Scientific culture, science education and the risk society

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Earth provides enough to satisfy every man's need, but not every man's greed.
Mahatma Gandhi (1869-1948)

Abstract. There is enough data giving evidence that the current economical system is in collision route with nature's capacity of tolerance. Our planet does not have natural resources to keep current consumption pattern in the future. If this model is not modified, we will drain the resources of the planet, risking our survival. To protect against the risks of production and consumption the citizen should be identified with the scientific culture. That identity depends on permanent education, starting from the acquisition of the first letters, essential for the human being to assume his/her actor's role within the scenario of global events. It is necessary to educate the youths scientifically as if there was a 'planetary emergency'. It is also an urgent task to develop in service and training courses for our teachers via revolutionary curricular updating that will prepare them to discuss the risk society at both levels: local and global, imbedded in their scientific culture. Key words: scientific education – global and local risks – social individual participation – public social responsibility– teacher education and continuous education.

Introduction

Concerns about the ´role´ of the scientific-technological success of mankind threatening the bases of our existence are not recent. More than 60 years ago, discussing the possible existence of other beings in the Universe Enrico Fermi (Physics Nobel Prize, 1938) asked: *May be the case is that very advanced civilizations do not survive to their own technology?*

Science education across most countries does not presently reach the broad objectives set by the principal international agencies recommendations (UNESCO, ICASE) neither contributes for the development of a scientific culture required from the citizen that faces the challenges of a ´risk society´ at local, regional and global levels. Consequently, it is necessary to educate the youth scientifically as if there was a 'planetary emergency' as reported by the Intergovernmental Panel on Climate Change (IPCC)[2]. To do so we propose that changes should be made in school science, introducing new curricula that emphasize discussions of planetary problems, being the main target the undergraduate and in service courses for all science teachers. Our claim is that most science educators in most countries have a ´fragmented perception and insufficient consciousness of the extent and seriousness of the planetary problems´ (Gil Perez et al, 2003).

Although scientific literacy as defined by the OECD Programme for International Student Assessment - PISA[3] (2006) encompasses reflective and participative science educational dimensions, we considerer that science teacher curriculum should go beyond and consider as one of its core issues the citizenship component. For this aim we propose a broader notion of scientific culture, defined as followed: a composite of Science literacy, originated from the learning of formal science in school (products and processes) + Capability of a public understanding of science (that can apply that knowledge to social and political contexts) + Capability to take actions derived from global social responsibility demands (accountability)

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[2] Intergovernmental Panel on Climate Climate, 2007 Report. http://www.ipcc.ch/.
[3] http://www.oecd.org/document/13/0,3343,en_32252351_32236225_33666189_1_1_1_1,00.html

that many a time collide with immediate personal habits and interests. That is, a citizen that recognizes the meaning of sustainable development is meeting the needs of the present without compromising the ability of future generations to meet their own needs" (UN, 1987). This perspective is in search of educational approaches that generate individual and collective local actions, at different levels, and which are based on risk assessment.

Production and management of risks in modern society (Beck, 1992) are generated by the non sustainable development of science and technology (S&T), centered in a global economy, that disregards a fair division of earth resources for all. Current production and consumption patterns give evidence that we are in an eminent collision route with nature's capacity to deliver the desired goods. The challenges presented by the risk society (RS) go beyond the individual's capacity to reverse global scale hazardous situations.

At the turning of this millennium, a major challenge posed to all of us, more specifically to the world's science education and the media communication systems, is: what values, knowledge, skills and attitudes should be communicated to our youth in order to prepare them to counter balance the risk society guaranteeing quality of life for all?

We argue that school has a large contribution and the responsibility to answer the question above.

In this paper we want to reflect about the following:

- Do young people understand that the future of this planet is not casuistic and does not necessarily happen by the forces of nature?
- Will a (formal) scientific education prepare the current generation to believe and ´fight´ for a peaceful and sustainable world?
- Is it possible to build up educational curricula that can be implemented in order to fulfill these expectations?

Science teacher education in the risk society

There is a consciousness, at different levels of society (government, school authorities, teachers and society at large), as much in Brazil as in most countries, that something needs to be done urgently in order to educate the youth for life in the RS. Acknowledging the role that understanding S&T plays in modern society is no novelty. Along the years many courses, such as STS, Science for all, Environmental education, Science for public understanding and many others were implemented without noticeable effect. But, how to fill the gap between acquiring such knowledge that "empowers individuals to participate appropriately in the determination of public policy where issues of science and technology impact on their lives" (PISA, 2006) and using it as a code of conduct, remains a question to be answered. The severe disjunction between what is learnt in formal science lessons and the kind of scientific knowledge we use in everyday context – the two domains problems – suggests a sociological approach to science education that brings politics and economics into the picture, as well as puts social values and social consequences at the top of criteria of relevance (Ziman, 1990).

It is easy to blame science teachers for their lack of commitment towards the implementation of educational innovations that will promote scientific literacy. Nevertheless, the necessary wide spread and long reaching changes will not happen without a firmly grounded confluence of structural policy and economic measures that empowering teachers for the desirable changes.

A country's educational system depends on its political spheres of influence. As an example we will examine the Brazilian context. We need to consider such issues common to developing countries: inequality and violence, illiteracy, low IHD, a very large number of lay teachers and a lack of science teachers at basic level, low and poor budgets distribution, teachers working conditions, undernourished children, limited school infrastructure among the many other illnesses that the educational system face. Nonetheless, one of the worst of these ´malaises´ are the negative impact of some attempts of implementing educational policies (official regulations and legislations), adding more problems than solutions, and many a time requiring to be modified the 'day after'.

The idea of a program that insures the development of education for sustainable development becomes a real challenge. It is necessary but not sufficient that the content curriculum should at the same time provide the teacher with a solid basic science background (biology, physics and chemistry), a sound numeracy capability to understand facts and data as well as elements of social sciences (history, human geography, epistemology, economics, etc.).

What kind of curricula will then prepare the teachers to work within his/her individual classroom (where he/she is king/queen) as a participant of a school's pedagogical project which leads to an ethical revolution. As Nobre (2007) puts it (…) *with scientific, political and philosophical dimensions that gives birth to a new Homo Sapiens*. It is obvious that such polyvalence can not be centered within the individual we today call the science teacher, neither the present curricula for the pre-service teacher training can be considered consistent with the challenges posed by such a demanding program.

Since the 1970´s the ecological and environment concepts permeate the literature, i.e, Lutzenberg in Manifesto Ecológico, 1976; World Declaration of Education for All, 1992; Rio Declaration on Environment and Development, 1992; Project 2000+, 1993; UN Education for Sustainable Development, 2002. Project 2000+ involved 80 countries and 400 delegates calling for continuing provision for teacher education in this field and for task forces to be set up to foster scientific and technological literacy for all by developing educational activities designed to set science and its applications in a wider social and cultural environment!

Global challenges are fundamentally of ethical nature (Aikenhead, 1985, Elmose & Roth, 2005) and therefore they should permeate educational efforts as well as discussions presented in the media. Following Solomon question (1998) - *Can [academic] science be taught so that it connects with attitudes, personal values, and political issues?* –, we propose that considerations on social, economic and political implications of science and technology should take part of regular academic undergraduate science education programs. They should reflect different perspectives, opening a large spectrum of ´significances´ for the taught content, supported by appropriate selections of numerous data available, i.e Diamond (2005).
Basic science should strain to overcome students´ dichotomy forms of thought: school brain (used in science class) and world of life brain; one of the hindrances to the students' understanding of current planetary problems. Lemke´s (2005) claims on world wide science education status should be considered: science content is too abstract; curricula have no empirical usefulness for non specialists; it is boring and alienating; content is shallow and superficial; all students learn the same content, in the same way; little emphasis is given on creativity, moral concerns, historical development, and social impact; projects an inhumane image of science as existing apart from the lives of people who do science as well as those who use it and are affected by it.

A science component approach

Margulis&Sagan (1997) claim that a genuine school scientific education should answer subjects of intrinsic interest for the human being, to elucidate the relationships between the live organisms and the environment. The questions to be answered by such a curriculum are a challenge for any science teacher: what are the relationships as ´mammals homo sapiens´ with the environment? what area and what type of soils are necessary to assure a person's health and growth? and of a family? what is life? how did it begin and develop? what is sex and when the system of two sexes appeared?

Raymo (1998) suggests a minimal agenda, enough to insure the formation of a scientific identity. It contains basic topics that provide fundamentals of scientific literacy that all students should know at the end of their compulsory schooling: Size, age, structure and dynamical evolution of the Universe. With this information the student will understand the message of the last topic: The Universe is wonderful and we should learn to preserve it.

It is worth to remind that preservation of natural environment and science education can be practiced with success. The December 2004 tsunami disaster killed over 200,000 people in 13 countries. Most of the fatalities occurred in coastal regions that had undergone real state development for tourism and housing. On the other hand, fishing populations in certain coastal areas of India were saved from the devastating effect of the tsunami because they had protected their original mangroves. In Phuket, Thailand, an 11 years old schoolgirl saved over 100 tourist lives recognizing the eminence of a tsunami, putting in practice what she had learned two weeks earlier in her geography class.

An ethical component approach

If thirty years ago population growth was the source of all evils, at the present time consumption is the real issue, as Le Bras (2007), a historian and demographer, points out. There is a need to reduce the social and resource impacts of lifestyle consumption habits to ensure the equitable availability of resources for all around the world. The problem, Le Bras states, is that "more and more, developing countries vie to emulate the American Way of Life". Can education create a more critical and responsible attitude towards consumerism in our everyday lives? Education and training for sustainable production and consumption depends upon literacy and basic education. We suggest that pre-service courses curricula contemplate the development of necessary skills to prepare the future consumer citizen to become an individual *whose choices are based on ethical, social, economic and ecological considerations and who care and act responsibly on family, national and global levels* (United Nations Decade of Education for Sustainable Development framework, 2005-2014). Much can be learned from the experience acquired by Erasmus Project Consumer Citizen Network[4]– CCN (http://www.hihm.no/concit/) which aims *to develop innovative interdisciplinary approaches to deal with the balance between material and non material well-being as well as to reflect on efficient ways to translate sustainable development values*

[4] The Consumer Citizenship Network (CCN) is an Erasmus 3 thematic network project for 2003-2006 and for 2006-2009, lead by Hedmark University College, Norway. It is an interdisciplinary network of educators from 123 institutions in 37 countries and includes UNESCO, UNEP and international citizenship and consumer organizations who all recognize the pressing need for constructive action by individuals in order to achieve sustainable consumption and global solidarity.

into viable consumption habits. CCN defines itself as "an interdisciplinary network of educators, researchers and representatives of non governmental organizations who share an interest in how the individual's role as a consumer can contribute constructively to sustainable development and mutual solidarity."

We believe that pre-service teachers´ courses are indeed a valuable environment to develop such approaches because they are based on cooperation, solidarity and responsibility. Responsibility means to be answerable, to be accountable. Taking responsibility is an act of mature civic participation by which we, individually or collectively, contribute to the development of a more just and caring society. Introducing consumer citizenship as part of education for sustainable development in undergraduate courses represents a difficult effort which aims to prepare the next generation to become caring citizens who exercise their rights and responsibilities locally, nationally and globally.

Final comments

As Hazen and Trefil (1993) state: (...) *it is necessary to have knowledge to understand public debates on subjects of science and of technology; a mix of facts, vocabulary, concepts, history and philosophy. It is not the specialists' speech, but more generic and less formal knowledge. The participation of a wider spectrum of society in education is unavoidable.* According to Roth (2006) (…) forms and contents of participation crucially hinge on the concept and praxis of responsibility, or more appropriately, collective responsibility. Experts and Scientific Societies have a duty to implement ethical procedures and reflect their real social contributions. Civil society organizations, NGO´s and other associations should be given strong support.

The civic role of science education should involve, at all levels, qualifying students to become responsible citizens that are capable to exercise continuous surveillance over the public affairs, health and preservation of freedom. According to Gil Perez et al. (2003), formative actions to change the perception of the teachers can be successful, when grounded in reflection based on abundant available data. In order to reach the scientific culture as stated in the first section, we propose the implementation of three curricular components: i) with emphasis on content and method with a broader scope of science; ii) that brings awareness of social and political global problems in the context of S&T contents and iii) that establishes good practices in fair consumer citizenship behavior, individual and collectively, when facing hazardous situations.

The implementation of such curriculum will require updating science teachers´ training programs prepared for the daily classroom discussion of planetary problems. This type of education is too complex and difficult to be presented as completely consistent within an integrated academic curriculum. Nevertheless, such complexity should not be a hindrance for its implementation. Every program should be able to make choices in accordance to their social educational context. Sometimes the choices will seem narrow, vague, content limited or even dogmatic. Yet, we need to try for the sake of life on Earth.

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