redesigning their existing programs and courses to focus on issues related to cultural diversity. In this session, I will present one such initiative. In this presentation I reflect on and share personal, professional, scholarly experiences specific to a research project aimed to promote connections between ethnomathematics theory and its practice as it applies to the teacher education context. The key goals of the research project are (a) to develop and implement a mathematics content course using the principles of a critical ethnomathematics curriculum and (b) to investigate whether and how participation in this course positively impacted prospective teachers' perceptions of mathematics and its pedagogy using a cultural and historical lens. A self-study methodology was employed to explore the research goals. This approach helped refocus the lens on the self (mathematics teacher educator); at the same time it enabled to maintain a focus on a more diverse variety of selves (prospective teachers).

Keywords: Ethnomathematics; Teacher Education; Self-study.

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V - ETHNOMATHEMATICS AND MATHEMATICS

Re-introducing Ethnomathematical Activities into the Māori-medium Classroom: The Example of Spatial Orientation

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One of the challenges of re-introducing ethnomathematical practices into schools from groups that have been colonised for many decades is that the original ethnomathematical practice may no longer be in general use in the Indigenous community, long replaced by a national standardised version belonging to the coloniser. This is the situation in Aotearoa/New Zealand where the indigenous Māori language and culture were excluded from schooling by national policies up until the 1970s. However, with the change to more enabling policies in the 1980s by the state, various initiatives were launched that focused on revitalising Maori knowledge and language, particularly so in Maori-medium schools (McMurchy-Pilkington, Trinick & Meaney, 2013). This paper presents a selection of ethnomathematical activities developed and taught in a wharekura (Māori-medium secondary school) that link geometry to spatial orientation. The philosophy and practice of this school reflect Māori cultural values with the aim of revitalising Māori language, knowledge and culture (Meaney, Trinick & Fairhall, 2012). Spatial *orientation* is the ability to understand and operate on relationships between objects in space. Spatial orientation is knowing where you are and how to get around in the world—at first, in respect to your own position and your movement through it. Eventually, it develops into a far more abstract perspectives that includes mental schemata in traditional Māori culture, and in Western mathematics, maps and coordinates. Many Māori spatial terms originate from East Polynesia, brought to the country by Polynesian seafarers migrating, most likely, from the areas of Tahiti

and southern Rarotonga. While the Māori language has evolved over several 100 years in Aotearoa/NZ in isolation from other Polynesian languages, with many adaptations made to the language in response to a temperate climate and an environment different from that of its tropical homelands–the directional terms remained in the language. However, most of the terms have undergone changes in orientation. Overtime, Māori concepts of spatial orientation have become much localised, tribal specific and learnt through stories and lived experience (Gauvain, 1993). This is in contrast to decontextualized Western mathematical concepts of location and direction, which are orientated to either magnetic or true north. Without the aid of magnetic compasses, Māori used a variety of terms and techniques to orientate themselves to the cardinal points, east, west, north and south, and intermediary directions. The techniques were derived from a mixture of phenomena, including the actions of the sun and wind, and geographic land forms. For example, prevailing winds became directional terms over time. This paper explores some of the major phenomena that gave rise to Māori "spatial frame (s) of reference" and eventually the major direction terms, drawing on historical literature and interviews with elders. Spatial frames of reference are ways of referring to how things are located with respect to each other. While the aim of wharekura are to revitalise traditional Māori knowledge, and it might seem contradictory, the ethnomathematical activities described in this paper also include some use of modern technology. Technology is a significant part of Māori teenage way of life in contemporary times and has many applications in geometry; therefore, the activities discussed in this paper also include the use of modern technology, for example, smart phones that have GPS capabilities.

Keywords: Indigenous Māori Language; Ethnomathematics; Spatial Frames of Reference; Environmental Phenomena.

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VI – ETHNOMATHEMATICS AND MATHEMATICAL GAMES

Language and Expressions in Ethnomathematical Research

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Language plays an important role in ethnomathematical studies. Mosimege (2013: 59-78) identified a number of methodological issues that needs to be addressed when ethnomathematical studies are undertaken. One of the methodological issues that needs to be reflected upon is language. In this respect Mosimege asks: a) How does language feature in ethnomathematical studies?, b) Is it important to share a language with the cultural group?, c) What happens if the researcher cannot speak the language of another cultural group? Does it mean that the researcher cannot continue with the research?, and d) Is it impossible for the researcher to continue with the research because of language problems? These are just a few of the issues that researchers come across and have to negotiate as they conduct ethnomathematical research, including trials in mathematics classrooms. The challenges of language are not confined to those raised above, they also relate to expressions that are used by knowledge holders as they engage in natural settings of such activities. Stathopoulou and Kalabasis (2006:232) talk about power relations that come from the use of language, not just in research conducted outside the classroom but also about the impact that they have on the understanding of learners in mathematics classrooms. They also argue that research that is not conducted in English or recorded in English is largely unseen by the international community. In the context of the argument by Stathopoulou and Kalabasis, how much do the issues of language affect interviews conducted in ethnomathematical studies and how translations from indigenous language to English and other languages affect the extent of the knowledge provided in ethnomathematical settings? This paper explores the challenges related to language and expressions in ethnomathematical research. It reflects on language and expressions that are used when research is conducted on indigenous games. Some of these expressions are indicated by

Nkopodi and Mosimege (2009). It also looks at examples of research conducted at cultural villages in South Africa, how language plays a central role in the recording and analysis of such studies. Interviews conducted with knowledge holders who exhibit knowledge of various artefacts show that the interviewees are more comfortable when they are interviewed in their indigenous language. In fact they seem to share more of their knowledge and related expressions when their language is used. This does not mean that lack of knowledge of the indigenous language of the interviewees would not be of use in such studies, but that there needs to be some form of knowledge and understanding of the indigenous language in order to maximise from such interviews and interactions.

Keywords: Language; Indigenous Games; Expressions; Ethnomathematical Research.

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Use of Games to Foster Connections between Culture and Content

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The interaction between different cultures of the world has contributed to the growth of mathematics. It is also true that much of the so-called Western mathematics "originated in the ad

hoc practices and solutions to problems developed by small groups in particular societies" (Katz, 2003, p. 557). In spite of this fact, traditionally told histories of mathematics have neglected the contributions to mathematics from the non-European cultures and have presented a Eurocentric view of mathematics (Joseph, 2000). According to the multicultural view of mathematics, mathematical ideas exist and develop in different cultures. From this perspective, a practitioner employs multiple approaches to acknowledge the role of culture in the teaching and learning of mathematics. Such a practitioner "corrects inaccuracies within mathematics, increases the universality of mathematics, and recognizes and acknowledges the existence of "other" mathematics (Uy, 2004, p. 4) in an attempt to overcome the Eurocentric bias that has prevailed over centuries of dominance. Curricular materials that "emphasize both the mathematical and sociocultural aspects of topics" play a crucial role in helping teachers achieve their goal for realizing their multicultural goals in the classroom (Croom, 1997, p. 4). Such approaches help both teachers and students gain a greater sensitivity to other cultures. In this session, I present curricular materials aimed to promote probability literacy among preservice teachers. The term "probability literacy" concerns one's ability to cope with situations that involve interpretation and generation of probabilistic situations as well as decision making (Gal, 2005, p. 44). A major implication for improving instruction in this domain is to use culturally diverse games to promote students' understanding of probability (Mccoy, Buckner & Munley, 2007; Carlton & Motlock, 2005). In this session, I present an overview of cultural games that could be used to explore probability concepts. Such games include AMPE (Ghana), IGBA-ITA (Nigeria), and Hulu (USA). The poster features two games that are part of my personal culture - Dhayakattam and Pallankuzhi (India). Session participants are invited to explore the connections between the cultural context and the mathematical content. The key goal is to promote games of chance to sustain learners' interest and motivations and also for "illustrating the place of mathematics within the students' own culture" (Greer & Mukhopadhyay, 2005, p. 317).

Keywords: Ethnomathematics; Cultural Games; India.

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VII – ETHNOMATHEMATICS AND PHILOSOPHY

Analogías Matemáticas en Elementos Filosóficos de la Cosmovisión Indígena

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Se presenta un planteamiento filosófico en el cual se vincula la etnomatemática con la cosmovisión indígena de América precolombina, dado que los indígenas precolombinos mesoamericanos desarrollaron diversas formas de conocer y de expresar y guardar los conocimientos, muy diferentes al pensamiento griego, o al pensamiento europeo de la edad media. Muchas de estas formas de comunicación aun están presentes en algunos pueblos indígenas (León Portilla, 1986). En no pocos casos, estas formas complejas de expresarse, comunicar y guardar conocimientos pasaron desapercibidas por los conquistadores europeos y fueron vistas como diseños decorativos de telas y ceramicas, o como extrañas leyendas y supersticiones. Muchas de estas formas de expresión estan profundamente ligadas al uso de telares y, por lo tanto, se expresan en modelos y conocimientos matematicos. En otros casos, el modelo matematico se expresó, luego, como una historia mítica, más facil de memorizar, pero que guarda en su interior, oculto, el modelo matematico que le dio origen (Jaén, 1996, 2006). Así, por ejemplo, los indìgenas bribrí y los cabécares de Costa Rica, ven el cielo como si fuera un rancho cónico (el Usuré), pero debajo de ese rancho, existe otro igual, solo que invertido, es decir, como reflejo especular. El Universo lo ven como la confluencia entre dos dimensiones: espejo y reflejo. En algunos casos, como en los diseños en telas, los canastos, entre otros, espejo y reflejo son dos dimensiones que se reiteran, se repiten, crean patrones. El mundo especular se vuelve plural, lleno de espejos y reflejos, que se proyectan en todas las direcciones del espacio y por qué no... del saber. Para un indìgena bribri, por ejemplo, en su mitología, cada ser humano

tiene su existencia en diversos mundos. Así, un problema central de la filosofía, como sería el *definir mi ser en el mundo*, significaría, para un bribri, *definir los diferentes seres que soy, en los diferentes mundos que habito*, de manera simultanea, o si se quiere, de manera sincrónica (García y Jaén, 2006). Una idea como esta, no solo nos remite a un espacio mítico, a un espacio filosofico, sino, al modelo matematico que subyace en su interior: un conjunto de mundos organizados de manera especular. Bribris y cabecares, son incluso capaces de determinar, con detalles, las formas en que cambian las dimensiones de un ser, cuando pasa de un mundo a otro. Lo que en el otro mundo es grande, en este mundo es pequeño, lo que en este mundo es grande, en el otro es pequeño. Lo que aquí esta de pie allá está de cabeza. Para los Bribri y cabecares, significaria que, en cada mundo, un ser humano tiene una existencia diferente: en un mundo existe como pajaro, en otro como un animal terrestre, en otro mundo son peces, más allá como arboles, como piedras y en otro mundo incluso, apenas son agua. Lo interesante es como esa concepciòn se expresa graficamente, matematicamente, en los diseños de canastos, hamacas, ceramicas entre otros. Más interesante aun es cuando vemos que, concepciones similares, se expresaron en antiguos pueblos mesoamericanos, suramericanos, como si existieran algunos patrones que se reiteran a lo largo de los siglos, de uno a otro extremo de la América Indìgena.

Palabras-clave: Etnomatemática; Cosmovisión Indígena; Mundo Precolombino.

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Potential Contribution of Language to a Pedagogical Philosophy of Ethnomathematics

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Ethnomathematics enjoys various philosophical and theoretical perspectives. The perspective of a critical theorist positions a worldview that emphasizes critique and empowerment, awakening of consciousness and awareness of social injustices, motivating group-empowerment and social transformation. A social transformation that critical ethnomathematics seeks are disempowering pedagogical philosophies. These are manifested in both traditional and reform mathematics classrooms. Ethnomathematics critiques the idea of a universal and neutral epistemology, one way of knowing that governs all thought (D'Ambrosio, 1997). Yet, some critical education theorists posit "once a fabric of relevance has been constructed, content learning naturally follows" (Kincheloe & Steinberg, 1996, p. 189). From this position, many questions emerge, not the least of which is what and whose relevance constitutes the fabric of relevance? A fabric of relevance implies a commonality. How is commonality achieved in a multicultural classroom where difference is respected? As a response, I propose an ontological and epistemological perspective for a pedagogical philosophy of ethnomathematics grounded in a universal human achievement: language. It is a distinctive cognitive, physiological, and cultural accomplishment of mind and body. Studies such as Gattegno (1973) indicate that speech involves a complex mental and physiological coordination between perceiving noises and determining how to produce them with one's articulatory system. The latter comprises an intricate synchronization of moving air from the lungs in coordination with the larynx, palate, jaw, tongue, and lips to form and concatenate vowels and consonants that expresses complex thoughts originating in the neural network of the brain. This synchronization performed so that other humans can understand. From the act of hearing and speaking, various mental powers can be identified such as to synthesize, analyze, focus and ignore, compare, extract, transform, abstract, and evoke images. These powers developed over time as children interact with their interior and exterior environments. Since children, in all cultures and linguistic groups, acquire their mother tongue, these mental powers, which evidence and develop discursively, are a cultural commonality with

which to construct a fabric of relevance. Respecting these mental powers, manifesting from language acquisition, can be the basis of a pedagogical philosophy of ethnomathematics. This philosophical approach views that mathematics develops from discursive attention to objects, relations among objects, and relations among relations. It posits that teaching ethnomathematically means to employ cultural materials, craft challenges, and ask questions that invite learners to use their mental powers to establish for themselves the nature of what they study. It distinguishes between cultural conventions and what learners can discover, giving learners the former and leaving the latter for learners to use their powers to intuit. Among mental powers tapped through this approach is learners' capacity to act purposefully and precisely, to perceive objects and relations and to formulate hypotheses, which they then test systematically. In concert with critical education theorists, rather than on content, this pedagogical philosophy of ethnomathematics focuses on learning — use of mental powers — and content learning will follow from the discursive expression of learners.

Keywords: Pedagogy; Philosophy; Language.

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Modelo para el Análisis de la Producción Científica en Etnomatemáticas

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Presentamos la segunda parte de un trabajo bibliográfico, en el que pretendemos realizar un "Estado de la cuestión o del arte" acerca de las publicaciones sobre Etnomatemáticas. La presente investigación tiene el propósito de avanzar en el estudio de las publicaciones realizadas en congresos, revistas y libros, cuyo tema se relacione con Etnomatemáticas, en un intervalo temporal y en unos contextos ampliados, respecto a los de la primera parte. Para ello se desarrolla especialmente el segundo de los dos objetivos: 1) Describir mediante algunas de las herramientas del modelo los estudios cuantitativos realizados. 2) Aplicar una metodología apropiada, para conseguir el propósito global de avance en la revisión y clasificación de producciones, y que se ajuste al objeto de estudio. Hemos utilizado el modelo MOMUME (Oliveras, 2008a, 2008b), para organizar, según diversas variables, la información recogida sobre nuevos documentos publicados recopilados, que pretende completar la compilación de la parte primera.Las conclusiones se refieren a: tipos de trabajos publicados (investigaciones teóricas, o de campo, experiencias educativas, aplicaciones de etnomatemáticas a la formación de profesores, desarrollo de fundamentos del Programa Etnomatemáticas, otros), nacionalidad de los autores, contexto de los estudios de campo, metodologías de la investigación desarrolladas por etnomatemáticas, etc.Se incluyen algunos protocolos de trabajo del modelo, con el estudio de casos de publicaciones no incluidas en la parte primera. y una síntesis global del periodo temporal abarcado entre las dos partes del estudio.

Palabras-clave: Investigación Básica; Modelos Teóricos; Campos en la Etnomatemática.

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Presentamos la primera parte de un trabajo bibliográfico, en el que pretendemos realizar un "estado de la cuestión o del arte" acerca de las publicaciones sobre Etnomatemáticas. La investigación tiene el propósito inicial de estudiar las publicaciones realizadas en congresos, revistas y libros, cuyo tema se relacione con Etnomatemáticas, en unos intervalos temporales y en unos contextos que progresivamente se irán ampliando. Para ello se definen dos objetivos: 1) Describir mediante algunas representaciones los estudios cuantitativos realizados; 2) Aplicar una metodología apropiada para conseguir el propósito inicial y que se ajuste al objeto de estudio. Una primera parte del trabajo consiste en crear diagramas y otras representaciones que visualicen

los recuentos realizados, y la segunda utilizar el modelo MOMUME (Oliveras, 2008a, 2008b), para organizar, según diversas variables, la información recogida sobre los documentos publicados.

*Palabras-clave***:** Investigación Básica; Estudio Cuantitativo; Técnicas de Presentación de Datos.

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Etnomatemática: el Vértice Matemático del Posmodernismo Poliédrico

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La pregunta clave acerca del Programa, de investigación y acción educativa y social, denominado Etnomatemática atañe a las metainterrogaciones: ¿qué es Etnomatemática? , ¿qué es Matemática?, y las posibles respuestas vienen del interior del propio programa. De las acciones y producciones de los miembros de la comunidad etnomatemática emergen modos de conceptualización, facetas de acción, metodologías de investigación, interrogantes para la reflexión, que van configurando lo que existe y perfilando lo pretendido, en una mutua integración entre lo logrado y lo que falta por alcanzar, en el futuro de la Etnomatemática. Desde mi aportación a las respuestas posibles, la Etnomatemática nos enseña la vida humana de las matemáticas. "Multimatemáticas vivas" es mi denominación de las etnomatemáticas, en plural.

Vivas en algún entorno social o personal, vivas también en el contexto científico y formal, con una de las muchas formas de vida posibles para esas indefinidas matemáticas, que nombramos pero no siempre tenemos un claro significado para su nombre. Ver el mundo y la ciencia desde una posición posmoderna nos aboca a considerar lo que existe, lo particular, lo que funciona, las experiencias y propuestas de grupos e indivíduos, buscando la explicación del cosmos más por analogías y metáforas que por definiciones, que en su pretendida generalidad no se encuentran en dicho cosmos, ni material ni abstracto. Lo que pensamos existe, pero su existencia no es compartida, siempre está mediatizada por la individualidad personal humana, el lenguaje nos comunica y sin embargo sus significados necesitan una árdua negociación. El mundo de las ideas está dentro de cada niño, de cada científico y de cada grupo social, las ideas siempre son tan concretas como lo que podemos sentir, ver, relacionar, mientras nos emocionamos ante los otros seres humanos y las manifestaciones de sus respectivos pensamientos. Especialmente los pesamientos matemáticos. Estan son algunas de las reflexiones que compartiré, apoyadas en autores relevantes, profesores, miembros del programa Etnomatemática, niños, personas de grupos culturales invisibilizados, gente. También hago un recorrido por los temas principales de los que se ocupa la Etnomatemáica en el presente y cuales son sus perspectivas de futuro, desde mi perspectiva.

Palabras-clave: Fundamentos de la Etnomatemática; Modelos Teóricos; Articulación de Marcos Teóricos.

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El Programa Etnomatemáticas y el Enfoque Ontosemiótico: Una Mirada Mutua

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La articulación de marcos teóricos es tema considerado por distintos foros de discusión como una fuente de enriquecimiento y punto de partida para avanzar el desarrollo teórico mediante la articulación de teorías. Nuestro trabajo establece una relación entre la *Etnomatemática* y el *Enfoque Ontosemiótico del conocimiento y la instrucción matemáticos (EOS)*. La Etnomatemática es un Programa de Investigación con una presencia consolidada a nivel internacional que propone una visión ampliada de la matemática y de la educación matemática. El Enfoque Ontosemiótico (EOS) es una propuesta teórica en Didáctica de la Matemática, muy difundida y valorada en la comunidad de estudiosos de la educación matemática. Una mirada recíproca de ambos marcos teóricos puede aportar un mutuo enriquecimiento. Iniciamos la comparación y posible articulación entre la Etnomatemática (D'Ambrosio, 1985; Oliveras, 1999; 2006) y el EOS (Font, Godino, & Gallardo, 2013; Godino, Batanero & Font, 2007). Mostramos que ambos marcos teóricos comparten una visión sociocultural de las matemáticas, y asumen un relativismo epistemológico de las prácticas matemáticas, sus significados, y objetos que intervienen en ellas. La Etnomatemática propone un programa de investigación sobre cuestiones de tipo epistemológico, antropológico, histórico, político y educativo. El debate esencial está en las relaciones entre las matemáticas y el contexto sociocultural, llevando a incomprensiones respecto a *las relaciones entre la matemática formal /académica y las etnomatemáticas.* Reflexionaremos sobre las relaciones entre contextos. Una educación intercultural inclusiva es

posible, rescatando elementos de las etnomatemáticas de todas las culturas y poniéndolas en interrelación, no sometiendo las unas a las otras de forma opresiva, generando un enfoque equitativo, el mutuo aprecio cultural y social, base de la paz política.

Palabras-clave: Fundamentos de la Etnomatemática; Métodos de Investigación; Articulación de Marcos Teóricos.

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