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The Program Ethnomathematics and the Challenges of Globalization

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ABSTRACT

This paper situates Ethnomathematics as a broad academic research program on the history and philosophy of mathematics, with implications for the history of science and technology, and for education. The main objective of the Program Ethnomathematics is to understand how, historically, cultural groups absorb innovation and incorporate it into their quotidian. In this paper special attention is given to the phenomenon of globalization, discussing the appropriateness of the Program Ethnomathematics in the era of globalization.

Keywords:

Ethnomathematics; Globalization

RESUMO

Este trabalho situa a Etnomatemática como uma ampla pesquisa acadêmica em história e filosofia da matemática, com implicações para a história da ciência e da tecnologia, e para a educação. O principal objetivo do Programa Etnomatemática é entender como, historicamente, grupos culturais absorvem inovação e como eles incorporam o novo no seu quotidiano. Neste trabalho, atenção especial é dada ao fenômeno da globalização, esclarecendo quão apropriada é a proposta do Programa Etnomatemática na era da globalização.

Palavras chave:

Etnomatemática; Globalização

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Introductory remarks on Ethnomathematics and a reflection on globalization

Ethnomathematics is gaining visibility worldwide. Since the first presentation of its basic ideas in the opening plenary lecture of the 5th International Congress of Mathematics Education in 1984 in Adelaide, Australia, Ethnomathematics has experienced an impressive growth in several countries, particularly in the education field. National and international congresses on ethnomathematics are regularly organized. Ethnomathematics has been presented to mathematicians as a research program in the history and philosophy of mathematics, with pedagogical implications.[1]

Although the word "ethnomathematics" suggests a form of mathematics, the Program Ethnomathematics is much broader than this. It deals with the concepts of reality and action, of space and time, and the ways of comparing, classifying, explaining, generalizing, inferring and, as part of every action, quantifying, measuring and evaluating, which are the bases upon which all forms of knowledge, including the ethnosciences and the ethnotechnologies, are founded.

It is an apparent paradox to raise the issue of ethnomathematics in the eve of a planetary civilization, relying on academic science and mathematics. I see all this as most favorable for the strengthening of the Program Ethnomathematics. Indeed, the intense cultural dynamics caused by globalization will produce a new thinking. Paraphrasing a popular lemma of the early 70's, I would say the new thinking will be characterized by "think locally, act globally". I will argue my point.

There are conflicting hypotheses on the origin of human species. It is largely accepted that about 50,000 years ago there was a global occupation of the planet. Cultures emerged, there were encounters and conquests. In 1492, we can see an unprecedented process of globalization, which attained planetary dimension, due to a new kind of conquest, followed by colonization. This is the beginning of the era globalization.

A second stage in this process resulted from the Industrial Revolution, with new modes of labor, production and transportation, with steam engines allowing for safer and faster navigation, railways crossing countries, and a new form of distance communication, from the telegraph, telephone, radio and television to digital media. All this required gross amounts of capital and the creation of large multinational complexes, mostly originated in or shifted to the United States of America. This was complemented by a growing cultural dominance of the United States, through Hollywood, jazz, Coca-Cola and McDonald's, creating a perspective of homogenization. The fall of the Berlin Wall and the disruption of the Soviet Union represented the apogee of this scenario. All this was possible, to a large extent, by the power of the new technologies of information and communication. Internet resulted.

There is a popular Spanish saying, "Cría cuervos y te sacarán los ojos". This expresses the fact that new intellectual and material instruments are crucial for criticism and renovation

[1] Ubiratan D'Ambrosio, "Ethnomathematics: A Research Program on the History and Pedagogy of Mathematics with Pedagogical Implications", *Notices of the American Mathematical Society* 39 (10, 1992): 1183-1185.

of the parent ideas. This fact is specially seen when rearing new generations and in the evolution of ideas, which is amply supported particularly by the history of science.

The widespread untamable presence of Internet is a very good example of this fact. The powerful instruments developed by the new technologies of information and communication in the transition from the 20th to the 21st century work against the homogenization scenario. The decrease in the predominant role of the United States is undeniable. This is essentially due to the fact that the individual is now empowered to act globally in its local environment. Thus, we may invoke a notion of local vitality, which releases an unexpected and astonishing cultural power, reinforced by the advantage supplied by the continual full participation in the community, simultaneous with the action in the global world. This globalization of the local has been applied to production system and industrial developments.[2] Regrettably also for military purposes. The attacks to the United States on September 11th, 2001, were a typical locally action with global effect.

It cannot be denied that this will have important reflections on culture. For example, the thriving cultural industries offer flexible employment conditions in community contexts and allow for innovative economic strategies adopted by Indigenous peoples. In order to achieve this, it is important the maintenance of traditional ceremonies, language and customary practices. But, according to David Maybury-Lewis,

> "People do not cling to their cultures simply to use them as interethnic strategies. They do so because it is through them that they make sense of the world and have a sense of themselves. We know that when people are forced to give up their culture, or when they give it up too rapidly, the consequences are normally social breakdown accompanied by personal disorientation and despair. The attachment of people to their culture corresponds, then, to a fundamental human need."[3]

Cultural industries have created and allowed new respect and economic possibilities for Indigenous peoples, which in turn has stimulated movements towards greater self-reliance. Although cultural industries have links in distant world cities, possibly more than in virtually any other context, they are the expressions of communities that have long been grounded in particular places. It is naïve to restrict these reflections to localities. From local sources, new ideas will fast spread globally.

The concept of ethnomathematics

The history of science has largely been a narrative of the triumph of Western science, reinforced by the successful conquest and colonization of the world by European empire, since the end of the 15th century.

Every culture is subject to inter and intra-cultural encounters. Rearing and conquering are common facets of these encounters. It is a truism that, as a result of the

[2] See the interesting paper by Abhijit V. Banerjee, "Notes Towards a Theory of Industrialization in the Developing World", in, *Development, Displacement and Disparity: India in the Last Quarter of the Twentieth Century*, ed. N. Banerjee & S.Marjit (New Delhi: Orient Longman, 2005).
[3] David Maybury-Lewis, "Foreword", in *Cultural Expression and Grassroots Development: Cases from Latin America and the Caribbean*, ed. C.D. Kleymeyer (Boulder&London: Lynne Rienner, 1994), xiv.

encounters, no culture is static and definitive. In this paper, I will refer to the encounters resulting only from conquest and colonization.

History tells us that in every process of conquest, cooptation has been an efficient strategy. But there have always been groups who resisted, in all kinds of ways, violent and non-violent, to the disruption of their culture. It is intrinsic to conquest the encounters of individuals, and the results of these encounters affect, in the long range, both the conquered and the conqueror, hence the emergence of a new culture, which is a hybrid, a mix of the old and the new. Groups are consequently affected. In the case of science, this represents a link between traditions and modernity. This characterizes cultural dynamics.

An important issue is to understand how mathematics permeates the founding myths of Western civilization, and this links to research on the history of the monotheistic religions (Judaism, Christianity, Islamism), of techniques, of arts and human behavior in general.

A great support is gained by looking into non-Western civilizations. Research in ethnomathematics is based on interpreting established forms of knowledge (communications, languages, religions, arts, techniques, sciences, mathematics) in different cultural environments, in the framework of a theory of knowledge and behavior which I call the "cycle of knowledge". This is based on an integrated study of the generation, intellectual and social organization, and diffusion of knowledge.

Some definitions are needed. A group of individuals is identified as a cultural group if it reveals shared knowledge and compatible behavior, both subordinated to a set of values. A system of shared knowledge, compatible behavior and a set of values is called culture. A cultural environment refers to groups which share small variations in knowledge, behavior and values.

The cycle of knowledge is affected by the cultural dynamics of the encounters of different cultural environments, based on what I call the "basin metaphor". The cycle of knowledge and the basin metaphor are complementary in explaining human behavior and knowledge.[4] The Program Ethnomathematics is based on this theoretical background.

An etymological construction better explains the meaning of ethnomathematics. It is a construct using the roots *ethno* (meaning the natural, social, cultural and imaginary environment) + *mathema* (meaning explaining, learning, knowing, coping with) + *tics* (a simplified form of *techné*, meaning modes, styles, arts and techniques). Breaking the word would allow for saying that ethnomathematics is a theoretical reflection on the *tics* of *mathema* in distinct *ethnos*.[5]

This etymological trick caused much criticism, because it does not reflect the etymology of academic mathematics. Indeed, the *mathema* root in the word ethnomathematics has not much to do with "mathematics", which is a neologism introduced in the 15th century. Although etymologically it means something learned, the source is the Greek *manthánein*, to learn, which came from an Indo-European root meaning think (which gave memory and mind). In Greek, it gave *máthëma* which gave *mathëmatikós*

[4] A synthesis of this theoretical proposal can be found in Ubiratan D'Ambrosio, "A Historiographical Proposal for non-Western Mathematics.", in *Mathematics Across Cultures: The History of Non-Western Mathematics*, ed. H. Selin (Dordrecht: Kluwer Academic Publishers, 2000), 79-92.

[5] For a detailed explanation, see Ubiratan D'Ambrosio, *Ethnomathematics: Link between Traditions and Modernity* (Rotterdam/Taipei: Sense Publishers, 2006)

and in Latin *mathëmaticus*, which gave in French *mathematique* and in English *mathematic*. These notions were associated with numbers and counting, hence with arithmetic, and with geometric reasoning, hence with astronomy and physics.

It is also important to clarify that the concept of ethnomathematics should not be confused with ethnic-mathematics, as it is misunderstood by many. This is the reason why I insist in using the terminology Program Ethnomathematics. The word "program", maybe inspired by Lakatos, suggests research to explain mathematics, as well as religion, culinary, dressing, sports and every other practical and abstract manifestation of the human species. Of course, the Program Ethnomathematics was, initially, inspired by recognizing ideas and ways of doing that reminds us of Western mathematics. I say "reminds" because what we call mathematics in the academia is a Western construct.

Although dealing with space, time, classifying, comparing, which are proper to the human species, the codes and techniques to express the reflections on these behaviors and to communicate them is undeniably contextual.

I had an insight into this general approach while visiting other cultural environments, during my work in Africa, in practically all the countries of continental America and the Caribbean, and in some European environments. Later, I tried to understand the situation in Asia and Oceania, although without field work. Thus, we can understand the proximity of ethnomathematics and cultural anthropology.[6]

All this links to the historical and epistemological dimensions of the Program Ethnomathematics, which can bring new light into our understanding of how mathematical ideas came into being and how they evolved into a corpus of knowledge known as Western (or academic) mathematics, and how it spread all over the world. Indeed, this is the history of Western mathematics from its earliest generation and organization as a corpus of knowledge, in the Mediterranean basin, its expansion to Europe and later, in the era of the great navigations, to the entire world. It is fundamental to recognize the contributions, in this process, of other cultures and the importance of the dynamics of cultural encounters. Culture is understood in its widest form, which includes art, history, languages, literature, medicine, music, philosophy, religion and science. Research in ethnomathematics is, necessarily, transcultural and transdisciplinarian.

Research in ethnomathematics

The encounters are examined in various ways, thus permitting the exploration of more indirect interactions and influences, and the examination of subjects on a comparative basis. Although academic mathematics developed in the Mediterranean Basin, expanded to Northern Europe and later to other parts of the world, it is difficult to deny that the codes and techniques to express and communicate the reflections on space, time, classifying, comparing, which are proper to the human species, are contextual. Among these codes are measuring, quantifying, inferring and the emergence of abstract thinking.
Of course, for this kind of research it is necessary to work with different cultural environments and, acting as ethnographers, to describe mathematical ideas and practices of

[6] Curiously, my first book on Ethnomathematics, *Etnomatemática: Arte ou Técnica de Explicar e Entender* (São Paulo: Editora Ática, 1990) was placed by the publishers in a collection on anthropology

other peoples. Although this is basic, absolutely necessary, for research in ethnomathematics, much more is needed. It is fundamental to give meaning to these findings. When we refer to different cultural environments, we are talking not only of indigenous populations, but also of labor, professional and artisan groups, urban and periphery communities, farms. These groups develop their own practices and methods, have their specific language and jargons, and theorize on their ideas.

As part of the colonial strategy of not recognizing structured knowledge of the conquered, particularly in science, technology and mathematics, mathematical ideas of the peoples of different regions of the world have been disregarded. Part of this strategy is the belief, still predominant, that Western mathematics is the privileged manifestation of the rationality of the human species, hence universal and culture-free. The emergence of ethnomathematics, as a research field, is the result of the recognition that every cultural group develops, as a result of its rationality, its own ways and styles of explaining, understanding and coping with their environment.

Science, technology and mathematics are responses to the environment, to myths and to cultural encounters. I will not dare to define each one of these systems of knowledge, but it is obvious that the three are mutually interdependent and cannot be separated. They have a symbiotic relationship. In my discourse, there may be more frequent references to mathematics, but this reflects the perception that Modern science and technology rely on mathematics. Sometimes, for convenience of writing, I refer only to one of them, science, mathematics or technology. But the reflections and discussions imply also the other two. The more frequent references to mathematics is seen in the adoption of the neologism "*ethno+mathema+tics*", instead of its equivalents, ethnoscience and ethnotechnology.

As I said above, transdisciplinarity is a characteristic of the Program Ethnomathematics. Repeating, ethnomathematics is a research program which focuses on the ways, the styles, the arts, the techniques, generated by identifiable cultural groups to explain, to understand and to cope with their environment, particularly in the development of methods of comparing, classifying, quantifying, measuring, explaining, generalizing, inferring, and, in some way, evaluating. As I observed above, these methods depend on conceptions of space and time, which are contextualized and culturally bound.

As a part of the decolonizing program, which intensified in the second half of last century, there was a recognition that there were non-Western forms of knowledge, a response to the pulsions of survival and transcendence among Indigenous peoples. Nations which were labeled as non-structured, politically unstable, economically undeveloped, and technologically backward, which even lacked a recognized salaried work force and an identifiable class structure, have been accepted in the United Nations as independent nations, with seat and voice. This resulted in a new geopolitics, and is usually referred to as the phenomenon of globalization of the world, discussed in the beginning of this paper.

Technology has a fundamental role in globalization. Indeed, technology shapes and is shaped by globalization. But, much before this model of globalization, diverse societies of the world have engaged in encounters and a complex sharing of interests and influences. Technology has always been central in the process of encounters, with direct influence in the distribution of power, determining either the prevalence or the sharing of power. In the historical and epistemological strand, the Program Ethnomathematics investigates the ways

science, technology and mathematics interact with, affect and are affected by societies. The political strand of the Program Ethnomathematics reflects the recognition that the presence of technology in different cultural groups leads, naturally, to questions about the future of these groups. Politics is, in essence, social action, obviously in the present, aiming at a social ideal in the future.

In recent decades there is a growing feeling that there must be a recognition and revitalization of knowledge systems which back different societal structures, but that have been hitherto disregarded, disclaimed and even repressed. Different societal structures have been studied by anthropologists. Although anthropology has a long history, in recent decades it acquired a broader meaning. This affected particularly mathematics, but, regrettably, anthropology, even cultural anthropology, very rarely appears as a matter of interest for mathematicians. There was a belief that anthropology was not important for a purely intellectual construct, such as mathematics. Only recently other systems of knowledge and cultural forms, including those involving mathematical ideas and results, and even different educational systems, are deserving academic recognition and interest.
Basically, investigations in ethnomathematics are based on three questions: 1. How are *ad hoc* practices and solution of problems developed into methods?; 2. How are methods developed into theories?; 3. How are theories developed into scientific invention?

To understand how societies generate and absorb innovation in the course of their history is a major challenge. It is important to understand the way material and intellectual innovation permeates the thinking, the myths and the ways of knowing and doing of a community. The basic ideas are part of the sacred books, of buildings and ceremonies, and of the classics.

For example, in Timaeus 47a, Plato says: "The sight of day and night, and the months and the revolution of the years have created number and have given us a conception of time, and the power of inquiring about the nature of the universe."[7] Indigenous science, technology and mathematics have, all over the world, similar explanations. As an example, to construct canoes, essential to the life of peoples in the Pacific Islands, the sky god *Supwunumen* sent to them a heavenly constructed canoe to teach the art of knots divination to a few selected men in the Caroline Islands.[8] Similarly, the heavenly bodies provided the Greeks with the signs allowing them divination and the counting of days.

The way new ideas are diffused and vulgarized, understanding vulgarize as making abstruse theories and artifacts easier to understand in a popular way, is a major challenge in understanding the evolution of ideas, particularly in the history of science.

It is also important to recognize the special role of technology to the human species and the implications of this for science and mathematics. The history of science and, of course, of mathematics, privileges "knowing" over "doing". There is a tendency to understand the role of technology as a consequence of science. But it is difficulty to deny that technology has been an essential element for furthering scientific ideas and theories.

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[7] Plato. *The Complete Dialogues*, ed. E. Hamilton & H. Cairns (New York: Bollingen Foundation, 1966), 1174.
[8] See Nicholas J. Goetzfridt, *Pacific Ethnomathematics: A Bibliographic Study of Mathematical and Environmental Space and Time Concepts of Indigenous Pacific Peoples* (forthcoming).

This is particularly noticeable in the late Middle Ages, when perspective and architecture provided the bases for the emergence of a new geometry in the 16th and 17th centuries. But also in the encounter of Greek and Roman civilizations, we recognize Archimedes predominantly as an engineer. A major advantage of Rome over Greece is illustrated by the tale of the killing of Archimedes by a Roman soldier. The reverse would have never occurred. A Greek soldier would have not killed an intellectual in the name of hierarchy.

In spite of this fundamental difference, Romans recognized and respected Greek culture. Even Greek language had a privileged position among Roman intellectuals. But the priority of the matters of State favoured technology, although science and mathematics were well known. This is clear when we read Vitruvius.

The historical dimension of the Program Ethnomathematics restores the importance of technology in the history of science. This allows to better understand the emergence of new scientific ideas as a result of the encounters. In the cultural dynamics of the encounters, the mutual exposure of technologies precedes the encounter of scientific ideas. This is particularly interesting in the emergence of a new health science as the result of the technology of cure, observed in the Crusades and by early navigators, particularly Duarte Pacheco Pereira and Garcia da Orta.[9] The same is true in the colonial era.

We have to look into the cultural dynamics of the encounter of peoples as a way of life. Encounters are characterized by trust and mistrust, dominance and cooptation, sharing and prevalence, which dominate the relations among peoples. A great challenge is to understand the way these categories of behaviour interact in building up knowledge.

It is also central to understand how peoples deal with space and time. Chronology and topology are dominating categories for the explanation of facts and phenomena. These categories become intimately related to the founding myths of every civilization. Let me clarify, at this moment, my understanding of civilization.

I will not attempt to define civilization. The word is relatively new. Building up on ideas mainly of Alfred Weber, Oswald Spengler and Arnold Toynbee, in lieu of a definition, I recognize what is generally meant by this term. It is related to some shared features of different cultures, such as aesthetic and intellectual achievements in architecture, painting, literature, sculpture, music, philosophy, and science and ways of establishing control over its human and physical environment.

These cultures have similar esteem and encouragement of higher mental activities and concepts of human life. Foremost among those concepts are the founding myths and the cosmovision, and, consequently, religious systems, which respond for explanations about the past and expectations about the future. Daily life is subordinated to these explanations and expectations. Commonalities of these features among a number of cultures sprang out of the geographical environment. This is supported by an overview of the evolution of the species and of different cultural systems.

This kind of commonality is illustrated when we study peoples whose behaviour is intimately related to the sea and to navigation. For example, in Maori language, *waa* means period of time, time, interval, season, space, region.[10]

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[9] Duarte Pacheco Pereira (1465-1533), *Esmeraldo de situ orbis* (1506-1508); Garcia de Orta (ca.1490-1568), *Colóquios dos simples e drogas e coisas medicinais da Índia*.

[10] Bruce Biggs, *English-Maori and Maori-English Dictionary* (Auckland: Auckland University Press, 2004).

In the traditions originated in the Mediterranean basin, it is typical the sacralization of chronology and of topology. In the *Book of the Genesis*, we have the "exact" geographical location of Eden. And in Greek Antiquity, the geography of Ptolomy gives the "exact" location of known cities. This is characteristic of the Mediterranean tradition and has much to do with the model of power structure which was common in the region.

This model prevails. Time and space are integrated in Western languages and in the quotidian, in philosophy and very much in the sciences. From this, distinct systems of knowledge emerged, such as mapping, geography, measurement, geometry, motion, physics and other areas. Conceptions of space are present in the organization of communities and urbanization.

This is greatly aided by looking into fiction (from iconography to written fiction, music and cinema). It is important to understand how material and intellectual innovation permeates the thinking and the myths, and the ways of knowing and doing of the non-initiated people. In a sense, how new ideas vulgarize, understanding vulgarize as making abstruse theories and artefacts easier to understand in a popular way.

In guise of conclusion

The main issues affecting society nowadays, such as national security, personal security, economics, social and environmental disruption, relations among nations, resources, and many others can be synthesized as peace in its several dimensions: inner peace, social peace, environmental peace and military peace. These four dimensions are intimately related and are profoundly affected by science, technology and mathematics. The attainment of peace in all these dimensions is the result of a general ethics, present in our quotidian and depending on cultural dignity.

A major objective of the Program Ethnomathematics is to restore cultural dignity to every individual and to families, urban or rural communities, larger socio-cultural groups sharing language and jargon, beliefs, knowledge, values. With this objective, the Program Ethnomathematics aims at understanding how, historically, societies absorb innovation, how do they incorporate the new into their quotidian.

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