Mathematics and Peace: Our Responsibilities

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Abstract: I am concerned with peace in its several dimensions: inner peace, social peace, environmental peace and military peace. This paper addresses the global responsibilities of mathematicians and mathematics educators in the quest for peace. It is observed that the evolution of mathematics is intimately related to the evolution of Western society, hence mathematics cannot be dissociated of human behavior. After some reflections on the specifity of the human species and the production of knowledge, I claim a symbiotic relation between human search of ways of explaining and coping with the environment and the development of mathematics. This leads to a broader approach to the history and pedagogy of mathematics and to some hints for the subordination of mathematics development to a global ethics, which incorporates the goal of peace in its multiple dimensions.

Kurzreferat: *Mathematik und Frieden: Unsere Verantwortung* Mein Anliegen ist Frieden in seinen verschiedenen Dimensionen: innerer Frieden, sozialer Frieden, ökologischer Frieden und militärischer Frieden. Der Beitrag handelt von der globalen Verantwortung von Mathematikern und Mathematikdidaktikern im Streben nach Frieden. Beobachtungen zeigen, daß die Entwicklung der Mathematik eng mit der Entwicklung der westlichen Gesellschaft verbunden ist; Mathematik kann also nicht vom menschlichen Verhalten abgetrennt werden. Nach einigen Überlegungen über das Besondere der menschlichen Spezies behaupte ich, daß es eine symbiotische Beziehung zwischen der menschlichen Suche nach Wegen, die Umwelt zu erklären, mit ihr umzugehen, und der Entwicklung der Mathematik gibt. Dies führt zu einem breiteren Zugang zur Geschichte und zur Pädagogik der Mathematik sowie zu einigen Hinweisen, wie die Entwicklung der Mathematik einer globalen Ethik unterworfen werden kann, die den Frieden in seinen verschiedenen Dimensionen als Ziel miteinschließt.

ZDM-Classification: A30, A40, E20

Introduction

This paper deals basically with the global responsibility of mathematicians and mathematics educators. The guiding question is *"How do we, as mathematicians and mathematics educators, fulfill our commitments to mankind?"*

To be highly provocative, I invite people to reflect about the fact that the most despicable human behavior in recent times was performed by people who had attained a high level of cultural development, particularly excellence in mathematics. Let me make it very clear that this is not an insinuation of an intrinsic malignity of mathematics. But it is clear that mathematics has been a companion in historical events which we all deplore. Let me make it very clear that I do see mathematics playing an important role in achieving the high humanitarian ideals of a new civilization with equity, justice and dignity for the entire human species without distinction of race, gender, beliefs and creeds, nationalities and cultures. But this depends on the way we understand how deeply related are mathematics and human behavior. These questions are rarely considered by mathematicians, historians of mathematics and mathematics educators.

It is undeniable that mathematics is well integrated into the technological, industrial, military, economic and political systems of the present "Westernized" world. Indeed, mathematics has been relying on these systems for the material bases of its continuing progress. We may say that mathematics is intrinsic to today's culture. It should be natural for us, as mathematicians and mathematics educators, to give some thought to the role of mathematics education in achieving a better social order and more dignifying quality of life. So, we are led to examine the history of mathematics as related to world history.

In order to appreciate the real significance and importance of mathematics in different cultures and in different times, it has to be viewed through what might be termed a "cultural lens". It is hoped that this approach will illuminate many areas of mathematical thought and indicate new directions of research. As a result, we may better understand the implications of mathematical research, its contents and the pedagogical methodologies in the achievement of *peace* in its several dimensions: *military peace*, *environmental peace*, *social peace* and *inner (individual) peace*. This is essential for building up a civilization which rejects inequity, arrogance and bigotry, which are essentially violations of peace in its various dimensions.

The prevailing attitude

Answering the guiding question above, it is not sufficient to say, as is common in our profession – indeed, in every profession – to rely on "Doing good mathematics" or "Being a good mathematics teacher". Our commitment and responsibility go much beyond that. We might ask "What is done with the mathematics we develop?" and "How will our students perform in their professions, that by and large have nowadays a strong mathematical component?" Our responsibility includes the uses society makes of our intellectual production and the influence we have in the behavior of our students. It is naïve to say that the intellectual production of mathematics and the competences resulting from our teaching are not related with the behavior of people.

The threat of another World War is real. I do not think we have to accept that it is normal to solve regional conflicts by military means and that isolated wars can be tolerated. Although isolated, the violence and violation of human dignity going on in these conflicts are abhorrent. Besides, history has shown us that there is a high possibility of a larger involvement of nations and that the escalation of these regional conflicts may result in World War III.

The possibility of the final extinction of civilization on Earth is real. Not only through war. We are now witnessing an environmental crisis, mounting social crises in just about every country, and above all the recurring threat of war. And there is also an alarming lack of internal peace for individuals, leading to drugs, violence and nihilism.

To survive we have to achieve peace, in its several dimensions, as was said above: inner peace, social peace, environmental peace and military peace. This means peace with dignity. In a letter to Albert Einstein, Sigmund Freud said "These two factors – man's cultural disposition and

well-founded fear of the form that future wars will take – may serve to put an end to war ... but by what ways or byways this will come about, we cannot guess." We all, particularly mathematicians and mathematics educators, have a responsibility in finding these ways.

As it was said above, and I repeat, mathematics is well integrated into the technological, industrial, military, economic and political systems and has been relying on these systems for the material bases of its continuing progress. This refers not only to science and technology, but to philosophy as well and hence to models of society.

The issues are essentially political. There has been a reluctance among mathematicians, and to a certain extent among scientists in general, to recognize the symbiotic development of mathematical ideas and models of society. Mathematics has grown parallel to the elaboration of what we call modern civilization. This is amply recognized by historians. Particularly explicit on this is Mary Lefkowitz when she claims that "the evolution of general mathematical theories from those basics [mathematics of Egyptians, Sumerians and others] is the real *basis of Western thought* (italics mine)".[1]

If, as mathematicians and mathematics educators, we try to answer the challenge of Sigmund Freud, it is natural for us to reflect about our personal role in putting an end to and avoiding future wars. But it is equally important to question the role of mathematics and mathematics education in arriving at this mode of behavior.

No one will deny that the *most universal problem* is survival with dignity. Many people claim that mathematics is the *most universal mode of thought*. I believe that to find the relation between these two universals is an inescapable result of the claim of the universality of mathematics.

Our commitment implies assuming a broad view of the world and of mankind in general. This is possible through a reflection about the future and a broad perception of the state of the world, which is disturbing. It is a general feeling that human behavior has not been ethical. We need an ethics of respect, solidarity and responsibility. But we, particularly as mathematicians and mathematics educators, have not been explicit in our practices about a comprehensive ethics.

It is natural for us to express our discontentment with the state of the world by chastising science and technology, which are recognized as the embodiment of modern society. Science and technology are thus blamed for the malaise of humanity. Mathematics is obviously directly affected by this criticism.

The challenges and counter-challenges we are witnessing reflect a defensive posture which is growing to contain the wave of discontent. For generations and generations, access to facts have been controlled by moral and material instruments, among them norms and codes, language and literacy, all organized in systems such as religions, sciences and technology. Paradoxically, the same instruments which were fragmentarily constructed to preserve the prevailing order have become so complex that they are no longer effective and have become increasingly permeable. An old Spanish proverb says "Cría cuervos y ellos te comerán los ojos" (Call the crows, and they will peck out your eyes). The creature escapes the control of the creator. Metaphors like Adam, Frankenstein, Hal of "2001", or the androids of the "Blade Runner", all point in this direction.

The reaction to the challenge

To raise these questions is sometimes interpreted as opening doors to anti-science and irrationality. In his recent book, Carl Sagan cautions about the lure of new directions in inquiry. In his denouncement of the "new Dark Age of irrationality", Sagan claims that "Each field of science has its own complement of pseudoscience. Geophysicists have flat Earths, hollow Earths, Earths with wildly bobbing axes to contend with, rapidly rising and sinking continents, plus earthquake prophets. Botanists have ..." (Sagan 1996, p. 43). But it is misleading to denounce discontentment as such.

Indeed, these conflicting postures have led to the so-called "Science War". Research done by sociologists of science have tended to focus on the relationship between science and society. But the new field of social studies of science has been chastised. Alan Sokal drew much attention to the issue in a hoax published in one of the cherished journals of the postmodern critics.[2]

The polemic thus started is not different from those focusing on afrocentrism and feminism. These polemics reveal that the use of the hermetic language by postmodern criticism to discuss scientific knowledge reveals the real issue, which is a political one, that goes much beyond the national arenas. Ideological labels are commonly used. This is very well illustrated by the fact that Sokal's hoax was used, a few weeks after its publication, by Brazilian Congressman Roberto Campos to support his political harangue. A few days later, Alan Sokal published a reply to Congressman Campos, in the same influential Brazilian newspaper, explicitly chastising Campos as a rightist and declaring himself to be a leftist. It is not irrelevant that the television debate between candidates Clinton and Dole, on October 6, 1996 revealed an insistence of Senator Dole on using the word "liberal" as a form of attacking the policies of President Clinton. There is a danger that these polemics result in the deviation of its main objective, which is to "condemn injustices and inequities of the capitalist system and try to eliminate, or at least minimize them", in the words of Alan Sokal.

To challenge knowledge, both scientific, religious, socio-political and historical, does not mean to retrogress. It has always been a coherent response to the state of society, and it can be understood if we look into the full cycle of knowledge in a historical perspective, of course freeing ourselves of the epistemological biases which are adopted to justify the prevailing socio-political and economic order. The essence of these biases is the argument that science is an object of knowledge of a different nature, in the realm of the ratioïd. This is particularly strong when we refer to mathematics. Metaphorically, mathematics is manichaestic. Its foundations rely on very strict dichotomies. Knowledge is generated by individuals and by groups; it is intellectually and socially organized, and it is diffused. The full cycle of generation, organization

and diffusion of knowledge intertwins with needs, myths, metaphors, and interests. The human species, like other animal species, developed strategies of hierarchical power. Intrinsic to hierarchical power is the control of knowledge.

In the discussion about the current state of the world, it is not so important to claim that although the Egyptians, the Sumerian and other civilizations were ahead of the Greeks, the contribution to build up general mathematical theories was indisputably Greek.[3] As it is irrelevant that the medieval scholars received Euclide through the Arabs, largely accepted. What is very relevant is the fact that mathematics as it is recognized today in the academia, developed parallel to Western thought (philosophical, religious, political, economical, artistic, cultural). It would lead to a redundant boredom to give examples justifying this assertion. Simply because mathematics and Western civilization belong to each other.

When we question the current social, economic and political order, we are essentially questioning the righteousness of Western civilization in face of a real threat to its continuation. How is it possible to avoid questioning its pillars, science and mathematics? How can discussions about these pillars be closed to non-scientists and non-mathematicians? The resource to arguments of authoritative competence leads to intimidatory language and to passionate arguments. How can we reach the new by refusing, discouraging, rejecting, denying the new? Indeed, a subtle instrument of denial is discouragement through intimidation. Language plays an important role in this process, as every school teacher knows. Particularly in mathematics, the use of a formal language inherent to academic mathematics has been a major cause of determent.

The organization of this language is the realm of epistemology. Epistemologies and histories, the same as norms, differ from group to group, from society to society, and are incorporated in what is called culture. The crux is the dynamical process of encounters of cultures and the resulting mutual expositions, which underly the construction and reconstruction of knowledge and the maintenance, substitution, dissolution and modification of epistemologies and norms. When this process is dominated by authority, as it was in the colonial process and equally characterizes conservative schools, the outcome is predictable: contest. The problem thus resides with authority and the denial of participation in the dynamics of this process.

Social and political scientist Marcus G. Raskin and physicist Herbert J. Bernstein, in their analysis of the connection between the generation of knowledge and political directions, claim that “science seeks power, separating any specific explanation of natural and social phenomena from meaning without acknowledging human attributes (such as love, happiness, despair, or hatred), the scientific and technological enterprise will cause profound and debilitating human problems. It will mask more than it tells us about the universe and ourselves” (Raskin/Bernstein 1987, p.78).

The nature of mathematics

The criticism inherent in re-establishing the lost connection of the sciences, technology and human values is causing unavoidable conflicts. This is particularly true in the case of mathematics, in which the acknowledgement of human attributes is conspicuously absent in its discourse.

This has not always been so in the course of history. Mathematics, just like the other sciences, used to be impregnated with religious, as well as social and political considerations. Current epistemology and history, and above all the educational framework, were constructed to justify the prevailing socio-political and economic order, in which we recognize different “theories of science”.

Imre Lakatos proposed, in his seminal work (Lakatos 1978, p.107), three main epistemological strands:

1. *Skeptical*, represented mainly by Paul Feyerabend, claiming that any system of knowledge is as good – or as bad – as any other.
2. *Demarcationist*, represented mainly by Popper and Lakatos himself, which essentially distinguishes between good science and bad science and, while recognizing that scientific results are mutable, propose a methodology which is, like religion, doctrinal.
3. *Elitist*, represented mainly by Kuhn and Polányi, which essentially claims that only scientists can distinguish and establish criteria for telling good science from bad science.

Mathematics usually finds its explanation in 2 and 3, in which the world of ideas prevail. Raskin and Bernstein (see Raskin/Bernstein 1987) add a fourth explanatory direction:

4. *Reconstructivist*, which views science as a humanistic activity and looks for its roots in faith and political power.

I myself see a limitation in all these directions, lessened but still present even in 4. They fail to recognize that the generation of knowledge is the result of a complexity of sensorial, intuitive, emotional and rational factors. We are “informed” by these factors and process the information in a way as yet unknown at the present state of knowledge of how the human mind functions. This holistic approach to knowledge owes much to artificial intelligence, biology and sociobiology.[4]

Although it has been common to place mathematics in 2 and 3, the growing movement of humanistic mathematics gives new breadth to the reflections about mathematical knowledge.[5]

Let us now examine the question of political power. We read that in the USA only 35% of students said they spent six or more weeks studying or doing homework during their senior year in high school and that 33.9% students report being bored in class. There is no point in putting the blame on youth, claiming that about half of the current generation is uninterested in learning and intellectualy “lost”. Maybe we should take a look at the blamers. The problem does not reside in youth, but in the older generation, in schools, in the institutions in general, for whom to bring discussions of important matters of societal ethics to the classroom is absolutely disregarded. In an abstract to Wolf, Alvin: Balancing Education: Let’s Hear It More for the Humanities (NASSP Bulletin 79(1995)573, p. 87–94) it is said: “The United States needs more citizens who question the morality of using military power

to conduct foreign affairs and who can ethically weigh federal spending and industrial, environmental, and social priorities. Instead of bemoaning students' dismal math and science performance, we should address their woeful ignorance of history, literature, philosophy, psychology, and the fine arts."

As Fred M. Hechinger puts it, "The drift toward a society that offers too much to the favored few and too little to the many, inevitably raises questions among young people about the *rewards of hard work and integrity* (italics are mine)" (Hechinger 1992, p. 206). The real problems facing education are political, essentially the result of an unequal distribution of material and cultural goods intrinsic to modern economy. There is no need to elaborate on these issues. I suggest a few sources where we find discussion of property, production and global issues in modern society.[6]

Some readers will claim that this has not much to do with the relations between peace, mathematics and mathematics education. I claim they have everything to do with them. These relations have been avoided in the discussions about the state of the world, and mathematics and mathematics education have been absent of the critical views on the main issues. The cultural consumerism practiced in schools and the academia have been efficient in trimming processes and focusing only in results. Mathematics and history of mathematics are delivered as frozen systems of knowledge.

Exceptions are notable. We have to mention the activities of the research group on "Political Dimensions of Mathematics Education/PDME" and also the movement "critical mathematics". And ethnomathematics has everything to do with all this.[7] There have been few writings about values attached to mathematics and even less about the moral quality of our actions. To search for a correlation between the current state of civilization and mathematics has been uncommon among mathematics educators. Particularly the political component, which was so well studied by Paulo Freire, Michael Apple, Henry Giroux and others with respect to education in general, seem to have drawn less attention of mathematics educators.

To a great extent, the polemics around the postmodern discourse of sociologists of science reflects the ideology intrinsic to words. Indeed, in the course of history language has been the main instrument in denying free inquiry. There is an implicit intimidating instrument in the language of academia and society in general. One must be reminded that the major confrontations of the sixties, particularly the Civil Rights and the student movements of 1968 and the popular, mainly academic, efforts to finish the Vietnam War, drew on the Free Speech movement.

The case of a school teacher comes to my mind who asked children to draw a color picture of a tree seen through the window of a classroom. Jane came with a tree painted red. The teacher corrected the child, even suggested to the parents that Jane might have a vision problem! A few days later the teacher was sitting in the same place as Jane, at the same time of the day, and the sun was in the same position. The teacher saw a red tree. Many say that this example is misleading as it does not deal with objective reason. Indeed, there is a general feeling that as math teachers we have to teach objective reason, to stimulate rational thinking among our students. But human mind is a complex of rational, emotional, intuitive, sensorial perceptions, which are all involved at the same time. Maybe we have placed too much emphasis on the rational component while denying, rejecting and repressing the others. It is not uncommon to see a child punished for being "too happy" in the classroom. And we always know of teachers saying to a boy "Stop crying. Men do not cry!" Is it possible to build knowledge dissociating the rational from the sensorial, the intuitive and the emotional? I believe this multi-dimensionality in building up knowledge is a very important aspect of the history of mathematics which has been practically ignored. And of course, this is very important in learning. There has been a resurgence of interest in the intuitive, sensorial (hands-on projects) and affective aspects in mathematics education. But not yet in the development of mathematics. How do emotions play a role in mathematics? When Gustave Flaubert wrote "Mathematics: the one who dries up the heart" (Flaubert 1987), what did he have in his mind? The reaction I usually hear to these comments is: "But this is natural, since mathematics is the quintessence of rationalism." Indeed. But much of the polemics going on relate to the prevailing acceptance of the superiority of rationality over other manifestations of human behavior. This was one of the main concerns of the mathematician-writer Robert Musil in his masterpiece "The Man Without Qualities". Commenting on scientists and engineers, the main character Ulrich says "Why do they seldom talk of anything but their profession? Or if they ever do, why do they do it in a special, stiff, out-of-touch, extraneous manner of speaking that does not go any deeper down, inside, than the epiglots? This is far from being true of all of them, of course, but it is true of a great many; ... They revealed themselves to be men who were firmly attached to their drawing-boards, who loved their profession and were admirably efficient in it; but to the suggestion that they should apply the audacity of their ideas not to their machines but to themselves they would have reacted much as though they had been asked to use a hammer for the unnatural purpose of murder" (Musil 1980, p.38). Musil's oeuvre antecipates the intellectual framework of Nazi Germany, in which he identifies incapacity to tolerate pluralism. Indeed, many of the reactions against irrationalism are mixed with a latent emotional incapability of accepting that which is different. The denial of access to knowledge is a strategy for the exclusion of the different.

Knowledge and ethics

Peace, in all its dimensions, depends on an ethical posture not only in human behavior but also in the production of knowledge. Current systems of knowledge give a character of normality to the prevailing social, economical and political order. Both the religions and the sciences have advanced in a process of dismantling, reassembling and creating systems of knowledge with the undeniable purpose of giving a sense of normality to prevailing human individual and social behavior.

The fundamental problem in this is the relation between brain and mind. It is possible to know much about the human body, its anatomy and physiology, to know much about neurons and yet know nothing about why we see something green or red. This gives rise to the modern theories of consciousness, which claims to be the last frontier of scientific research.[8]

Through a sophisticated communication system and other organic specificities, man tries to probe beyond the span of his own existence, to the time before birth and after death. Here we find the origins of cults, traditions, religions, arts and sciences. These are undistinguishable in their first manifestations of mankind throughout history and in child development. Essentially, this is a search for explanations, for understanding, which goes together with the search for predictions. One explains in order to anticipate. This helps to build up systems of explanations (beliefs) and of behavior (norms, precepts). These are the common grounds of religions and sciences, until nowadays.

The drive towards *survival* is intrinsic to life. But the incursion into the mysteries beyond birth and death, which are equivalent to the search for past and future, seem to be typical of the human species. This is *transcendence*. The symbiotic drives towards survival and transcendence constitute the essence of being human.

The analysis of this symbiotic drive is focused on three elements: the individual, the other(s), and nature, which have clear relations of dependence (see Fig. 1).

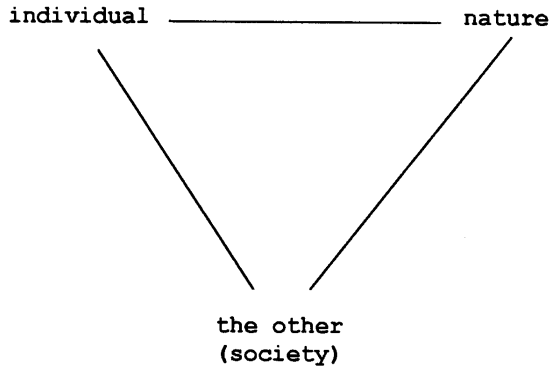

Fig. 1

These relations generate individual and social behavior in all living species.

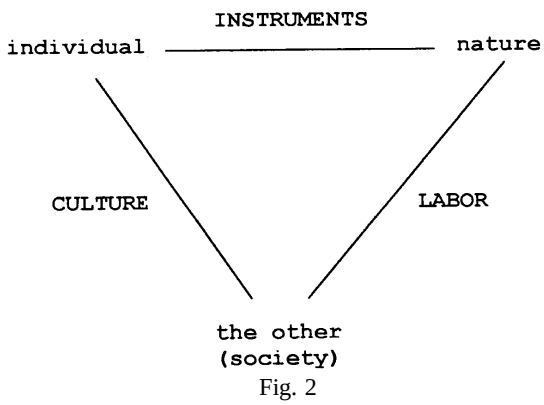

Fig. 2

In the human species these relations are intermediated by instruments, culture and labor, which have been essential in the development of civilizations (Fig. 2). They play a fundamental role in the development of individual and social behavior and of knowledge, which is the means of accessing the intermediaries.

It is a mistake to claim, as many mathematicians do, that this refers to other forms of knowledge and that mathematics has little to do with these relations. A holistic view of the history of mathematics shows the interrelations.

It is an undeniable right of every human being to share all the cultural and natural goods needed for her/his material survival and intellectual enhancement. This is the essence of the Universal Declaration of Human Rights (1948), to which every nation is committed. The educational strand of this important profession of faith in the future of mankind is the World Declaration on Education for All (1990), to which 155 countries are committed. Of course, there are many difficulties in implementing the resolutions contained in the document. But as yet this is the best instrument available that may lead to a planetary civilization, with peace and dignity for all mankind.

Aren't these the most fundamental principles to which we subscribe? Regretably, these documents are not known to most mathematicians and mathematics educators (Haggis/Fordham/Windham 1992).

In guise of conclusion

It is an unrelinquishable duty of human beings to cooperate with each other, with respect and solidarity, for the preservation of the natural and cultural patrimony. This is the essence of the *ethics of diversity*: *respect* for the other (the different); *solidarity* with the other; *cooperation* with the other. This is a sure road to quality of life and dignity for all mankind.

This is an unusual piece on mathematics education, many will say. But if one does not accept, very clearly and unequivocally, that her/his professional commitments are subordinated to a global ethics such as the proposed ethics of diversity, it will be very difficult to engage in a deeper reflection of her/his role as mathematics educator.

I see my role as an educator and my discipline, mathematics, as complementary instruments to fulfill these commitments. In order 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. Of course, this has everything to do with ethics.

I believe most mathematics educators share these views. No doubt they are authentically concerned with quality of life and dignity for mankind. But sometimes the relations between ideals and professional practice are not clear. Particularly in mathematics, there is an acceptance that we are fulfilling our broad responsibilities if we do our mathematics well, thus instilling attitudes of rigor, precision and correctness in the students' behavior. Undeniably true. But this is not enough. This must be subordinated to a much broader attitude towards life. This paper looks into the possibility of broadening this attitude.

I would like to finish by reporting on my practices with children, teenagers, college and graduate students and in-service courses for teachers. The problem is always the same: we have to awaken them for more reflective think-

ing, even when they do mathematics. I propose questions as "What do you think of [a current event or a philosophical question]?", let some discussion follow and then come with another question "What does mathematics have to do with this?" Of course, the educator must be prepared to move into a subject not very familiar to him. There is good literature available. As an example, with teenagers I read Musil's "The Young Törless" and with college students, Musil's "The Man Without Qualities", and excerpts of Borges. Literature offers a good area of reflections about the relations of mathematics, ethics and peace (D'Ambrosio 1993).

Notes

[1] Interview given to Ken Ringle, The Washington Post, June 11 1996

[2] See the polemics around the article by Alan Sokal published in Social Text, chastizing postmodernism, particularly sociologists of science, and also the article by Steven Weinberg (1996). Particularly interesting are articles by Michael C. Sullivan (1996) and by Evan M. Harrell II (1996). It is illustrative to look at the exchange of letters between Noam Chomsky and Marcus G. Raskin in Raskin/Bernstein, Chapter 4, Note 9, pp. 104–156

[3] This is the main issue of the polemics about Afrocentrism. See Lefkowitz 1996

[4] See D'Ambrosio 1981. I am particularly indebted to Norbert Wiener 1948, Humberto R. Maturana & Francisco J. Varela 1987 and Charles J. Lumsden and Edward O. Wilson 1981

[5] See White 1993. There is a growing movement of "Humanistic Mathematics", publishing regularly the Humanistic Mathematics Network Journal (ISSN 1065-8297. Harvey Mudd College, Department of Mathematics Education, 301 E. Twelfth Street, Claremont, CA 91711, USA)

[6] See for example D'Ambrosio (to appear); the book Margalit 1996 is also interesting. The International Network of Scientists and Engineers for Social Responsibility/INES offers a good electronic forum for discussion of these basic issues (http://www.mindspring.com/~us016262/ines.html)

[7] Three conferences of the PDME movement were realized: 1995: Bergen, Norway, 1993: Cape Town, South Africa, 1990: London, UK. Proceedings of all three are available (Noss et al. (Eds.) 1990, Juhe/Angehs/Davis (Eds.) 1993, Kjærgard/Kvamme/Lindén (Eds.) 1996). In the Eighth International Congress of Mathematics Education/ICME 8, in Seville, Spain, July 14-21, 1996, the WG 22 chaired by Richard Noss, entitled "Mathematics, education, society, and culture", focused on the political dimensions of mathematical education. The book Frankenstein 1989 is representative of this movement. See also Powell/Frankenstein 1997

[8] See the important oeuvre of Oliver Sacks, particularly Sacks 1995. Theories of consciousness also give rise to several academic controversy. See for example Papineau 1996

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