An Ethnomathematics View of Space Occupation and Urban Culture*

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Abstract:
In this talk I will not elaborate on the beautiful and important mathematical analyses of artifacts from different cultures. There is an abundant literature on this.

Instead, I will point to another strand of Ethnomathematics. The effects of globalization and capistalist greed on the State of the World and the unplanned growth of cities and demographic dynamics asks for a new mathematics. I will suggest how the Program Ethnomathematics may contribute to the emerging new mathematics.

Introduction

The ISGEm/International Study Group of Ethnomathematics has completed 25 years and we have convened four international congresses.

The advances in ethnomathematics are shown in the amazing amount of publications and the rich program of this meeting reflects these advances. Many books are produced, journals and sites have been created as well as events organized all over the World.

Ethnomathematics is a rich research area. Its importance for Education in general is unquestionable. It is remarkably transdisciplinarian and transcultural. It relies on research in various disciplines, particularly anthropology, ethnography, cultural studies, cognitive sciences, history and social dynamics.

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We are fascinated with the beauty and with the recognition and analyses of mathematical ideas present in professional and everyday practices, in folklore, in artisanship, in dressing, tapestry and basketry, in games, music and dance, and even in cults of native, both in cultures situated in the periphery of the most developed centers, but also in the dominant cultures. This is fascinating. The books by Claudia Zaslavsky, Marcia and Robert Ascher,

Paulus Gerdes and some others are classical references about the recognition and theoretical discussions of mathematical ideas present in artifacts from different cultures. The increasing interest in the mathematical study of cultural artifacts results in various dissertations, publications, journals and sites. There is much research that do not get published and is not known to most researchers. In the pictures that follow, I give some examples of excellent research being conducted in various parts of the World.
Symmetry in a Bororo pariko
(thanks to Wanderleya Nara)

Symmetry in Artisanship (Belém, Pará)
All three themes are subjects of relevant research. But in this talk I will not comment on these beautiful advances of Ethnomathematics. Instead, I will reflect on the way I see the relation of Ethnomathematics with society as a whole and with the State of the World.

The State of the World

I quote a recent interview (2010) of the mathematician Mikhail L. Gromov (1943-), of the *Institute des Hautes Études Scientifiques* de Bûres-sur-Yvette, France, who was awarded the Abel Prize 2009, for his revolutionary contributions to Geometry:
“Earth will run out of the basic resources, and we cannot predict what will happen after that. We will run out of water, air, soil, rare metals, not to mention oil. Everything will essentially come to an end within fifty years. What will happen after that? I am scared. It may be okay if we find solutions, but, if we don’t, then everything may come to an end very quickly! Mathematics may help to solve the problem, but if we are not successful, there will not be any mathematics left, I am afraid!”

Mikhail Gromov, 2010

Even more frightening than the exhaustion of resources tomorrow is the destruction we are witnessing every day.

Again, in the words of Gromov:

“Being inside our ivory tower, what can we say? We are inside this ivory tower, and we are very comfortable there. But we cannot really say much because we don’t see the world as well enough either. We have to go out, but that is not so easy.”

We are risking creating an Ivory Tower for Ethnomathematics, fascinated by its beauty and meaning in different cultures, while we give less attention to what should be our main concern: THE SURVIVAL OF CIVILIZATION ON EARTH WITH DIGNITY FOR ALL.

Mathematics has been the decisive intellectual instrument for weaponry, for an unrestrained form of capitalism and for strategies of domination. It has been used for greed, aggression, destruction and killing.

We must look for mathematics that leads to an ethics of respect, solidarity and cooperation. This is the main concern of the Center for Global Nonkilling. The volume on Towards a Nonkilling Paradigm, has a chapter on “Nonkilling Mathematics”.

1  http://www.nonkilling.org
2  http://www.nonkilling.org/pdf/volume_toward.pdf
According to Gromov, we have to go out of the Ivory Tower and to reach other academic fields, as well as to open dialogue with “the first man whom you meet on the street”, quoting the phrase of David Hilbert in his anthological conference at the International Congresso of Mathematicians, held in Paris in 1900.

I see the Program Ethnomathematics as a response to the appeal of Gromov and to the suggestion of Hilbert.

Although you may be tired of listening to my conception of ethnomathematics, I dare to repeat it:

The Program Ethnomathematics is an analysis of the *tics* (techné, arts and techniques) of *mathema* (explaining, understanding, dealing with) in different *ethnos* (natural and socio-cultural environments).

The Program Ethnomathematics is a Research program in the History and Philosophy of Mathematics and its pedagogical implications, focused on how and why the human species

- generates,
- organizes,
- transmits and diffuses knowledge, particularly Mathematics.

The research methodology of the Program Ethnomathematics is based in three steps:

- how do *ad hoc* practices and solutions to deal with situations and problems develop into methods?
- how do methods develop into theories?
- how do theories result in innovation?

The three steps

\[ ad \text{ hoc} \rightarrow \text{methods} \rightarrow \text{theories} \rightarrow \text{innovation} \]

synthesize the research program.
We have to draw from recent scientific advances for relevant research in Ethnomathematics:

- from Jean Piaget, Lev Vigotsky, Alison Gopnik\(^3\) and others, we learn to observe and listen to children;
- from neuroscience we learn to monitor synapses;
- from history we learn the dynamics of cultural encounters.

But we also rely on mathematical ideas recognized in oral and written narratives, some forgotten, lost or repressed and others implicit, sometimes unnoticed, in academic sources, in folk tales and artifacts, as the examples given above, in mythologies and in fiction and, of major importance, in the **concepts of time and of space occupation** and urban planning.

In this talk I reflect on space occupation and on urban culture.

**The Ethnomathematics of Urban Space**

Occupation of land has been, and continues to be, a major characteristic of cultures. Towns and urban design are arranged focusing religious and political hierarchy and play a fundamental role in society.

Since early dwelling through nowadays, the mutual influence of urbanization and mathematics is evident. Both *polis* and *urbs* reflect power structure and political organization.

The Greek *polis* and the Roman *urbs* are concepts of citizenship, as seen by contemporaneous chroniclers, not as a sort of fortresses, as seen by some later observers.

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\(^3\) Her book on *The Philosophical Baby* is a master-piece on children observation.
The classic book *De Architectura*, by Vitruvius (1st century BCE), is about urban planning and reveal concepts of time and space, as well as the power structure in the Roman Empire.

The way in which urban centers are understood, planned and described throughout history reveal the supporting science and technology, particularly mathematics, of the period.

Urbanization reflects the organization of space and time, Particularly giving sacred attributes to space and time. Descartes comments on urbanization:

““The old cities, which were at their beginnings nothing but small towns, and have become in time large cities, are generally not well designed as by compass, at the cost of the regularity of their squares that an engineer traced following his fantasy on the plane”

Such remarks can be very well illustrated by design of cities from different periods of civilization, with characteristics that reflect the religious, the social and the political circumstances.

Jerusalem, 7th century

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4 R. Descartes, Le Discours de la Méthode,1637, p.83.
Dogon Village, Mali

Gao, Mali
Brescia, 6th century

North Carolina, 16th century
Machu Pichu, 15th century

Collège de la Flèche, 17th century

The Collège de la Flèche is the school where Descartes studied, spending there his youth. This may be a source for inspiring the coordinate methods of Descartes:

“The grounds and buildings of the Collège de la Flèche [where René Descartes studied], perfectly symmetrical and square in their design, seemed constructed as if by straightedge and compass. Descartes’ writings later in his life … make it clear that he was impressed by symmetry and straight lines in the design of buildings and towns.”

The Ethnomathematics of the Urban Scenario today?

A few pictures, from São Paulo, from the USA, from India and from China are alarming.

"The geometrically planned and surveyed town, with rectangular blocks of houses and regular streets at right angles, was an intellectual concept, rather than any natural evolution of the primitive village, and as such it tended to disregard environmental limitations and the unsystematic accretions of social communities."

Earl B. Smith, 1938

This leads us to observe the reality of unplanned growth and how this affects children perception of space. The concept of urban planning is not part of any mathematics curriculum, although the perception of what is the urban reality is part of children imagination and concern.
The important research of Sonia Maria Clareto, in Laranjal do Jari, Brazil, illustrates the subordination of common sense in urban planning to economic interests.

Laranjal do Jari       Main Street

How did this urban reality emerge? The community of Laranjal do Jari was founded in 1967. It is located in the State of Amapá, in the rain forest, in the margins of the River Jari. It was legally established as a city in 1987 and today has a population estimated at 50,000 inhabitants.

The community was founded in 1967, as a village to house workers of an enormous industrial complex. The workers built their houses over the River Jari.

The industrial complex was part of the ambitious project of the billionaire Daniel Ludwig (1897-1992), established in 1967, with the agreement of the Brazilian Military Government, then in power, to build what would be the largest paper mill in the World. The area, in the Amazonian rain forest, was equivalent to the State of Connecticut. The Project became known as Project Jari. It was a project similar to the project of the fictitious RDA Corporation to explore a mineral resources of Pandora (Avatar, the movie).

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As a result of unplanned urban and family growth, a large sector of the population are children that live in the “streets”.

The exemplary research of Clareto was to understand children perception of space and of geometry in this urban environment. This is an urban map designed by a child:

We can guess that something similar to Aczel’s observation, about the possible inspiration of Descartes to the coordinate system, may affect the future of these children. Their perception of space is unique.

A basic question is: How do these children build their perception of space in such an environment? How do these children, with no or only minimal schooling, generate the mathematical strategies for survival in that environment?

We may pose the same question about children living in a modern urban environment, like São Paulo. The city was founded by Jesuit missionaries in 1554. It is now the largest metropolis of the Southern Hemisphere, and the most important financial,
As a result of unplanned urban and family growth, children are a large sector of the population. Many live in the streets, in miserable conditions, subject to criminality, drug dealing and drug addiction. The following is not an uncommon scene:
The question we pose is not different than the one posed by Sonia Maria Clareto in her thesis. How do these children, with no or only minimal schooling, generate the mathematical strategies for their survival in the streets? How do they socialize these strategies? How do they deal with time and space, with quantifying and measuring, with money?

In other words, what is the ethnomathematics of street children in São Paulo?

Mônica Maria Borges Mesquita did extensive research on the life of street children in São Paulo, which became part of her doctoral thesis, entitled *Children, Space, and the*
Urban Street: An Ethnomathematics Posture, submitted, in 2008, to the Faculty of Science and Technology of the Universidade Nova de Lisboa.7

Besides Clareto and Mesquita, I mention also a forthcoming book by Joselita Macedo Filha, Dances with Wolves – The street of street children, which is the result of her dissertation, in which she establishes a methodological dialogue with the movie Dances with Wolves (Kevin Kostner, 1990). She applies ethnomathematics as a research methodology to analyze the behavior and knowledge of street children and adults living “permanently” in a public plaza, in the city of Salvador, Bahia, which was founded 1549 and has now a population of about 3,000,000 inhabitants.

Another strand for ethnomathematics of the urban scenario results from immigration. Legal or illegal, immigrant population is a fact and immigrant children are a reality in the school systems all over the World.

The immigrant population asks perspectives of Education for their children, particularly in Mathematics Education, since Mathematics is perceived as the door to social access, as a key instrument for citizenship. This leads, naturally, to reflections about the knowledge associated with the cultural roots of the immigrants, hence about their ethnomathematics.

There is much research on the theme of the ethnomathematics of immigrant populations. I mention only three, with which I am more familiar:

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Cláudio Cadeia research deals with the ethnomathematics of a gipsy community in Portugal, focusing on their capacity for mental calculation. His dissertation was submitted to the Universidade do Minho, 2006.

Stathopoulou Xara (Charoula) researched the ethnomathematics of Romany gipsy children in Greece. Her doctoral dissertation was published as a book, in Greek, in 2008.

Milton Rosa’s ten years work with classes of immigrants at Encina High School, in Sacramento CA, was the basis of his doctoral thesis at California State University Sacramento 2010.

**Perspectives for the future.**

The world is incessantly transformed by the revolution in information and communication. The World Wide Web establishes an entirely new appropriation of time and space and new human connections. The network society raises new issues, problems and possibilities for the economic, cultural and political world scenario. Indeed, networking characterizes a new civilization.

Individuals today acquire, virtually, new social, political and cultural habits of mind and ways of being. Traditions are challenged by new world-wide perspectives. People save, spend and optimize time in a different way. Design and implementation are no longer spatially and temporally fixed.

The concepts of time and space, which I mentioned as essential in the beginning of this paper, are changing rapidly. Traditional ways of dealing with time, which evolved thanks to the development of the clock, are changing rapidly. Traditional ways of communicating location is changing. The @-addresses compete with postal addresses.
Time, which refers to when, and space, which refers to where, acquire new meanings.

We all know that time and space are the essential components of mathematics. Hence, new concepts of space and time, which are the imprint of the new civilization, imply a new mathematics.

Globalization acquires a new meaning, since it instantly overcomes boundaries and language barriers. The new mathematics must respond to the new meaning of globalization and will, necessarily, be transdisciplinary and transcultural. Ethnomathematics may be the response.