

The Role of Mathematics Education in Building a Democratic and Just Society*

UBIRATAN D'AMBROSIO

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As we approach the Fifth Centenary of the "discoveries" of new worlds and we dream about moving into our sixth century with a democratic and just society, let us reflect on the intellectual adventure behind those events and the model of society which grew out of them. Essentially, the dichotomy of *have's* and *have not's* became rationalized and efforts to justify it underlie much of the political discourse of those times, anchored sometimes in scientific evidence. Mathematics accompanied this adventure and to some extent served as the basic supporting factor of what is sometimes called "the western civilizing mission"

A preliminary comment on the use of the word *civilizing*. It is taken in its accepted meaning: that is, "tending to advance civilization"; while *civilization* means "an ideal state of human culture characterized by complete absence of barbarism and nonrational behavior, optimum utilization of physical, cultural, spiritual and human resources, and perfect adjustment of the individual within the social framework" [Webster's *Third New International Dictionary*, 1971]. *Colonialism* has been justified as the political action of the "civilizing mission", conducted by the major European powers, in the name of establishing accepted concepts of property, of production, of institutionalised values and religion, since the 16th century. [Norberto Bobbio et al., *Dizionario di Politica*, UTET, Torino, 1983]. Denying the very concept of civilization, the existing cognitive, social and political behaviors and the efficient utilization of resources were steadily destroyed and substituted by others. This so-called western civilizing mission, which started about 500 years ago, resulted in the model of a society dominated by science and technology and their consequent economic, social and political orders. Modes of production, labor division, concepts of property and wealth, are intimately related to the underlying philosophy which made possible and justified the conquest-colonization process. In this process new gods, new languages, new modes of thought, of labor, of property, of health, and so on, were imposed around the globe. This gave rise to concepts such as those of natives, Indians, primitive peoples, and the concepts of civilized and savage, and more recently of minorities and progress, of peripheral and central nations, of development, of Third World.

Although this expansionist venture reached out to the entire planet with the same conceptual frameworks, from the point of view of culture what were then called the Indies (subse-

quently Americas, New World, Western Hemisphere) and Africa suffered most of all in this process. In these parts of the "discovered" world a process of physical and cultural genocide, not exclusive of each other, occurred and hit, with different degrees of intensity, the prairie, the Amazonian, and the insular — Caribbean — cultures, reducing them to numerically inexpressive populations, as well as the Andean and Mesoamerican societies, which are still, even in the 20th century, culturally and numerically very strong. Across the Atlantic the brutal practice of a new form of slavery took root in Africa, bringing people to serve in far away lands of no return with no possibility of redemption, breaking off both the basic cells of society — families — and the categories of cultural identification such as religion, language, values and institutions, food and health: violating in this process several nationalities, putting them together with no regard at all for languages, religions, values and family and tribal ties. In this civilizing process both native and transplanted slaves were used to build up powerful agricultural and industrial colonies in the New World. Science and the values associated with scientific and rational thought were often used to rationalize variants of the exploitation of human beings by human beings in the process of building up agricultural and industrial states in the Old World, selfishly using masses of peasants and workers, and in the New World, where shameful and merciless slavery was the primary source of labor.

Parallel to these developments, mathematics was growing to become the essence of the so-called scientific and rational mode of thought, to become the primal discipline in the variety of intellectual tools that characterize the modern world, and the most central among all the disciplines in all the school systems which sustain, in every modern society, the current style of life. "You cannot be a citizen of the 20th Century without Mathematics" is the title of an epoch-making article published by the magazine *The Economist* of London in the mid-70s. Now that universal education has become an aspiration and indeed a need in all modern societies, everyone seems to agree that no educational system can proceed without mathematics for all at all levels and in all grades. Mathematics has become the imprint of modern society, of modern thought, and of an educated people. It seems to be agreed that individuals are more or less capable, more or less able, more or less intelligent, more or less reliable, accord-

ing to their higher or lower scores in mathematics. These are facts taken for granted among employers, among parents, teachers and administrators, and consequently among children themselves. There is no “geography anxiety” or “music anxiety” and not even “literacy anxiety” — “Never heard of it!” — among the main problems by which educators are confronted world-wide today, but “math anxiety” has become a dominating issue.

At this moment let us look briefly into what is called the History of Ideas and of Institutions. It does not take much for us to realize that the dominant ideas in religion, in art and communications, in consumerism and styles of production, in property and wealth distribution, all grew under the philosophy of scientific rationalism, relying on an underlying logic with values suitable to these conceptions. But none of these behavioral manifestations, religious, artistic or societal, were immune to the previous cultural forms which were in the way of the so-called civilizing process which took place during these last five centuries. Remnants of the non-Biblical traditions were incorporated into all Christian religious practices; the same with every art and culinary form, with every health and production system. All of them reveal the dynamics of cultural exposure, of mutual influences in the evolution of ideas. But the expansion and absolute imprint of science is unchallenged. There is no other science and no other mathematics. [1].

We approach the close of the 20th century under the shadow of the complete destruction of mankind. There are urgent and dramatic appeals for survival, which always refer to poverty, to hunger, to social conflicts, to drug abuse, to energy starvation, to pollution, and others of the so-called “civilization diseases”. We see the emergence of AIDS, of CFS (chronic fatigue syndrome), and who knows what else to come. We cannot face these issues without paying attention to the fact that by the turn of the century, 80% of the world population will be in what is called the Third World and that in the USA, the champion of the First World, 50% of its population will belong to the category of the so-called minorities. Similarly, and with similar and somewhat aggravated problems, in the USSR the majority of the population will be, at the turn of the millenium, of non-Caucasial stock. These are the strata of the *have not*'s in the industrialized world inside a welfare society. Is there room for a Third World and for minorities in an ethical world society? I see an absolute inconsistency between the ideas of the existence of Third World and minorities and the struggle for democracy, peace, and survival of mankind. Either we survive as a single world, with justice and equal opportunities for all, or there is no hope. It is ethically unacceptable to have 80% of the world population under the social, political, economic, cultural and emotional stress of being Third World, just as it is inadmissible to have 50% of a population under the stress of belonging to the category of minorities.

Democracy and education for all

Democracy becomes more than a word at the instant it provides access to leadership to all sectors of society, independent of race, creed, and socioeconomic background. School systems in a democratic society should be structured to make

this possible. On the other hand, systems in aristocratic or oligarchic societies are structured to identify, through *filters*, those who can serve the interests of the aristocracy or of the oligarchy by assuming *uncritically* the roles of either commanding or obeying, and to distribute people into categories such as achievers and failures, successful and unsuccessful, winners and losers, and the like. Medals and rewards, titles and degrees, tests and exams, and other selective processes are typical filtering instruments. The management of these filtering systems has been exercised sometimes by religious orders and courtesan practices, by civil servants (mainly in the Asian tradition), and in modern society by public systems, such as the health system, military service, and above all the school system.

Many will be asking: “What has mathematics education to do with all this?”. Mathematics has been a favorite instrument as a filter since Greek times. [2] In modern society, dominated by modern science and technology, which originated in the 16th and 17th centuries, mathematics has a dominant role. It is in the basis of all modern knowledge. Science and technology depend on mathematics, our economic systems are analyzed and regulated through mathematical methods, our opinions rely on statistical data, our health is controlled by the indices of our body chemistry, we are socially classified according to our income, our daily life is paced by schedules, dates, and times. We know that certain jobs require cholesterol indices of such-and-such and we have sad memories of the use of IQ and other tests for recruitment in the armed forces — placing in the most exposed battalions those who could be dispensed with in view of their low achievement on specially prepared tests. Indeed, our life is regulated by mathematical indices. This entire paragraph represents a curriculum proposal. [3]

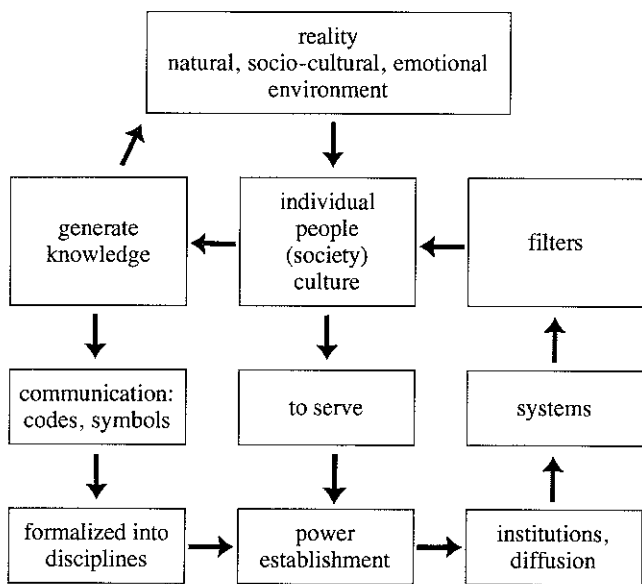
Still, some people may insist on asking what this has to do with mathematics education. Let me claim that it is misleading to see mathematics education primarily as something that prepares for a job. Instead it should be looked upon as something that prepares for full citizenship, for the exercise of all the rights and the performance of all the duties associated with citizenship in a critical and conscious way. Mathematics education ought to prepare citizens so that they will not be manipulated and cheated by indices, so that they will be allowed to change and to accept jobs which fulfill and appeal to their personal creativity; that is, so that individuals will be allowed the satisfaction of their own creativity and will be free to pursue personal and social fulfillment thus being able to achieve happiness. In the modern world mathematics surely interferes with this. I would like to go further along this line of thought, but let me shift more closely to the topic announced as the title of my lecture. But before that I must ask you all to go deeper into the writings of Michel Foucault, Ivan Illich, Michael Apple, Paulo Freire, and Henry Giroux for this kind of reflexion. Again, this sequence of writings in the sociology of education might be a curriculum component.

Education and the environment: ethnomathematics

The underlying assumption is that learning does not proceed

as a one-way transmission of knowledge from teacher to student but results from the interaction of the learner with the social and natural environment. The teacher is a component of the social environment. This is the base of my holistic view of education [4] which considers the classroom environment as an essential component of the learning process. This has been assumed by other educators, ever since John Dewey, and indeed is explicitly mentioned in the recent document *Professional standards for teaching mathematics*, Working Draft, NCIM [1989]: “The environment of the classroom is foundational to what students learn.” [page 12] But we go further in remarking that the concept of environment goes beyond the classroom and includes the entire life history of a child from birth. So, when children go to school they carry with them their personal history, full of experiences accumulated in living in a particular family, in a particular community, and these different environments result in experiences which include customs, perceptions, explanations, mysteries. In their previous life, some have experienced approval, acceptance, and have learned to master situations; others have experienced humiliation, rejection, and have even faced failure. These previous interactions with different environments generate coping mechanisms and self-esteem in different degrees, positive or negative. Among these coping mechanisms, or strategies and tactics for dealing with the environment, social and natural, we easily distinguish *ethnomathematics*. Resorting to etymology, the term *ethnomathematics* is introduced as “the art or technique (*tics*) of explaining, understanding, coping, with (*mathema*) the socio-cultural and natural (*ethno*) environment” This can be taken as a definition [5]

The basic assumption in defining ethnomathematics by appealing to the etymology of mathematics is that socio-emotional and cognitive development is the result of an interactive dynamic involving the individual and the environment. Knowledge is generated through socio-emotional and cognitive steps originating in the interaction between an individual and the environment — natural, social, cultural — from birth. The dynamic of this interaction, mediated by



communication and the resulting codification and symbolization, produces structured knowledge which eventually becomes disciplines. These are expropriated by the power structure or the establishment and returned to the people, who indeed are primarily responsible for having generated this same knowledge, now modified through codes and symbols — of course, with modified symbolic meanings — by means of a diffusion process through systems impregnated with filters. The figure clarifies this entire process.

Clearly, the filtering is done in such a way that the interests of the establishment, indeed the power structure, are adequately served. In the case of aristocracies and oligarchies, it preserves dynasties or the parties or corporations in power.

The life history of a child

This model of generation, transmission, and diffusion of knowledge includes systems as important factors in bridging the gap between individual, social, and cultural behaviors. The first steps in moving from individual to social behavior come very early, when a child discovers “the other”. But the first “others” to be discovered and to have an influence in the building up of the child’s behavior are emotionally very close to the child: parents, brothers, close relatives, neighbours, friends. All carry an emotional attachment. The first time a child gets involved with the other as stranger is in school. Connotations about “the stranger” obviously play a role in the process. Thus schools are a necessary step towards social behavior. Probably here is the most important reason for keeping schools: they are more than a mere arrangement for the transmission of knowledge unavailable to the family and community environments. The transmission of knowledge is surely more effectively done and more efficiently achieved through other systems, including the media. But school is essential to the process of initiation into conviviality with strangers — an essential step in modern society, both for the generation of knowledge and for production. To cooperate, to work together, to give up some of one’s individual behavior in favor of collective behavior, to collaborate in the pursuit of knowledge and in the search for common good, are the essential goals of the school.

All this activity is based in *interaction* and clearly depends on the already acquired coping mechanisms and self-esteem brought to school as part of the history of every single child. It is unproductive for any school system to ignore this and to try to erase the history of each child in the name of pre-established syllabi and methodologies. But I go further: it is not only unproductive, it is criminal! In erasing the history of a child a teacher is throwing away and annihilating the various instances of creativity through which a child has built up his or her personality and basic knowledge. Instead, teachers and schools should build upon this. Current teacher training, both pre-service and in-service, is unfortunately inconsistent with this view. Proposals for enhancing teacher education, both pre-service and in-service, are dominated by demands for more content and methodology, which clearly lead practically nowhere. The First IEA Study showed this in 1968, the Second Study confirmed it, and I am sure the Third Study will show an even worse situation. Investment in education, particularly in mathematics education, is beside the point. More attention should be paid to students and

teachers as human beings [6], to schools as systems at the service of society to which evaluation and testing must be subordinated [7], and to mathematics — as with other disciplines — as an epistemological system, with its specific dynamics, and in its sociocultural and historical perspective, and not as a finished and static body of results and rules. [8]

Negative self-esteem is particularly strong among minority students of mathematics. The cultural image of mathematics recalls the most successful chapters in the history of European thought. It bears the imprint of Western culture. Add to this the preconceived opinions about mathematics that a child is subject to even before going to school. We all have listened to phrases like “Mathematics is the hardest subject in school”, “I was never good at mathematics”, “Fred is a genius, see how well he did in mathematics”, “Mathematics is not for everyone”, “I don’t care how good you are at sports, let me see what you can do in mathematics” — amounting to “social-terrorism” as an initiation rite for mathematics. [9]

Ethnomathematics avoids these preconceptions and the problem of negative self-esteem. Success in ethnomathematics depends on how one manages the situation he/she has to face in life. Thus both the social aspect and the cultural achievement are always present. Every single manifestation of art, production, behavior, leisure, planning, and so on — all the activities of a human being — brings with it numbers, figures, symmetries, harmonies, regularities, extent, design, logic, and so on, and all of this builds up into ethnomathematics. Every single culture, tribe, community, individual, develops a way of coping with everyday needs, with the environment, with fellow human beings, always trying to understand what is going on, to explain what is seen and felt, thus contributing to building up knowledge. Knowledge is the accumulated production of the whole of mankind since the appearance of *homo sapiens* on our planet. Modes of thought differ from individual to individual, from community to community, from culture to culture, and they are changeable and modifiable as the result of mutual exposure, throughout time, thanks to the dynamics of interactive behavior. There is no permanent, finished, and absolute knowledge either in time or in cultural space. There is no absolute superiority among cultures, communities, and individuals. *Civilization* in another, non-colonialist, acceptance of the term is “the whole of the advances of human culture and aspirations beyond the purely animal level” [Webster’s *Third New International Dictionary*, 1971]. Aspirations that go beyond the purely animal level include explaining, understanding, i.e., *mathema*. Modelling and ethnographic methods appear to be appropriate practices if we want to bring all this into schools. [10]

A proposal for a reconceptualization of curriculum

Several paragraphs in this paper carry, implicitly, curriculum proposals for both pre- and in-service teacher training. There is not much hope if we do not radically change our approach to teacher training. A curriculum proposal must be understood in the general sense given in Note 4. The essence is to look at schools not as mere transmitters of knowledge but giving priority to their social, political, and psycho-

emotional roles. Traditional and modern media, such as printed material — books and journals — and electronics are better equipped and certainly more efficient at transmitting accumulated, “finished”, knowledge than a teacher performing psittacism! The amplitude, variety, and the necessary updating of information make it too complex to be dealt with by traditional methods and remain the responsibility of the common teacher. There are new roles for schools and teachers which are reflected in the new concept of curriculum itself. This essentially coincides with the idea advanced in “Project 2067”, sponsored by the AAAS in the USA.

These new roles for schools and teachers reside in their essential function of generating the dynamics for interactive behavior in situations proposed by the environment. In addition to teaching as traditionally defined (“to give instruction”, “to impart knowledge”), teachers should see themselves as partners in a common search, in the common and shared process of building up knowledge. The clear edge that the teacher most often has over the students may be adapted to become a congenial partnership which builds up positive self-esteem in the students and never adopts an arrogant, imposing, authoritative attitude. Teachers together with the students should be persistent but humble in the common search so that all bring to the process their previous knowledge, their insights, and their creativity. Teachers can hardly play their role in building up a democratic and just society if they do not foster democratic and just behaviors. Mathematics is an essential component in this entire process.

Notes

- [1] Everything is derived from Greek science, with the possible exception of the Hindu numerals
- [2] See Plato: *The Complete Dialogues*. org E. Hamilton & H. Cairns. Bollinger Series, Pantheon Books, New York, 1966; Republic VII
- [3] See for example Marilyn Fankenstein: *Relearning mathematics*, Free Press, London, 1989; and Sergio Roberto Nobre: *Aspectos Sociais e Culturais no Desenho Curricular da Matemática* (Social and Cultural Aspects in Curricular Design in Mathematics) Master’s Thesis. UNESP, Rio Claro, 1989
- [4] See Ubiratan D’Ambrosio: *Uniting Reality and Action: A Holistic View on Mathematics Education*. In: L. Steen and D. Albers (eds.) *Teaching students teaching teachers*, Birkhauser-Boston, 1981. and also Ubiratan D’Ambrosio, *Environmental Influences*, In: R. Morris (ed.) *Studies in mathematics education*, v. 4, UNESCO, Paris, 1985, pp. 29-46
- [5] See Ubiratan D’Ambrosio: *ETNOMATEMÁTICA Raízes Socio-Culturais da Arte ou Técnica de Explicar e Conhecer*, (A Collection of Six Essays), UNICAMP, Campinas, 1987; and Ubiratan D’Ambrosio: *Etnomatemática*, Editora Atica, São Paulo, 1990
- [6] See the excellent approach of James Garbarino et al. *What children can tell us*. San Francisco: Jossey-Bass Pub., 1989
- [7] See the excellent research of Teresa Amabile, *The social psychology of creativity*. New York: Springer-Verlag, 1983
- [8] See in this respect Ubiratan D’Ambrosio, *A methodology for ethno-science: the need for alternative epistemologies* *THEORIA Segunda Época*, n. 2, 1986, pp. 397-407
- [9] It would be worthwhile to produce a repertoire, a kind of dictionary, of such “social-terrorism” phrases which are so common in home conversations when the subject of mathematics comes into the discussion
- [10] See for example, Marcelo de Carvalho Borba, *Um Estudo de Etnomatemática Sua incorporação na elaboração de uma proposta pedagógica para o Núcleo-Escola da favela de Vila Noqueira-São Quirino*. Dissertação de Mestrado, UNESP, Rio Claro, 1987; Sergio Roberto Nobre, *Aspectos Sociais e Culturais no Desenho curricular da Matemática*. Dissertação de Mestrado, UNESP, Rio Claro, 1989; Regina L. C. Buriasco, *Matemática de Dentro e de Fora da Escola*. Dissertação de Mestrado, UNESP, Rio Claro, 1989; and Project FOXFIRE. by Eliot Wigginton. Garden City, N.Y.: Anchor Press/Doubleday. (Mainly *Foxfire* n. 6, 1980 and *Sometimes a shining moment*, 1988).