The Role of Mathematics in Building a Democratic Society

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Political issues deal with government, economics, relations among nations and social classes, people's welfare, and the preservation of natural and cultural resources. Mathematics is deeply involved with these issues and mathematicians and mathematics educators cannot ignore them.

The possibility of the final extinction of civilization on earth is real, and not only through nuclear war, which was a major threat during the Cold War, and which, in 1955, prompted two eminent mathematicians, Albert Einstein and Bertrand Russell, to invite other Nobel laureates to subscribe to a moving document, which became known as *The Russell-Einstein Manifesto*, and which gave origin to the Pugwash Conferences on Science and World Affairs (Pugwash, retrieved 2002).

We are witnessing an environmental crisis, disruption of the economic system, institutional erosion, mounting social crises in just about every country and, above all, the recurring threat of war. And now, after the attacks in New York and Washington on September 11, 2001, the uncertainties are a real threat to our mental and emotional equilibrium. We are anxious about the next minute and we look with fear and suspicion at our neighbor. 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. Survival of mankind, with dignity for all, is a most urgent and universal problem.

It is clear that mathematics is well integrated into the technological, industrial, military, economic, and political systems and that mathematics has been relying on these systems for the material bases of its continuing progress. It is important to look into the role of mathematicians and mathematics educators in the evolution of mankind, especially because mathematics is recognized as the most universal mode of thought.

Thus it is appropriate to ask what the most universal mode of thought—mathematics—has to do with the most universal problem—survival with dignity (D'Ambrosio 2001). I believe that the need to find the relation between these two universals is an inescapable result of the claim of the universality of mathematics. Consequently, as mathematicians and mathematics educators, we have to reflect about our personal role in reversing the current world situation.

Mathematics, Education, and Curriculum

The nature of mathematical behavior is not yet clearly understood. Although in classical philosophy we notice a concern with the nature of mathematics, only recently have the advances of the cognitive sciences probed into the generation of mathematical knowledge: How is mathematics created? How different is mathematical creativity from other forms of creativity?

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From the historical viewpoint, there is need of a complete and structured view of the role of mathematics in building our civilization. For this we have to look into the history and geography of human behavior and find new paths to advance the search. History is global in time and space. It is misleading to see history only as a chronological narrative of events, focused on the narrow geographic limits of a few civilizations that have been successful in a short span of time. The course of the history of mankind, which cannot be separated from the natural history of the planet, reveals an increasing interdependence, which crosses space and time, of cultures, civilizations, and generations.

Education is a strategy created by societies to promote creativity and citizenship. To promote creativity implies helping people to fulfill their potentials to the maximum of their capability. To promote citizenship implies showing people their rights and responsibilities in society. Educational systems throughout history and in every civilization have been focused on two issues: to transmit values from the past and to promote the future.

In other words, education aims equally at the new (*creativity*) and the old (*societal values*). Not irresponsible creativity (we do not want our students to become bright scientists creating new weaponry) nor docile reproduction (we do not want our students to accept rules and codes that violate human dignity). This is our challenge as educators, particularly as mathematics educators.

The strategy of education systems to pursue these goals is the curriculum. Curriculum is usually organized in three strands: objectives, contents, and methods. This Cartesian organization implies accepting the social aims of education systems, then identifying contents that may help to reach the goals and developing methods to transmit those contents.

The Political Dimension of Mathematics Education

To agree on objectives is regarded as the political dimension of education, but very rarely has mathematics content and methodology been examined with respect to this dimension. Indeed, some educators and mathematicians claim that content and methods in mathematics have nothing to do with the political dimension of education.

Even more disturbing is the possibility of offering our children a world convulsed by wars. Because mathematics conveys the imprint of western thought, it is naïve not to look into a possible role of mathematics in framing a state of mind that tolerates war. Our responsibility as mathematicians and mathematics educators is to offer venues of peace (D'Ambrosio 1998).

There is an expectation about our role, as mathematicians and mathematics educators, in the pursuit of peace. Anthony Judge, the director of communications and research of the Union of International Associations, expressed how we, mathematicians, are seen by others:

> Mathematicians, having lent the full support of their discipline to the weapons industry supplying the missile delivery systems, would claim that their subtlest thinking is way beyond the comprehension of those seated around a negotiating table. They have however failed to tackle the challenge of the packing and unpacking of complexity to render it comprehensible without loss of relationships vital to more complex patterns. As with the protagonists in any conflict, they would deny all responsibility for such failures and the manner in which these have reinforced unsustainably simplistic solutions leading to further massacres. (Judge 2000)

I see my role as an educator and my discipline, mathematics, as complementary instruments to fulfill commitments to mankind. To make good use of these instruments, I must master them, but I also need to have a critical view of their potentialities and of the risk involved in misusing them. This is my professional commitment.

It is difficult to deny that mathematics provides an important instrument for social analyses. Western civilization entirely relies on data control and management. "The world of the twenty-first century is a world awash in numbers" (Steen 2001, 1). Social critics will find it difficult to argue without an understanding of basic quantitative mathematics.

Since the emergence of modern science, enormous emphasis has been placed on the rational dimension of man. Recently, multiple intelligences, emotional intelligence, spiritual intelligence, and numerous approaches to cognition, including new developments in artificial intelligence, challenge this. In mathematics education, this challenge is seen in the exclusive emphasis given to skill and drilling, as defended in some circles of mathematicians and mathematics educators.

In this paper I argue that the emphasis on the quantitative cannot be detrimental to the equally important emphasis on the qualitative. My proposal of *literacy, matheracy,* and *technoracy,* discussed below, is an answer to my criticism of the lack of equilibrium. *Literacy* is a communicative instrument and, as such, includes what has been called quantitative literacy or numeracy. This is very much in line with the mathematics learned from the Egyptians and Babylonians, but not central in Greco-Roman civilization nor in the High Middle Ages. It was incorporated into European thought in the Lower Middle Ages and it was essential for mercantilism and for the development of modern science. Indeed,

it became the imprint of the modern world. In contrast, *matheracy* is an analytical instrument, as proposed by classical Greek mathematicians (for example, in Plato's *Republic*). I will return to this subsequently.

It is an undeniable right of every human being to share in all the cultural and natural goods needed for material survival and intellectual enhancement. This is the essence of the United Nations' *Universal Declaration of Human Rights* (UN 1948) to which every nation is committed. The educational strand of this important profession on the rights of mankind is the *World Declaration on Education for All* (UNESCO 1990) to which 155 countries are committed. Of course, there are many difficulties in implementing United Nations resolutions and mechanisms. But as yet this is the best instrument available that may lead to a planetary civilization, with peace and dignity for all mankind. Regrettably, mathematics educators are generally unfamiliar with these documents.

The Ethical Dimension of Mathematics Education

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.

It is impossible to accept the exclusion of large sectors of the population of the world, both in developed and undeveloped nations. An explanation for this perverse concept of civilization asks for a deep reflection on colonialism. This is not to place blame on one or another, not an attempt to redo the past. Rather, to understand the past is a first step to move into the future. 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.

We have to look into history and epistemology with a broader view. The denial and exclusion of the cultures of the periphery, so common in the colonial process, still prevails in modern society. The denial of knowledge that affects populations is of the same nature as the denial of knowledge to individuals, particularly children. To propose directions to counteract ingrained practices is the major challenge of educators, particularly mathematics educators. Large sectors of the population do not have access to full citizenship. Some do not have access to the basic needs for survival. This is the situation in most of the world and occurs even in the most developed and richest nations.

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 program *Ethnomathematics* 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 (D'Ambrosio 1999a).

A consequence of this program for a new curriculum is synthesized in my proposal of three strands in curricular organization: literacy, matheracy, and technoracy (D'Ambrosio 1999b). The three provide, in a critical way, the communicative, analytical, and technological instruments necessary for life in the twenty-first century. Let me discuss each one.

Literacy is the capability of processing information, such as the use of written and spoken language, of signs and gestures, of codes and numbers. Clearly, reading has a new meaning today. We have to read a movie or a TV program. It is common to listen to a concert with a new reading of Chopin. Also, socially, the concept of literacy has gone through many changes. Nowadays, reading includes also the competency of numeracy, the interpretation of graphs and tables, and other ways of informing the individual. Reading even includes understanding the condensed language of codes. These competencies have much more to do with screens and buttons than with pencil and paper. There is no way to reverse this trend, just as there has been no successful censorship to prevent people from having access to books in the past 500 years. Getting information through the new media supersedes the use of pencil and paper and numeracy is achieved with calculators. But, if dealing with numbers is part of modern literacy, where has mathematics gone?

Matheracy is the capability of inferring, proposing hypotheses, and drawing conclusions from data. It is a first step toward an intellectual posture, which is almost completely absent in our school systems. Regrettably, even conceding that problem solving, modeling, and projects can be seen in some mathematics classrooms, the main importance is usually given to numeracy, or the manipulation of numbers and operations. Matheracy is closer to the way mathematics was present both in classical Greece and in indigenous cultures. The concern was not with counting and measuring but with divination and philosophy. Matheracy, this deeper reflection about man and society, should not be restricted to the elite, as it has been in the past.

Technoracy is the critical familiarity with technology. Of course, the operative aspects of it are, in most cases, inaccessible to the lay individual. But the basic ideas behind technological devices, their possibilities and dangers, the morality supporting the use of technology, are essential issues to be raised among children at a very early age. History show us that ethics and values are intimately related to technological progress.

The three together constitute what is essential for citizenship in a world moving swiftly toward a planetary civilization.

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