Reflecting on Ubiratan D'Ambrosio's Pursuit of Peace, Social Justice, and Nonkilling Mathematics: A Transition from Subordination to Autonomy through Ethnomathematics

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Abstract

One of the main contributions of D'Ambrosio for humanity was his concern about how humanity can pursue peace and social justice and how education and mathematics education, in particular, can support this objective. H is life history shows that D'Ambrosio reflected on peace and social justice and on how ethnomathematics contributes to the development and the evolution of humankind. This context leads us to understand that humanity depends essentially on the analysis of his proposed triad: *individual-society-nature*, and the effectiveness of the relations among these elements. However, it is necessary to avoid that survival and transcendence are used as the roots for conflict and domination, which is developed into confrontation, violence, and the submission of members of distinct cultures. Therefore, D'Ambrosio's search for peace through the development of non-killing mathematics is also related to the expansion of social justice. Thus, D'Ambrosio's personal life and professional and academic achievements are responses to achieve this objective.

Keywords: Ethnomathematics, peace, social justice, nonkilling mathematics, Ubiratan D'Ambrosio.

Resumo

Uma das principais contribuições de D'Ambrosio para a humanidade foi a sua preocupação sobre como a humanidade pode buscar a paz e a justiça social e como a educação e a educação matemática, em particular, podem apoiar esse objetivo. A sua história de vida mostra que D'Ambrosio refletiu sobre a paz e a justiça social e sobre como a etnomatemática contribui para o desenvolvimento e a evolução da humanidade. Esse contexto nos conduz à compreensão de que a humanidade depende essencialmente da análise da proposta da tríade: indivíduo-sociedade-natureza, e da eficácia das relações entre esses elementos. Contudo, é preciso evitar que a sobrevivência e a transcendência sejam utilizadas como raízes do conflito e da dominação que se desenvolvem no confronto, na violência e na submissão de membros

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de culturas distintas. Portanto, a busca de D'Ambrosio pela paz por meio do desenvolvimento da matemática que não-mata também está relacionada com a expansão da justiça social. Assim, a vida pessoal e as conquistas profissionais e acadêmicas de D'Ambrosio são respostas para atingir esse objetivo.

Palavras-chave: Etnomatemática, paz, justiça social, matemática que não-mata, Ubiratan D'Ambrosio.

Initial Considerations

One of the main contributions of D'Ambrosio to Education and Mathematics Education was his concern about how humanity can pursue peace and social justice. In this regard, his life history showed us that he reflected on peace and social justice and how ethnomathematics as a program could contribute to their development and the evolution of humankind. For exemple, D'Ambrosio (**2007**) stated that:

> Issues affecting society nowadays, such as national security, personal security, economics, social and environmental disruption, relations among nations, relations among social classes, people's welfare, the preservation of natural and cultural 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 (p. 25).

In this context, for almost 25 years ago, D'Ambrosio (**1997**) stated that we are living in a world dominated by fear, uncertainty, and arrogance. As well, there is a general feeling that the planet is moving toward some form of catastrophe, a mix of economic, political, and environmental. In order to reduce and/or minimize the effects of this crisis humanity is going through, we "must accept, as a priority, the pursuit of a civilization with dignity for all, in which inequity, arrogance and bigotry have no place" (D'Ambrosio, **2017a**, p. 655).

Currently, the most visible catastrophic risks are related to health (Covid-19), political ideologies, and environmental crises. For example, D'Ambrosio (**2020**) was preoccupied about the internationally experienced pandemic crisis by affirming that:

> We are experiencing a difficult time with this pandemic. There has to be solidarity about that. It is a very strange solidarity to not embrace, but to stay away, to have the distance because we know that this physical distance, in truth, is an intimate, personal solidarity. We are not embracing, but we are embracing, this is respect (online).

Another, more subtle, but equally lethal crisis is humankind's relationships to its extensions, institutions, ideologies, as well as the unjust power relations between members of distinct cultural groups that inhabit the globe. It seems that faith in humanity has been forgotten as part of the rationalistic model that characterizes contemporary and globalized society (D'Ambrosio, **1999**). In accordance to this context, it emphasized that:

> It is not possible to relinquish our duty to cooperate, with respect and solidarity, with all human beings who have the same rights for the preservation of good. The essence of the ethics of diversity is respect for, solidarity with, and cooperation with

> the other (the different). This leads to quality of life and dignity for all (D'Ambrosio, 2017b, p. 4).

In this context, D'Ambrosio (2020), stated that it is necessary to discuss about respect, solidarity, and cooperation so that we are able to combat current crisis that still prevail in this planet, thus the coronovirus pandemic battle must be conducted in conjunction with:

> (...) Mathematicians and other scientists, because they are directing their intellectual capacity and their knowledge to solve this very serious problem of the pandemics. This is the cooperation between all scientific areas, all knowledge fields, and all areas of the humanities (online).

According to his personal, professional, and academic life history, D'Ambrosio (2020) sought social justice by proposing respect for others and *solidarity* and cooperation with the others, which is associated with the pursuit of peace needed to build up a civilization free of truculence, arrogance, intolerance, discrimination, inequity, bigotry, and hatred. Thus, it is important to emphasize that the:

> (...) path to peace is respect, solidarity, and cooperation. We are all human beings who are part of humanity. And, if we do mathematics, if we are mathematicians, we have to do mathematics for this humanity. It has to be a Humanistic Mathematics, otherwise it will lose its meaning (online).

Regarding to this assertion, D'Ambrosio (2007) stated that, throughout history, religion, politics, and sciences have focused on giving a sense of normality to prevailing humanity and social behaviors. Yet, it is not possible to "accept inequity, arrogance, and bigotry is irrational and may lead to disaster. Mathematics has everything to do with this state of the world. A new world order is urgently needed. Our hopes for the future depend on learning - critically - the lessons of the past" (p. 29).

This context enabled D'Ambrosio (1999), approximately two decades ago, to share his vision in relation to the relevance of discussing political issues that deal with government, economics, relations among nations and social classes, people's welfare, and the preservation of natural and cultural resources. For example, in his opinion, the political dimension of education helps us to understand that:

> (...) The possibility of final extinction of civilization in Earth is real. Not only through war. We are witnessing an environmental crisis, disruption of the economic system, institutional erosion, mounting social [and health] crises in just about every country and, above all, the recurring threat of war. A scenario similar to the disruption of the Roman Empire is before us, with the aggravation that the means of disruption are, nowadays, practically impossible to control (p. 34).

On the other hand, it is important to highlight what D'Ambrosio (2020) reafirmed his faith in humanity when he acknowledged the possibility of capturing and developing the creative flow of humankind. For example, Rosa and Orey (2021) emphasize that for D'Ambrosio, throughout history, humanity was able to deal with conflicts during period of crisis in order to creatively find solutions to the problems faced daily, such as the "rapid development of

vaccines for Covid-19 and the international adaptation of teachers to their teaching practices'' (p. 446).

In this creative insubordination approach, Rosa and Orey (2021) state that members of distinct cultural groups react differently to the phenomena and events that occur in their daily lives and to the sociocultural conditions they live in. Thus, they create communicative, analytical, material, and technological instruments that help them to develop answers to solve problems faced in their own contexts and surroundings. The Program *Ethnomathematics* is a response to this search for survival and transcendence.

From *Ad Hoc* Solutions to Scientific Inventions: An Ethnomodelling Approach

Mathematics is one of the most powerful instruments created by humanity that enables us to face and solve unpredicted phenomena. Historical evolution enabled the development of alternative forms of mathematical knowledge systems that provide explanations of daily problems, situations, and phenomena, which leads to the elaboration of models and ethnomodels as representations of facts present in our own reality (Rosa & Orey, 2010).

Through D'Ambrosio's professional work and academic investigations encompassed social, political, economic, environmental, and cultural arenas, enabled him to establish an important relation between mathematics, anthropology, and society (Rosa & Orey, 2021), which enabled him to discuss the role of mathematics as the dorsal spine of the Western societies.

By developing his investigations regarding to the connection between mathematics, culture, and anthropology, D'Ambrosio (2007) gained sociocultural insights by looking into non-Western civilizations, which helped him to:

> (...) base my research on established forms of knowledge (communications, languages, religions, arts, techniques, sciences, mathematics) and in a theory of knowledge and behavior which I call the ''cycle of knowledge'' . This theoretical approach recognizes the cultural dynamics of the encounters, based on what I call the ''basin metaphor'' . 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 are generated and how they evolved through the history of humankind. It is fundamental to recognize the contributions of other cultures and the importance of the dynamics of cultural encounters (p. 30).

This broader view of D'Ambrosio on mathematics helped him to explain the cultural dynamism between distinct cultures, societies, and communities, through a dialogical action that can transform mathematical knowledge in search of the common good (Rosa & Orey, 2021). In accordance with D'Ambrosio's ideals, it was his concern as an investigator and an educator:

> (...) how to close the gap between (professional) mathematics and its appreciation by the population in general. Mathematics, and the same is also true for science in general, should not be mystified in favour of the dominating power establishment. To demystify mathematics has been a major concern for me (D'Ambrosio & Gomes, 2006, p. 2).

In this regard, since the beginning of his profissional and academic life, D'Ambrosio was interested in:

> (...) looking into the implications of this broader view of the history of mathematics. Broader, since it recognized also the mathematics done by non-mathematicians. I was, indeed, building up the theory and practice of what I would later call ethnomathematics. There has always been a reaction to ethnomathematics, [by] claiming that this is not mathematics. Indeed, it does not fit into the academic epistemological cage that identifies theories and practices as mathematics and as mathematicians. This is a major theme of the history of philosophy – how were disciplines established? – which has, since then, been attracting much of my attention (D'Ambrosio & Gomes, 2006, p. 2).

In approaching this broader view of the history of mathematics, D'Ambrosio investigated the transdisciplinarian and transcultural perspectives of mathematical knowledge by stating that:

> I believe that history benefits much from multicultural readings of narratives lost, forgotten or eliminated. The Program Ethnomathematics approaches history in this way. It looks into history and epistemology with a broader view, avoiding the denial and exclusion of the cultures of the periphery, of what prevails in society (D'Ambrosio & Gomes, 2006, p. 2).

Regarding to this assertion, ethnomathematics seeks to understand, value, respect, and document the various mathematical ideas, procedures, and practices developed by members of distinct cultural groups. Thus, D'Ambrosio (2007) argued that ethnomathematics as a 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 mankind. In everyday life, it is a system of knowledge that offers the possibility of a more favorable and harmonious relation between humans and between humans and nature (p. 30).

This context enabled D'Ambrosio to help us to develop the concept of ethnomodelling as the translation of mathematical ideas, procedures, and practices related to the development of mathematical knowledge by the members of distinct cultural groups. Hence, ethnomathematics adds cultural perspectives to the mathematical modelling process through the application of pedagogical actions of ethnomodelling (Rosa & Orey, 2016) because it:

> Takes into consideration diverse processes that help in the construction and development of scientific and mathematical knowledge that includes collectivity, and the overall sense of and value for creative and new inventions and ideas. The processes and production of scientific mathematical ideas, procedures, and practices operate as a register of the interpretative singularities that regard possibilities for symbolic constructions of the knowledge in diverse cultural groups (Rosa & Orey,, p. 10).

Similarly, the ethnomodelling process helps members of distinct cultural groups to draw information about their own realities through the elaboration of ethnomodels that are representations from reality, which generate mathematical knowledge that deals with creativity and invention (Rosa & Orey, 2017).

Ethnomodelling is a way in which people from particular cultures use their own mathematical ideas, procedures, and practices for dealing with quantitative, qualitative, spatial, and relational daily phenomena. This validates and confirms their own mathematical experience that is inherent to their lives. For example, Orey () states that the "paradigm that diverse cultures use or work within evolves out of unique interactions between their language, culture and environment" (p. 248).

In this direction, it is important to argue that, in an ethnomodelling perspective, mathematical thinking is developed in diverse cultures in accordance with the common problems that are encountered within a sociocultural context (Rosa & Orey, 2019). According to this perspective, D'Ambrosio (1997) has affirmed that in order to solve specific problems, members of these cultural groups create *ad hoc*[1] solutions, and methods are generalized to solve similar situations, and then theories are developed from these generalizations so that they are able to understand these phenomena.

Therefore, Katz (2003) states that western mathematics "originated in the *ad hoc* practices and solutions to problems developed by small groups in particular societies" (p. 557). In the ethnomodelling context, members of distinct cultural groups come to *know* mathematics in ways that maybe different from academic-western mathematics as taught in schools. The historical tendency has been to consider these *ad hoc* mathematical practices as non-systematic and non-theoretical, and inferior.

In contrast, Rosa and Orey (2017) state that ethnomodelling studies underly a structure of inquiry in *ad hoc* mathematical practices by considering how these *ad hoc* solutions and problem-solving techniques can be developed into methods and theories. Since diverse types of problems are common to distinct cultures, the kinds of solutions, methods, and theories they have developed may differ from place to place, and culture to culture.

In this regard, D'Ambrosio (1997) taught us that phenomena that are recognized as problems and solutions in one culture, may have no meaning or value to the members of other cultural groups. This means that aspects of culture manifest itself through its unique mix of jargon, codes, myths, symbols, utopias, and ways of reasoning and inferring. Associated with these elements there are ethnomathematical practices such as ciphering, counting, measuring, classifying, ordering, inferring, and modelling, which constitute the development of ethnomodelling.

During the development of its theoretical basis, one basic question can be posed: *How theoretical can ethnomodelling be?* Hence, it has long been recognized that local mathematical

[1] *Ad hoc* is a Latin expression whose signification is *for this purpose* . It generally means a solution designed for specific problems or tasks, non-generalizable, and which cannot be adapted to other purposes (Rosa & Orey, 2010).

practices are *known to* the members of distinct cultural groups, yet they substantially differ from the western or its academic ways of *knowing* and *doing*. It is important to state here that interest in these accounts has been because of a sense of curiosity in and/or the source of anthropological concerns about learning how these members think and act mathematically.

Consequently, D'Ambrosio (**1997**) argued that there is a need to take a step further in trying to find an underlying structure of inquiry in these *ad hoc* solutions by posing the following three questions:

1. How are *ad hoc* solutions, problems, and practices developed into methods?
2. How are methods developed into theories?
3. How are theories developed into scientific invention?

In harmony with these three questions, Rosa and Orey (**2010**) affirm that ethnomodelling develops an alternative body of mathematical knowledge that helps the conduction of pedagogical actions in the classrooms, as well as its development during the conduction of mathematical education investigations.

In line with this assertion, Rosa (**2019**) states that it is necessary to understand how mathematical practices develop from observations to adhoc solutions, from experiences to experiments, from scientific methods to reflections, and from abstractions to scientific inventions and theoretical bases, which are used in the ethnomodelling process. For example, in school settings, students can:

> a) Develop analyzes when they are working with experimental geometry (*observations*).
>
> b) Observe geometric solids inside a box with water (*ad hoc practice*).
>
> c) Measure the water level (method).
>
> d) Explain changes in water level (reflection and abstraction).
>
> e) Develop the concept of volume (theory).
>
> f) Constructing geometric solids with a given volume (invention) (Rosa, **2019**, p. 2).

According to this point of view, this approach is based on the integration of the mathematical knowledge system with the issues inherent to the survival and transcendence of humanity. Thus, the relation between mathematical knowledge and practices developed by members of distinct cultural groups summarizes the existing dialogue between the observation of reality (*empiricism)* and the set of fundamental principles of a science (*theory)*.

In this regard, D'Ambrosio (**1993**) commented that these questions can guide a reflection on the evolution of knowledge because it is related to the generation, organization, dissemination, and also its return to those who produced it. Figure 1 shows the Dambrosian knowledge cycle.

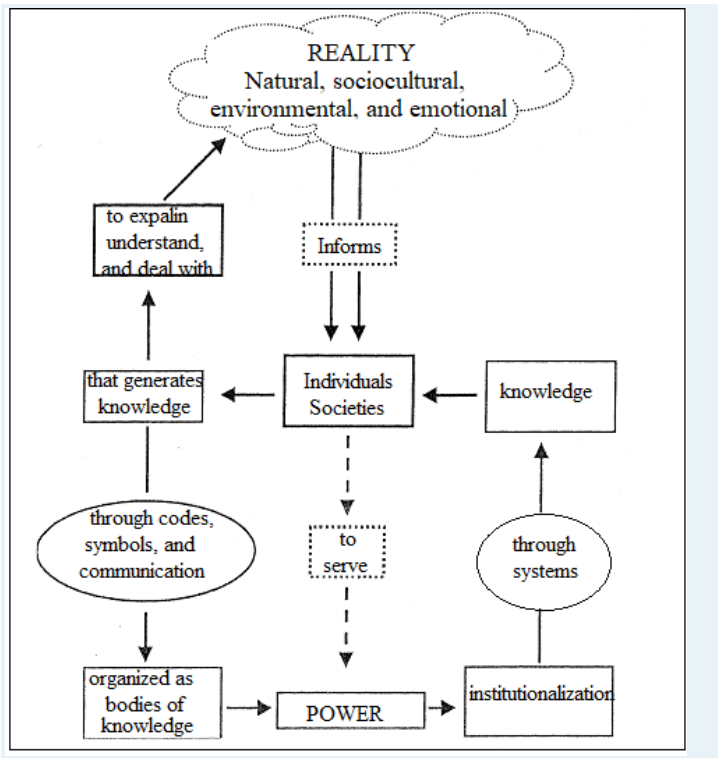

Figure 1. Dambrosian knowledge cycle
Source: Adapted from D'Ambrosio (2009a, p. 38)

This approach promotes a harmonious *knowledge cycle* in an integrated manner, which considers the constant inter-relation of members of distinct cultural groups with reality through their engagement in actions that seek to transform society. This ethnomodelling context is based on the interconnectedness of these relations as given by *ad hoc practices* ⇛ *methods* ⇛ *theories* ⇛ *inventions*. These three questions are essential to help members of distinct cultural groups to develop their own scientific ideas, methods, and theories (Rosa, 2019).

However, there is unquestionably a timelag between the appearance of mathematical ideas, procedures, and practices outside of the circle of its academic practitioners with the recognition that they can be theorizable into mathematics through ethnomodelling (Rosa & Orey, 2017).

Yet, members of distinct cultural groups have developed and organized a diversity of ideas, procedures, strategies, and techniques that envolve representations of reality through the elaboration of ethnomodels that simulate these processes. This approach is endowed with appropriate codes and the mathematical knowledge needed, until the expropriation of these ideas and procedures in direction to its formalization as mathematics (Rosa & Orey, 2016).

Thus, the organization of systems related to the explanations of the origins of mathematical practices is developed through these representations by using ethnomodelling. These collective responses to these ideas, procedures, and practices are organized as alternative mathematical systems.

However, in many cases, these *ad hoc* practices are never formalized, and they continue to be restricted to the members of distinct cultural groups who developed it. In this context, the mechanism of schooling replaces these practices by equivalent ones that have acquired the status of mathematics, which have been expropriated in their original forms and returned in a codified version (Rosa, 2019).

In this regard, Rosa and Orey (2017) argue that ethnomodelling can be considered as a set of *ad hoc* practices developed dialogically into a body of mathematical knowledge. Therefore, we need to collect examples on the practices developed by the members of distinct cultural groups that are identifiable as mathematical practices. This means that ethnomodelling enables the connection of these practices to patterns of reasoning and modes of logical thinking in order to bring them into the greater body of mathematical knowledge.

What D'Ambrosio (2017b) taught us is that ethnomathematics can lead members of distinct cultural groups to challenge mathematical structures that have been historical forces related to the development of mathematical theories. It analyses the advancement of mathematics within the framework of historiography, which recognizes that *ad hoc* solutions that deal in solving daily problems and situations lead to the development of alternative methods.

This initial step lead to the development and evolution of ethnomodelling related to the generation and organization of mathematical knowledge developed in distinct cultural contexts as one way to apply ethnomathematics. The next step is related to the elaboration of ethnomodels that goes beyond the application of a sequence of algorithms because it is not only the application of induction and deduction procedures as normally presented in classrooms but is the mathematization of cultural practices (Rosa & Orey, 2017).

Thus, ethnomodels can represent daily phenomena that require the elaboration of models that capture the imagination of members of distinct cultural groups, and which involves the development of mathematical creativeness and inventivity (Rosa & Orey, 2010). When facing new situations or problems, members of distinct cultural groups come to, indeed, construct their own understanding of these phenomena by applying *ad hoc* solutions they developed overtime and history (D'Ambrosio, 2007).

In the next step, students may use the same procedures to solve similar phenomena previously faced in their own daily lives and contexts by organizing them into methods. If they succeed, this process repeats itself until they achieve and to proceed to the development of their own worldview and theories and from there to the advancement of invention and creativity. This approach allows for the creation (inventivity and creativity) of new ways of dealing with daily phenomena that are part of the realities of the members of distinct cultural groups (Rosa, 2019).

These steps are the essence of the development of ethnomodelling process, which contemplates, inherently, the complementarity of ethnomathematics and modelling. In this process, ethnomodelling discusses the evolution of mathematical knowledge through the history of humanity as a response to a variety of situations and problems originated in and by the distinct contexts.

Thus, ethnomathematics contributes to restoring cultural dignity and offers the intellectual tools for the exercise of citizenship. It can contribute to the enhancement of creativity, reinforces cultural self-respect, and offers a broad view of humankind. In everyday life, it is a system of knowledge that offers the possibility of a more favorable and harmonious relation between humans and between humans and nature (D'Ambrosio, **2017b**).

In this sense, this broader view of D'Ambrosio (**1997**) on ethnomathematics explains the cultural dynamism within and between diverse societies and communities, through a dialogical action that can transform mathematical knowledge in pursuit of the common good. Furthermore, the epistemology of this program is consistent with Freirean ideals, as mathematical knowledge is dynamic, being considered as the result of human activity.

Final Considerations

I conclude this article by stating that I first met Ubi in 1998 when he was teaching a discipline named: *The History of Mathematics*, in the specialization course in Mathematics Education, which emphasized ethnomathematics and mathematical modelling at the Pontifícia Universidade Católica de Campinas, Brazil, in 1998.

At that time, I understood the role of D'Ambrosio as an educator in the field of mathematics education and his program ethnomathematics as a complementary and holistic sociocultural paradigms that fulfilled his commitments to seek for a better social order with more dignity and quality of life for humanity.

Before his passing in May of 2021, D'Ambrosio was seeking for new directions in mathematics education in order to provide innovative references to his investigations. I would like to point out here that to me it has been particularly motivating and interesting to further his exploration regarding to his reflections in relation to localization, globalization, glocalization, survival, transcendence, epistemological cages, and creative insubordination.

As well, it is necessary to highlight D'Ambrosio's constant search for peace and social justice through the development of the concept of non-killing mathematics, which are also concerned with the tic's of mathema in distinct ethnos. For example, D'Ambrosio (**2009b**) commented that:

> Our main goal is nonkilling [mathematics]. Otherwise, we are on the road to extinction. I am simple in my proposal — we need ethics; and didactic in my style — every individual, whether the sophisticated intellectual or the common man, has a responsibility and should find the means to direct their energies to socially constructive goals (p. 256).

This assertation shows that D'Ambrosio believed and dreamed of a more egalitarian society and humanistic mathematics as he never gave up support for the development of innovative ways of reaching this goal in order to direct students towards transcendence. His achievements, contributions, and legacies go beyond mathematics education, as he encouraged us to "accept, as a priority, the pursuit of a civilization with dignity for all, in which inequity,

arrogance, and bigotry have no place, in order to achieve a world in peace'' (Rosa & Orey, 2021, p. 448).

It is important to point out that D'Ambrosio showed us that humility and love for our actions and achievements transcends any limit imposed by dominant society. His examples taught us to resist as well as to understand the process of transition from subordination to autonomy. Thus, Rosa and Orey (2021) stated that it is relevant to:

> (...) highlight the importance of the Brazilian mathematician educator and philosopher Ubiratan D'Ambrosio in relation to the development and evolution of the ethnomathematics program, as he is the most important theorist in this field of study. Thus, by offering encouragement to investigators and researchers around the world, D'Ambrosio's leadership drives the dissemination of new ideas, notions, concepts and perspectives involving ethnomathematics, as well as reinvigorating its applications in Mathematics Education (p. 448).

This assertation shows us that ethnomathematics builds on and values the cultural experiences and knowledge of students regardless of whether they are represented by dominant or non-dominant cultural systems and empowers them intellectually, socially, emotionally, and politically by using cultural referents to impart their knowledge, skills, and attitudes in the pedagogical work in schools. As well, by using ethnomodelling as a tool towards pedagogical action of an ethnomathematics program, students learn how to find and work with authentic situations and real-life problems.

This context leads us to understand that humanity depends essentially on the analysis of D'Ambrosio's proposed triad: *individual-society-nature*, and the effectiveness of the relations among these elements. Hence, it is necessary to avoid that survival and transcendence are used as the roots for conflict and domination, which develops into confrontation, violence, and the submission of members of distinct cultural groups and nature. Thus, D'Ambrosio's personal life and professional and academic achievements are responses to achieve this objective.

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