13th International Congress on Mathematical Education
Hamburg, 24-31 July 2016

ETHNOMATHEMATICS AND ITS PEDAGOGICAL ACTION

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Ethnomathematics school practices favor respect for, solidarity and cooperation with the other. It is thus associated with the pursuit of PEACE. The main goal of ethnomathematics is building up a civilization free of truculence, of arrogance, of intolerance, discrimination, inequity, bigotry, and hatred. These are basic questions that define philosophical and ideological postures. These postures are in the roots of a holistic theory of knowledge, looking into the generation, the individual and social organization, and the institutionalization, transmission and diffusion of knowledge, as studied in the Ethnomathematics Program. My concept of ethnomathematics is primeval: recognizing, in every corner of the planet, the different emergence of perceptions of space and time and the techniques of observing, comparing, classifying, ordering, measuring, quantifying and inferring and, as consequently, different styles of abstract thinking.

INTRODUCTION

I am frequently asked: *Is ethnomathematics a theory or a practice?* I reply with another question: *Is there a practice without a theory supporting it? Is it justifiable to have a theory without a practice?* In this paper, I will discuss that it is false to consider the dichotomy between theory and practice.

The main reasons to bring ethnomathematics to schools are to:

1. Demystify school mathematics as a final, permanent, absolute, unique form of knowledge. There is a current misperception in societies, very damaging, that those who perform well in mathematics are more intelligent, indeed *superior* in relation to others. This erroneous impression given by traditional forms of teaching is easily extrapolated to religious, ideological, political, and racial creeds.
2. Illustrate intellectual achievement of various civilizations, cultures, peoples, professions, and genders. Western mathematics is absolutely integrated with conquest and colonialism that came to dominate the entire world. The acceptance, forced or voluntary, of western mathematics and western knowledge in general leads to the acceptance of behavior and values, of ideas like *the winner is the best, the losers are to be discarded*. More than any other form of knowledge, mathematics is identified with the winners. This is true in history, in professions, in everyday life, in families, and in schools. The only possibility of building up a planetary civilization depends on restoring the dignity of the losers and both winners and losers, moving together into the new. This requires respect for each other. Otherwise, the

> losers will direct their efforts to become winners and the winners will do the best to protect themselves from the losers, thus generating confrontation.

School ethnomathematics practices encourage respect, solidarity and cooperation with the other. It is thus associated with the pursuit of PEACE. The main goal of ethnomathematics ist o support the building up of a civilization free of truculence, of arrogance, of intolerance, discrimination, inequity, bigotry, and hatred.

These are basic questions that define philosophical and ideological postures. These postures are found in the roots of a holistic theory of knowledge, looking into the generation, the individual and social organization, and the institutionalization, transmission and diffusion of knowledge, as studied in the Ethnomathematics Program (D'Ambrosio 2015). Repeating what is written in many of my papers, my concept of ethnomathematics is primeval. It recognizes, in every corner of the planet, the different emergence of perceptions of space and time and the techniques of observing, comparing, classifying, ordering, measuring, quantifying and inferring and, as consequently, different styles of abstract thinking.

In each corner of the planet and at every time, individuals have developed strategies to satisfy the pulsions of survival and transcendence. These strategies are synthesized in three words: the *techné* ≈ *tics* [*ie*, the ways, modes and styles, the arts and techniques] that people developed for *mathemá* [*ie*, for explaining, learning and understanding, knowing and coping with] their *ethno* [*ie*, their natural facts and phenomena and the social, cultural, mythical and imaginary environment]. This etymological exercise lead me to construct the concept of *tics* of *mathema* in distinct *ethnos*, or *ethno* + *mathema* + *tics*, hence, by rearranging the words, ethnomathematics.

There is no contradiction with this concept of ethnomathematics and the universally accepted concept of academic or scholarly mathematics. Indeed, a very synthetic view of ancient cultural history show that the universally accepted concept called western mathematics, is an elaboration of the specific way of that peoples of the *ethno* of the Mediterranean basin organized their *tics* of *mathemá* in that region, hence their own ethnomathematics. Since there were many civilizations in this broad region, they had many contacts and cultural encounters and their ethnomathematics, as every one, went through reformulations.

We recall the encounters of civilizations around the Mediterranean, mainly those of Ancient Iraq, of Egypt, of Israel, of Greece, of Persia, of Rome, and many others. They were close enough to have mutual influence, through a dynamics of cultural encounters, and eventually gave origin to Greek philosophy, which was synthesized in the *Elements*, composed by Euclid of Alexandria, *c*300 a.C., and which inaugurated what became known as the *Euclidean Style*, by creating a specific kind of narrative and criteria of truth. Although no authentic complete copy is extant, The *Elements* became the canon of what is now called western mathematics.

For religious reasons, it was rejected by Christianity in the period known as the Early Middle Age, but in this period it was preserved and advanced in Hellenistic academies in Northern Africa, specially in Alexandria, and by Arabic and Islamic scholars. After the Crusades, the *Euclidean Style* was absorbed by Europe. in the periods known as the Late Middle Age and Renaissance. This gave rise to the corpus of knowledge now called western, academic or school mathematics or, simply, mathematics.

This corpus of mathematics knowledge came to be organized as a discipline in the 15th century, and was successful as the theoretical foundation of modern science and technology and of the capitalist economic system. This discipline spread through Europe and after the great navigations, conquests and subsequent colonialism, to the entire world. For the rest of this paper, when I use the word mathematics, I mean western, academic and/or school mathematics.

The colonial process established school systems in the occupied territories, which was continued after independence and which has prevailed tot he present. In the schools, mathematics was and continues to be central in schools, in all levels, and also in the universities and in research. Mathematics became necessary for the commerce, for the production and for the economy systems, for technology and for sciences.

A major cause of social exclusion is the lack of competencies in mathematics. It results in difficulties in employment and in many common daily activities. The same as in illiteracy and innumeracy that excludes individuals from participation in society. The same as in learning to read and write, learning to deal with basic quantities (arithmetic) and forms (geometry) that are essential in every cultural environment. They are essential as communicative instruments.

Mathematics is central to school systems all over the world, it dominates and, sometimes is considered the most important subject. But in every society it has not eliminated the practices of the ethnomathematics of the many culturally identified groups. The ethnomathematics of the *invisible society*, of the *non-elite population*, which produces and provides for the basic needs of the people, and of the upper classes, is present and practiced. For example, craftsmen and retailers are responsible for small scale manufacturing, for producing and selling basic goods, like food, clothing, and other utilities for daily consumption.

These professionals deal with certain branches of the economy and they provide non-material needs such as religious and popular rituals and festivals, for popular medicine, for the arts and for sports and for the many other social and cultural activities. All these, craftsmen, retailers and other professionals, rely on people's knowledge and on the traditional wisdom, passed from generation to generation, and from their peers. It is impossible to deny that *official* competencies coexist with other people's competencies to deal with daily life.

To build a civilization that rejects inequity, arrogance, and bigotry, education must give special attention to the redemption of peoples that have been, for a long time, subordinated and must give priority to the empowerment of the excluded sectors of societies.

THE CONCEPTUAL DIMENSION OF THE ETHNOMATHEMATICS PROGRAM

The ethnomathematics program contributes to restoring cultural dignity and offers the intellectual tools for the exercise of citizenship. It enhances creativity, reinforces cultural self-respect, and offers a broad view of the mankind.

The ethnomathematics program offers the possibility of harmonious relations in human behavior and between humans and nature. Intrinsic to it is the ethics of diversity:

- Respect for the other (the different).
- Solidarity with the other.

- Cooperation with the other.

Let me elaborate on the genesis of this research program, which has obvious pedagogical implications.

I repeat the question in the beginning of this paper: is Ethnomathematics research or practice? I see Ethnomathematics arising from research, and this is the reason for calling it the Ethnomathematics Program. But, equally important, indeed what justifies this research, are the implications for curriculum innovation and development, for teaching and teacher education, for policy making, all focusing the effort to erase arrogance, inequity, and bigotry in society.

As discussed above, the theoretical approach of an ethnomathematics program recognizes the cultural dynamics found in the encounters between cultures, which result in the coexistence of both the *official* and people's competencies. All of this links the historical and epistemological dimensions of the ethnomathematics program, which brings new light into our understanding of how mathematical ideas are generated and how they evolved through the history of humankind. It is fundamental to recognize the contributions of various cultures and the importance of the dynamics of cultural encounters.

Culture, understood in its widest definition, includes aspects of art, history, languages, literature, medicine, music, philosophy, religion, science, and technology. It is characterized by shared knowledge systems, by compatible behavior and by acceptance of an assemblage of values. Research in ethnomathematics is, necessarily, transcultural and transdisciplinarian. The encounters between cultures are examined in its widest form to permit exploration of more indirect interactions and influences, and to permit an examination of subjects on a comparative basis.

At this moment, it is important to repeat that my view of ethnomathematics should not be confused with ethnic-mathematics, as it is mistakenly understood by many. This is the reason why by using the denomination *Ethnomathematics Program* I stress the fact that ethnomathematics is not a final form of knowledge, but is a theory and a practice in permanent re-elaboration. Just like the various systems of knowledge, such as mathematics, religion, culinary, dress, sports and gaming, and several other practical and abstract manifestations of the human species in different contextual realities.

Ethnomathematics is permanently subjected to revision and to reformulations. Although dealing primarily with space, time, classifying, comparing, which are practices proper to the human species, ethnomathematics examines the codes and techniques that we use to express and communicate our reflections on these practices, which are, undeniably, contextual. To express these ideas, which I call a research program, I created the neologism, *ethno + mathema + tics*. Indeed, the word *mathematics* is also a neologism, with Greek origin, created in the XIV century. It is not *mathema + tics*.

THE PEDAGOGICAL DIMENSION OF THE PROGRAM ETHNOMATHEMATICS

In general, education was classified as a commodity by the World Commerce Organization, which is a special agency of the United Nations Organization. Since then, Education has become increasingly subordinate to big corporations and the result is that contents and methodologies are out of context. This affects particularly Mathematics Education. The main concern is attaining pre-decided goals of proficiency, which favor uniformity and sameness and surely leads to the promotion of docile citizens and irresponsible forms of creativity. Tests are the best instruments to support this corporate aspect of education. Tests penalize creative and critical education, which leads to the intimidation of the new

and to the reproduction of the current model of society. I will further these reflections and propose broader perspectives.

Education, particularly mathematics education, must focus on the immediate questions facing the world, this includes both social and environmental threats. As a mathematics educator, I address these questions and the pursuit of peace in all four dimensions: individual peace, social peace, environmental peace and military peace. This is the relation of the ethnomathematics program with peace, ethics and citizenship.

As I said above, it is important to insist that the ethnomathematics program is not ethnic mathematics, as some commentators interpret it. Of course, one has to work with different cultural environments and try to describe mathematical ideas and practices of other cultures, acting as an ethnographer. This is a style of doing ethnomathematics, which is absolutely necessary. Cultural environments include indigenous and also urban populations. In urban populations and in the periphery of major cities we must look into the practices of culturally identifies groups, through their professional practices, as retailers and laborers, as farmers, as artisans. The scenario is of individuals facing specific situations and problems in their daily life.

Individuals develop their own *ad hoc* practices to deal with the specific situations and to solve the problems they face, sometimes sharing their practices with their peers. When the *ad hoc* responses reveal that they are efficient in dealing with similar situations and solving similar problems, they are organized as methods, with specific jargon, and they are acquired as common practices by the culturally identified group. It is natural that practitioners ask: why does this method work? This is the moment a theory comes into the scenario. Individuals and groups reflect and theorize on their methods and ideas. This is the proper ground to germinate inventions, to propose the new. This is a most important element for the ethnomathematics program.

Synthesizing the arguments of the paragraph above, research and practice in ethnomathematics are the responses to three basic 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 inventions?

The answers to these questions results in learning the methods and practices of individuals and of their peers of a cultural identified group. This is an ethnographic approach to ethnomathematics. The ethnomathematics program goes further, asking how these practices, ethnographically studied, develop into methods (related to studies on cognition) and how methods develop into theories (related to studies on epistemology) and how theories develop into inventions (related to studies on creativity).

A question that usually arises is about the objective of incorporating ethnomathematics in the curriculum. Would not be enough to teach the mathematics that will be useful to students, to pass in tests, to apply for jobs, or to improve their own professional practice? True, these are the immediate objectives expected by students, by parents and by society as a whole. I do not deny these immediate expected objectives. But education can not be resumed to practical immediate objectives. It is even more important to prepare students to face the new, to aim further than what they have now. They have to acquire high esteem of themselves.

There is a similarity with the offering of languages other than the mother language. Of course, it is important to learn and to use properly the language of the family and of the community. If we are proficient in only one language, we are less equipped to be successful in the modern World. No one denies this. But there is another factor, of cognitive nature, that applies also to mathematics. Studies in cognition show the advantages of knowing other languages. There is evidence that the utilization of one language favors the utilization of another language. The bilingual speaker has to select the best from two competing options. This may be determined by the social context, but cognitive resources are activated. A very difficult question is which one to select in a determined circumstance. A possible explanation for the selection has to do with control systems recruited into linguistic processing.

What do we expect of a good education? My answer, which is repeated in many of my papers, is

- To promote full citizenship by preparing the individual to be integrated and productive in society, through the transmission of values and the clarification of both their responsibilities and their rights in society.
- To promote the expression of the creativity of every individual, by encouraging people to achieve their potential at the highest level of their interest and ability, which leads to progress of the society.

To achieve full citizenship, no one can deny that the proficiency in mathematics is absolutely necessary. Like being illiterate, without proficiency in basic school mathematics the individual is excluded from participation in society. It will be difficult to have employment, to be a conscious consumer, to perform daily routines. But we have data that confirms the failure of school systems around the world in providing proficiency in basic school mathematics.

We have to question the meaning of basic school mathematics. There are no valid arguments that justify insisting on teaching geometry as organized 25 centuries ago, arithmetic as organized more than 10 centuries ago and algebra invented about 5 centuries ago, as it is done in most schools in the world. Teachers teach the way they were taught, ignoring progresses occurred during their professional career. This is particularly serious in mathematics, which changed so much since the evolution of computers, calculators and informatics in various forms. The insistence in teaching geometry, arithmetic and algebra, and even calculus, as knowledge frozen for many centuries, memorizing techniques and availing the proficiency in tests, is unsustainable. The result is that students are bored and reject mathematics. As a consequence, students are not acquiring necessary competencies for full citizenship.

Of course, some basic geometry, arithmetic and algebra are important tools to solve real problems, but the access to these tools is possible, thanks to modern technological resources, without the need of memorizing techniques. The role of the teacher is to propose interesting real problems. If there is interest of the students, they will look for tools. Then, the teacher acts listening to the students and learning their approach to solve the problems, and in many cases their approach rely on ethnomathematics learned from their parents and from their communities. This is extremely valuable and must be respected by the teacher and by fellow students.

At the same time, students may compare different approaches to deal with the problem, which reveals the existence of multiple ethnomathematics, which enriches the learning experience. Surely, the teacher may also reveal her/his own way of dealing with the problem, based on School Mathematics and the appropriate use of technological devices. The various approaches lead to possible new

approaches, combining aspects of different ethnomathematics and of school mathematics. This is an important example of the dynamics of cultural encounters.

The most important aspect of the pedagogical dimension of the Ethnomathematics Program is the mutual exposition of different cultural approaches to face a situation or problem. This mutual exposition, with full mutual respect, is responsible to advances of knowledge throughout the evolution of the human species. This is the essence of what I call the dynamics of cultural encounters, as discussed in many of my papers.

Not only in mathematics, the dynamics of cultural encounters forms the great hope of new approaches concerning the mounting environmental crises, particularly the fast exhaustion of water supplies, and to face the mounting health problems and to the social and religious tensions around the world.

Regarding health care, the scientific developments since the Renaissance have led to a scientific and highly technical form of medicine, displacing traditional medicine of indigenous populations. The traditional practices survived, even if they became prohibited as criminal practices. Now, the World Health Organization has launched a project to support countries in developing proactive policies and implementing action plans that will strengthen the role Traditional Medicine keeping populations healthy (WHO 2013).

The eminent cultural historian Geoffrey Ernest Richard Lloyd refers to the encounter of Western medicine and traditional medicine saying that:

> (…) the possibilities of mismatch between what biomedicine [with a battery of tests to call on] pronounces to be the case and what individual patients feel, are unlikely ever to be completely removed. If so, alternative styles of medicine, with their more or less articulate elites to promote them, are likely to continue to bear witness to the complexities of our understanding of what it is to be truly well, and it would surely be foolhardy to suppose that biomedicine has nothing to learn from its rivals (Lloyd 2009, p. 92).

I can paraphrase what Geoffrey Ernest Richard Lloyd says by just replacing a few words and saying that the:

> (...) possibilities of mismatch between what Mathematics [with a battery of frozen knowledge and tests] pronounces to be an instrument to solve real life problems, are unlikely ever to be completely removed. If so, alternative styles of Mathematics, which are Ethnomathematics practiced by cultural identifies groups, are likely to continue to bear witness to the complexities of our understanding of what it is to face problems posed by real life, and it would surely be foolhardy to suppose that Academic and School Mathematics has nothing to learn from its rivals Ethnomathematics.

A good education cannot be limited to promote full citizenship, to succeed in employment, in being a conscious consumer and in performing well in daily routines. These are immediate, necessary goals, but not enough for a good education. A good education should also help students to attain their personal satisfaction, attaining higher objectives in life, according to their interest and abilities. This requires raising their self-esteem and creativity.

AS A CONCLUSION

Modern Civilization is failing in supplying the humanity with the basic strategies for survival and, at the same time, it is denying cultural identities and social justice. Words like democracy, freedom and equity are political slogans suggesting affirmative action. But they have been used by social movements and political factions to draw applause and to recruit and align cadres, which are soon voided by internal contradictions and conflicts. There are no real benefits for the people. This opens a space for reactionary counter-action, which are well coordinated and silent, and gain space in maintaining the *status quo.* We see international corporations displacing public schools, all over the world co-opting educators for new programs and new methods of instruction, with the fallacious objective of getting better results in tests.

The proposals favor the economic interest of corporations, but fail to develop the dignity of the individual and the imperatives of justice, compassion and peaceful modes of resolving conflicts, aiming at a new future, in which the humanity can live together in grace and peace. I recall the appeal of Bertrand Russell and Albert Einstein in the Pugwash Manifesto (1955):

> There lies before us, if we choose continual progress in happiness, knowledge, and wisdom. Shall we, instead, choose death, because we cannot forget our quarrels? We appeal as human beings to human beings: Remember your humanity, and forget the rest. If you can do so, the way lies open to a new Paradise; if you cannot, there lies before you the risk of universal death (Russel and Einstein 1955).

The ethnomathematics program is an answer to this appeal. It is a theoretical framework that establishes the foundation for organizing practices and systems of explanations developed by the species throughout its evolution in order to survive and to transcend. It is a system of knowledge that offers the possibility of a harmonious relation among humans and between humans and nature. It contributes to restoring cultural dignity and offers the intellectual tools for the exercise of citizenship. It enhances creativity, reinforces cultural self-respect and mutual respect, and offers a broad view of humanity.

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