A proposal to enrich teachers' perception of the state of the world.
First results

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SUMMARY   *The "state of the world" has become an object of growing concern during recent decades. For this reason educators have been asked to contribute to public awareness and understanding of the problems and challenges related to our planet's future, in order to make possible citizens' participation in well grounded decision-making. In spite of these appeals, attention paid by science teachers and science education researchers to the present state and future of the world is still very slight and constitutes a serious missing dimension in science teachers' education. In this paper we describe a workshop conceived to favour a better teacher perception of global problems and possible remedies, as well as the promotion of more favourable attitudes towards the incorporation of these issues in the curriculum. Results of the implementation of this workshop are presented.*

Introduction: a missing dimension

Up until the second half of the twentieth century, our planet seemed to be immense, limitless and the effects of human activities were locally segmented (Fien, 1995). But these frontiers have begun to blur during the last decades and thus many problems (greenhouse effect, ozone layer depletion…) have acquired global characteristics which have led to concern for the state of the world. This has brought about the creation of international institutions such as the *World Watch Institute*, whose works give us a well-documented and sombre perspective of the situation of our planet (Brown et al., 1984–2002). According to Giddens (1999), "There are strong and objective reasons to think that we are living amidst a crucial historical transition. Besides, the changes affecting us cannot be reduced to a specific zone of the globe, but are spread everywhere".

The situation is so worrying that at the Conference of the United Nations for Environment and Development, held in Rio de Janeiro in 1992, a course of action was asked for from the educational system to make citizens aware of the problems and prepare them for well founded decision-making (U.N., 1992). Answering this call, the *International Journal of Science Education* dedicated, in 1993, a special issue to the theme "Environment and Education" (Gayford, 1993), in which the editorial recognised the lack of enough science education research in this field of study.

What is happening a decade after the Rio Conference? We continue to find an almost complete absence of works on the state of the world, according to an analysis of the articles published in the most important international science education journals (Edwards, 2000), with only a few exceptions (Sáez & Riquarts, 1996; García, 1999; Anderson, 1999).

As Orr (1995) denounces, "we still educate the young for the most part as if there were no planetary emergency". In the same vein, several authors lament the scarce attention given to planning for the future by our educational systems (Hicks & Holden, 1995; Anderson, 1999). Most of the works on environmental education are focused exclusively on local problems without paying attention to the global situation (González & De Alba, 1994). Hicks & Holden (1995) reach the same conclusion after an analysis of 25-years of environmental education in the United Kingdom. A correct "global perception of the world situation" is still negligible (Deléage & Hémery, 1998). On the other hand, these works show a reductionist approach, focusing almost exclusively on natural resources, ignoring the strong connections between natural environment and social, cultural, political and economic factors (Fien, 1995; García, 1999). Daniella Tilbury (1995) writes: "environmental and development problems are not solely caused

by physical and biological factors, but (…) an understanding of the parts played by aesthetic, social, economic, political, historical and cultural elements is required".

As a result, in *Agenda 21* (U.N., 1992) educators of every subject where asked to contribute to a correct perception of the current global problems that Humankind has to face. But this perception must not make us fall into the depressing and ineffectual discourse of "it will only get worse": "Our daily existence will not improve if our anguish increases. It is not suffering which will help us, but lucidity and creativity" (Folch, 1998). In fact, Hicks & Holden (1995) state: "To study only the problems at best leads to indignation and, at worst, despair". Thus, the authors propose that students should be stimulated to explore "alternative futures" and to participate in actions which may favour these alternatives (Tilbury, 1995; Mayer, 1998). We educators of every field should contribute to enable citizen participation in the search for solutions. But there is a serious difficulty in fulfilling this task, because our perceptions of the world situation are, generally, as fragmented and superficial as those of most citizens, including the majority of national and international leaders in the fields of politics, business or science (Mayer, 1995). For this reason, teacher preparation should be the "priority of priorities" (Fien, 1995).

But, although science teachers' perceptions of the state of the world show a serious lack of understanding (Gil et al., 2000b; Edwards et al., 2001; Praia et al., 2000), we are convinced that if we favour a global discussion in some depth, based on founded documentation, we may obtain more correct perceptions and more favourable attitudes from teachers for the inclusion of this issue in education. Bearing this in mind, we shall present a workshop proposal aimed at teachers in service and in training. This is an open proposal which has been tested and reviewed several times (Gil et al., 2000a) and which can be adapted to concrete circumstances such as the time available or teachers' background.

We shall describe this workshop in the first part of this paper and in the second part we shall present some results obtained from its application.

I. Description of the workshop "Current problems and challenges that humanity has to face"

With this workshop we aim to contribute to the enrichment of teachers' perceptions of the world situation and to change the usual lack of attention paid into a conscious attitude. We do not intend an indoctrination, but to make teachers aware of the current scientific and social debates about the state of the world.

The workshop consists of a programme of activities conceived to favour a collective reflection by teachers, grouped in teams of about five members. These activities are followed by comments which explain the goals of, give support information to and present some qualitative results obtained from the essays. As a starting point we conducted this first activity:

Activity 1. *Enumerate the problems and challenges which, in your opinion, humankind will have to face in the near future, in order to construct a view as complete and correct as possible of the current situation and of the measures that should be taken.*

Comments A.1: When we ask for individual teachers' reflections, we generally get very fragmented views, often exclusively focused on the problems of pollution, without mentioning other aspects closely related and equally relevant to the state of the world (García, 1999; Vilches et al., 2002).

This shows the necessity to favour a well documented discussion about this problematic situation, so that we can obtain a more correct perception of the world situation and of the measures to be taken. This is, very precisely, the aim of this workshop, answering requests from experts and international organisations (Myers, 1987; U. N., 1992; Gore, 1992; Sáez & Riquarts, 1996; Colborn, Myers & Dumanoski, 1997; Folch, 1998).

If we propose this task to teams of teachers, instead of asking for an individual reflection, we can expect more positive results as correspond to a debate which enriches individual visions. In fact, although each team continues to express reductive and rather incomplete views, the ensemble of contributions

usually covers a great part of the aspects studied by experts. This becomes a guide for the development of the workshop.

After this initial reflection, the successive activities are aimed at favouring discussion in small groups of each one of the problems and challenges enumerated. This is followed by a general inter-group discussion and a comparison with experts' points of view. We have structured this task in several sections, beginning with an analysis of the growing degradation of the planet due to human activity.

1. The degradation of the environment

Perhaps the most common problem signalled when we reflect on the world situation is environmental pollution and its consequences.

A.2. *Explore more deeply the problem of pollution, enumerating its different forms and their consequences.*

Comments A.2: After this discussion, the contributions are usually quite rich and signal -in accordance with many expert studies- that environmental pollution is nowadays without borders and affects the whole planet (World Commission on Environment and Development, 1987; Brown, 1998; Flavin & Sunn, 1999; Folch, 1998). However, these contributions refer indistinctly to forms of pollution and their consequences. Therefore, it is necessary to help teams to distinguish them. As forms of pollution we find frequent references to:

- Air pollution by heating, transport, industrial production;
- Superficial and underground water pollution by liquids of industrial, farm and urban origin;
- Soil pollution by waste dumping, in particular by solid dangerous products: radioactive material, heavy metals, non-biodegradable plastic…;

There are also references to accidents connected to the production, transport and storage of dangerous substances (radioactive material, heavy metals, oil products…) as contributors to soil, water and air pollution.

On the other hand, it is important to focus on other forms of pollution less frequently mentioned, but equally as dangerous:

- Acoustic pollution, due to industrial activity, transport and inadequate urban planning, which can cause serious physical and psychological damage;
- Light pollution which affects the vital processes of living beings;
- Visual pollution from unsightly waste dumping, the absence of aesthetic concern for industrial and city buildings, etc.;
- Space pollution with so-called "space waste", the consequences of which may prove to be serious to the communication network which has converted our planet into a global village…

Among the consequences of pollution, acid rain, the green-house effect, the destruction of the ozone layer… and global climatic change are usually mentioned. Some of the consequences of pollution appear related to the destruction of natural resources. Thus, when acid rain is mentioned, reference is made to the destruction of forests. This is an example of a close connection between different problems and allows us to continue to the discussion of natural resource depletion.

A.3. *Point out the resources whose disappearance may be most concerning.*

Comments A.3: Among the natural resources whose depletion is most worrying (Brown, 1993, 1998; Folch, 1998; Deléage & Hémery, 1998), the teachers mention fossil energy and mineral resources, but frequently there is no mention of the serious and accelerating loss of the fertile top soil or of water resources (over extraction of subterranean waters, etc.).

The environmental pollution problem and resource exhaustion are particularly worsened by the process of urbanization, which, in a few decades, will have multiplied the number and size of large cities.

A.4. *Consider possible reasons why city growth may prove to be a great concern.*

Comments A.4: This is an aspect that initially is not taken into consideration by the teachers. For this issue it is necessary to comment on the reasons why urban growth is of great concern today (World Commission for the Environment and Development, 1987; O'Meara, 1999). Experts refer, among other things to:

- Waste concentration and its polluting effects on soils and waters;
- Air and sound pollution (the result of traffic density, heating, etc.) with their respective consequences of respiratory diseases, stress, …;
- Destruction of agricultural soil;
- Speculation and lack of planning, which leads to chaotic growth ("illegal" construction without the proper infrastructures), use of substandard materials, occupation of zones vulnerable to natural catastrophes, …;
- More time and energy needed for commuting;
- Separation from nature;
- Social exclusion and citizen insecurity, which increases with cities' dimensions.

As Folch (1998) concludes, "populations of reduced dimension do not have the necessary critical mass to offer the desirable services, but large populations do not do it better, although services become much more expensive…".

The problems mentioned so far -pollution, resource depletion and chaotic urban growth- are deeply interconnected (World Commission on Environment and Development, 1987) and cause the degradation of the environment:

A.5. *It is necessary to deepen our understanding of the degradation of the environment indicating the most troubling aspects.*

Comments A.5: As examples of the degradation of the planet, we can mention, firstly, the destruction of fauna and flora with the growing disappearance of species and ecosystems, which threatens biodiversity and the continuity of human life on the planet. Proof of the loss of biodiversity is more and more convincing for many authors (World Commission on Environment and Development, 1987; Folch, 1998; McGinn, 1998; Tuxill & Bright, 1998; Mayor Zaragoza 2000…) and the main causes, according to a World Bank Report (Banco Mundial, 2000), can be found among modern agricultural techniques, deforestation and destruction of marsh land and ocean habitats, phenomena closely related to economic growth. "Nature is diverse by definition and necessity" -summarises Folch (1998)- "If humankind maintains its current behaviour of attacking diversity, humankind will pay highly for its carelessness". More concretely, we can refer to the destruction of life and water resources in rivers and seas and to desertification: each year, according to the World Commission on Environment and Development (1987), six million hectares of productive land are transformed into sterile deserts.

These degradation processes affect very particularly the human species, by generating diseases which affect the immune and nervous system, skin, etc., or by increasing natural catastrophes (draughts, heavy rains, …) which can result in the destruction of dwellings and agricultural zones, and produce famine.

We should add that reference is seldom made to another serious aspect of the degradation of the quality of life: the loss of cultural diversity, this is to say, of the diversity of languages and ways of life. This frequent omission is an example of the reductive orientation which has characterised environmental education (González & de Alba, 1994; Fien, 1995; Tilbury, 1995; García, 1999). We shall now discuss this question in depth.

A.6. *Consider the importance and the reasons for the loss of cultural diversity.*

Comments A.6: Many studies have commented upon the seriousness of the destruction of cultural diversity (Delors et al., 1996; Maaluf, 1999; Giddens, 1999). A destruction that produces "a sterile uniformity of cultures, landscapes and ways of life" (Naredo, 1997). "Cultural diversity is also a dimension of biodiversity", states Folch (1998), "albeit in its sociological facet, which is the most

characteristic and singular of humankind". In the same sense, Maaluf (1999) asks: "Why should we be less concerned with cultural diversity than with animal or vegetal diversity?". This loss of cultural diversity is connected to:

- The exaltation of cultural forms (religious, ethnic…) considered to be "superior" or "true", which leads to their imposition on others, generating social and political conflicts, movements of ethnic cleansing…;
- Opposition to the linguistic pluralism of native populations or migrant groups, generating school failure and social turmoil;
- Imposition by the culture industry, through mass media control, of impoverishing patterns which are generators of exclusion;
- Imposition by educational systems of the same cultural patterns on the whole of youth, excluding in particular linguistic pluralism (Mayor Zaragoza, 2000).

Enrichment produced by cultural diversity should be emphasised, enhancing the right to difference and, at the same time, openness to the universal (Delors et al., 1996), but without accepting "cultural expressions" which do not respect human rights as, for instance, women's sexual mutilation (Maaluf, 1999).

2. Causes of degradation

The ensemble of problems mentioned characterises a clearly *unsustainable* growth which produces the degradation of human life and that of other species. We need to clarify what can be considered as *sustainable* development, one of the basic concepts in the current reflection on the world situation.

A.7. *Explain what can be understood by sustainable development.*

Comments A.7: The teams' contributions are coherent with the definition of sustainable development given in 1987 by the World Commission on Environment and Development: development which "meets the needs of the present without compromising the ability of future generations to meet their own needs". This definition has obtained a wide consensus, although sometimes this consensus is purely formal and obscures serious misunderstandings as, for instance, interpreting 'sustainable *development'* as a 'sustained *growth'*, which is, of course, the opposite.

As Daly (1991) points out, we have to distinguish between growth and development: growth is a quantitative increase in a physical scale; development is the qualitative improvement or the unfolding of potentialities… Given that the human economy is a subsystem of a global ecosystem which does not grow, although it develops, it is clear that economic growth is not sustainable over a long period. For this reason, the expression 'sustainable development' has begun to be critically analysed (Plant, 1995; Luffiego & Rabadán, 2000), giving place to the use of other expressions such as *'construction of a sustainable society'* (Roodman, 1999). Nevertheless, sustainability continues to be "*the central unifying idea society most needs at this point of human history*" (Bybee, 1991).

After having identified some of the problems that Humankind faces today associated with unsustainable growth, we have to consider their possible causes.

A.8. *Try to identify the causes of the growing degradation of our planet.*

Comments A.8: In order to undertake this task, we have to overcome the reductionism that has guided environmental education exclusively towards natural systems, while ignoring the connections between physical environment and social, cultural, political and economic factors (Fien, 1995; Tilbury, 1995). The concept of Environmental Education for Sustainability (E.E.F.S.) has thus been developed, using a holistic approach to the study of environmental and development problems.

This holistic approach allows us to identify, as the origin of the degradation process, the current economic growth guided by the search for short-term private benefits whose instigators act as if the planet

had limitless resources (Ramonet, 1997; Brown, 1998; Folch, 1998; García, 1999). However, it is necessary to elicit the causes of such unsustainable growth and to understand their connection with:

- Consumption models of so-called "developed" societies;
- The demographic explosion;
- Extreme inequalities between different human groups, associated with the imposition of private interests and values.

It is important to note that the role these aspects play, particularly the demographic explosion, is not easily recognised because of strong political or religious prejudices. This forces us to deal with these problems carefully. Initially, we have to clarify a misunderstanding about the roll of scientific and technological development in environmental degradation:

A.9. *Discuss the role played by scientific and technological development in the degradation process of the planet.*

Comments A.9: There is a growing tendency among citizens, and even among science teachers, to blame science and technology for the environmental degradation in process on our planet, with the destruction of the ozone layer, acid rain, etc. In our opinion this is a serious oversimplification. We cannot ignore that many scientists study the problems humanity has to face nowadays, draw attention to the risks and look for solutions (Sánchez Ron, 1994; Giddens, 1999). It is true that scientists and technologists have a clear responsibility for activities such as the production of substances which are destroying the ozone layer, but along with businessmen, economists, workers or politicians. For this reason, criticism and calls to responsibility should be extended to all of us, including the "simple consumers" who use dangerous products. In other words, environmental problems have a social origin: "We suffer from serious environmental problems as the consequence of no less serious deficiencies in the functioning of social systems" (Folch, 1998). We shall now approach some of these deficiencies:

A.10. *Point out some characteristics of consumption patterns that may make sustainable development difficult.*

Comments A.10: Discussion and the use of scientific literature helps us to understand that consumption in "developed" societies continues to grow as if the Earth's capacities were endless (Daly, 1991; Brown & Mitchell, 1998; Folch, 1998; García, 1999) and that such consumption has the following characteristics:

- It is stimulated by aggressive advertising, aimed at the creation of needs, ephemeral fashions and product-durability reduction;
- Promotion of products in spite of their high energy consumption and ecological impact;
- Short-term benefit guidance, without concern for the consequences in the medium and long terms.

Excessive consumption cannot be viewed as something positive: "Immediate gratification is addictive but is not capable of hiding its effects of permanent frustration, its incapacity to increase satisfaction. The 'more is better' culture feeds on its own inertia, but it is more a damnation than a promise" (Almenar, Bono & García, 1998).

Now we shall consider the role played by the demographic explosion.

A.11. *To what extent can the current demographic growth be considered a difficulty for the success of sustainable development?*

Comments A.11: Given the frequent resistance to accepting that a growing population poses a serious problem today, it is necessary to present some data about the influence it has in relation to the present unsustainable rate of economic growth (World Commission on Environment and Development, 1987; Orr, 1994; Hubbert, 1993; Ehrlich & Ehrlich, 1990, 1993; Brown & Mitchell, 1998; Folch, 1998):

- Since the second half of the 20th century, more human beings have been born than in the whole of humanity's history. As some authors have pointed out, soon there will be as many people alive as deceased in all history; half of all human beings that have ever existed will be alive (Folch, 1998).
- The *present* population would need the resources of three Earths to generalise the standard of living of the developed countries (United Nations, 1992).
- Although the rate of population growth has lately diminished, the population increases every year by about 80 million and will double again in a few decades.

Such facts have led Ehrlich & Ehrlich (1990) to affirm emphatically that, without any doubt, the demographic explosion will soon stop. What we do *not* know is if the end will arrive in a gentle way, through a diminution of the birth rate, or tragically, through the growth of mortality. These authors add that the demographic explosion is the most serious problem humanity has to face today, given the time gap between the start of an appropriate control programme and the beginning of population decline. These considerations contrast with some countries' growing concern about the decrease in the birth rate. A recent report by the U.N. on the evolution of the working population signals that at least a minimum of four-or-five-workers-per-pensioner are needed to enable the welfare systems to be maintained in developed countries. Thus, one fears that this ratio will decrease rapidly, thereby making the welfare system impossible, given the low European birth rate.

A.12. *Comment on the problems in the welfare system due to the low birth rate.*

Comments A.12: Thinking in terms of the four-or-five-workers-per-pensioner ratio is a good example of how often we refuse to take into account the medium-term consequences of our actions. Effectively, the majority of those "four to five workers" will also have to become pensioners, demanding a new multiplication of the number of workers. This, of course, is not sustainable, even if we resort to immigration, for immigrants will also have the right to a pension. The consequence in the medium-term would be an unsustainable population growth rate. The fact that most Europeans (including educators and politicians) see the current low birth rate as a problem is quite illustrative of the near absence of values related to sustainability (Almenar, Bono & García, 1998).

Brown & Mitchell (1998) summarise the question by saying that population stabilisation is a fundamental requirement to halt the destruction of natural resources and guarantee the fulfilment of everyone's basic needs. In other words, a sustainable society is a demographically stable one, but the current population is far from having that stability.

On the other hand, over-consumption in developed countries and the demographic explosion in others provokes grave inequalities, with thousands of millions of human beings who can scarcely survive, mainly in developing countries, while a fifth of the human population offers its high-consumption model (United Nations Development Program, 1997; Folch, 1998; Mayor Zaragoza, 2000).

A.13. *What could be the consequences in the long term of the current extreme inequalities between different human groups?*

Comments A.13: As in the case of demographic growth, the attention given to these inequalities by environmental education has been utterly insufficient. However, many analyses have stressed the serious consequences of such inequalities (González & de Alba, 1994). These analyses have shown that eighteen percent of humanity possesses eighty percent of the world's wealth. If distribution of wealth does not occur, it could result in great conflicts, in massive emigration and in space occupation by force. In the same vein, Folch says (1998): "Poverty -unfair and conflicting- leads inexorably to an unsustainable exploitation of natural resources, in a desperate attempt to pay back interest, satisfy external debts and gain some benefit. This upsetting poverty and consequent discrimination can give birth to nothing more than dissatisfaction and anger, hate and revenge". And we must not forget that these inequalities and discrimination weigh especially upon women (Giddens, 1999).

We will now analyse in depth the different kinds of conflicts associated with these inequalities and the imposition of private interests and values on them:

A.14. *Identify the different types of conflicts which can result from the imposition of private interests and values.*

Comments A.13: We can refer to different - although intimately related- types of conflicts (Delors et al., 1996; Maaluf, 1999; Renner, 1999; Mayor Zaragoza, 2000):

- Wars, with their arms races and destruction;
- Class, interethnic and intercultural confrontations, which lead to terrorist behaviours in groups and states;
- Mafia activities: trafficking with weapons, drugs and people, thereby contributing to violence;
- Trans-national enterprises which seek to avoid any democratic control;
- Forced migrations of thousands of people, worsened by the clashes between nations;
- The risk of democratic retrogressions resulting in citizens' growing lack of interest in public issues.

Everything noted so far points to a hopeless portrayal that some have described as "a guide-less world" (Ramonet, 1997), or even worse, as a world with a definite course towards ruin and the extinction of humanity (Naredo, 1997; Lewin, 1997).

However, a holistic approach to the state of the world demands more than diagnosing the problems; it is also necessary for teachers to study the possible solutions to the current planetary crisis, in order to help their pupils explore alternative approaches and to participate in actions aiming to help solve these problems.

2. Measures to be taken

A.15. Suggest w*hat kind of measures could be taken to solve the problems described and make possible a sustainable development*

Comments A.15: We can structure the different proposals to make possible a sustainable society, put forward by researchers and institutions (and also by the groups of teachers attending the workshop) into the following three groups:
- *Technological* measures to better satisfy human needs without damaging the environment;
- *Educational* measures to make possible the necessary changes in personal values and life-style choices;
- *Political* measures at a planetary level to avoid the imposition of particular interests and values harmful to other people or future generations.

We shall now discuss in detail each one of these measures.

A.16. *Which characteristics should technological measures have in order to favour a sustainable development?*

Comments A.16: There is general agreement about the need for technologies which favour sustainable development (Gore, 1992; Daly & Cobb, 1989; Daly, 1991; Flavin & Sunn, 1999). The proposed measures extend from the search for new energy resources, the improvement of efficiency in food production, the prevention of illnesses and catastrophes, to the diminution and recycling of waste. But, what are the criteria to distinguish when technology favours sustainable development? Daly (1991) suggests two obvious principles:

- The gathering rates of resources must not surpass the regeneration rates (or, for resources that are not renewable, the creation of renewable substitutes).

- The waste production rates must be lower than the assimilation capacities of the planet's ecosystems.

Additionally, Daly insists on the fact that we are passing from an economy of an *empty world* (where technology was the limiting factor for taking profit from the exploitation of natural resources) to an economy of a *full world,* where natural capital will be more and more the limiting factor. In other words,

the aim of technology for a sustainable development must be to increase the efficiency of the use of the resources, rather than raise their extraction rate. This means, for instance, that we need to invent more efficient lamps instead of constructing more electrical power stations.

Although technology has an important role to play, it is necessary to question the widespread and erroneous idea that the solutions to the serious problems which humanity has to face today depend solely on better knowledge and on more advanced technologies: options and dilemmas are essentially matters of ethics (Tilbury, 1995). This conclusion directs us in part to the educational measures we have to consider.

A.17. *What educational proposals may contribute to sustainable development?*

Comments A.17: Most of the groups propose educational measures to contribute to a sustainable society which are coherent with the recommendations of experts on sustainability (United Nations, 1992). These measures put the accent on global analyses and solidarity (Delors et al., 1996), in opposition to the usual tendency to attend to particular interests in the short term (or to behave in a way that corresponds to an 'empty' world of isolated compartments). We need an education that contributes to a correct perception of the state of the world and prepares citizens for decision-making (Aikenhead, 1985, 1996), generating responsible attitudes and behaviours (Bybee, 1991; Fien, 1995; Tilbury, 1995; Mayor Zaragoza, 2000) oriented to the attainment of a culturally plural and physically sustainable development.

Questions like "What energy policy should be promoted?", or "What role should be given to genetic engineering in the food industry?" and "What controls on genetically modified food production should be introduced?", demand informed decision-making and the adoption of suitable policies (Jiménez-Aleixandre & Gallastegui-Otero, 1995). We need an education that promotes responsible behaviours, not just favourable opinions and attitudes (Almenar, Bono & García, 1998).

Some authors have signalled that these responsible attitudes and behaviours cannot be attained without overcoming the typical anthropocentric stance that gives priority to human beings over the rest of nature (García, 1999). But, in our opinion, it is not necessary to abandon an anthropocentric point of view in order to understand the need to protect the environment and biodiversity. Who could continue to promote an unsustainable exploitation of nature after becoming aware of the serious dangers that this entails for his or her *own* children? An education for a sustainable society should be based on what can be reasonably understood by most people, even if their ethical values are more or less anthropocentric. In other words, the borderline should be one that separates people who have, from people who do not have, a sound perception of problems and an inclination to contribute to the necessary decision-making and actions. Such a perception should be sufficient to understand, for instance, that an education for sustainable development is incompatible with aggressive publicity which stimulates non-intelligent over-consumption; is incompatible with simplistic "explanations" which attribute any difficulty to "foreign enemies"; and is incompatible with the promotion of competitiveness, understood as a contest to achieve something at the expense of others who are pursuing the same objective (Chomsky, 2000).

It is necessary for such an education to question conceptions that are presented as "obvious" and "unquestionable", without alternatives, thus obstructing the possibility of making choices. This is the case with the idea of *competitiveness*. Everybody speaks of competitiveness as something absolutely necessary, without realising that success by one person or group in a competitive battle implies the *failure* of others. And this is incompatible with the aim of sustainable development which has necessarily to be global and embrace the whole planet.

Instead of promoting competitiveness, we need an education system which helps us to analyse the efficiency of our actions from a global viewpoint, taking into account their repercussions in the short, middle and long term, both for ourselves and for the whole of humanity. We need an education which helps to transform the current economic globalisation into a democratic and sustainable project (Delors et al., 1996) which enhances the richness of biological and cultural diversity. Nevertheless, it is quite frequent to hear some doubts about the effectiveness of such an education, given that individual behaviour has little influence on big problems such as, for instance, resource depletion or environmental degradation (Connell et al., 1999). These problems are provoked, basically, by big industries. But it is easy to show (using very simple calculations) that although an individual can save a very small quantity

of energy or materials, when these quantities are multiplied by millions of people, the totals that could be saved become quite large, with a consequent reduction of environmental pollution and degradation. In fact, appeals to individual responsibility are multiplying; they include detailed lists of possible concrete actions in different fields, from water and food supply to traffic, from cleaning, heating and lighting to family planning (Button & Friends of the Earth, 1990; Silver & Vallely, 1998).

On the other hand, individual contributions can and must go beyond the private domain and extend to professional, social and political activities. Citizens can support, for instance, non-governmental organisations and political parties which promote solidarity and environmental protection. They can also demand positive actions by public institutions (town councils, parliaments). It is necessary, in particular, that individual and collective actions avoid local or partial approaches, but that they contemplate many-faceted environmental questions (pollution, resource depletion…), and other related problems such as social inequalities and conflicts, from a planetary perspective. The ecologists' slogan "think globally, act locally" has its limitations; we now know that it is necessary to *act globally* as well (O'Connor, 1992), adopting *political measures at a planetary level*, capable of avoiding the imposition of particular interests and values harmful to other peoples or future generations.

A.18. *How can the current process of planetary globalisation affect the aim of sustainable development?*

Comments A.18: Very few groups mention initially the need for political measures to guarantee the defense of the environment and life on Earth. Moreover, discussions about the political measures that could promote sustainable development usually produce inflammed debates and are viewed by most science teachers and citizens with scepticism and with a certain reluctance. Scepticism because previous attempts have shown scarce effectiveness. Nevertheless, "radioactivity that knows no borders reminds us that we are living - for the first time in human history - in an interconnected civilisation that embraces the whole planet" (Havel, 1997). We can understand then the absolute necessity, also for the first time in human history, for a political integration which puts environment, as the common substratum of life, above the economic interests of any country, region or trans-national enterprise.

We could think that the danger of exclusively local approaches is disappearing because of the present vertiginous process of economic *globalisation*. Paradoxically, this process is not global at all when it concerns the survival of life on our planet. As Naredo (1997) has pointed out, "in spite of so much talking about globalisation, our approaches continue to be partial, sectorial and unidimensional". We do not consider, concretely, environmental destruction… or rather we take it into account, but not in order to avoid it. Economic globalisation explains Cassen (1997) "irresistibly pushes to displace production centres towards countries where ecological norms are less restrictive".

Economic globalisation appears, thus, as something quite unidimensional. Because of this, planetary norms are necessary in order to avoid a general environmental degradation process, the economic cost of which has only just begun to be evaluated (Constanza et al., 1997). For this reason, political integration on a planetary scale is considered to be something absolutely necessary and *urgent*; an integration capable of promoting and controlling the measures necessary for the protection of our social and physical environments, before the degradation process becomes irreversible. In short, a new world order is required, based on co-operation and solidarity, with institutions capable of avoiding the imposition of particular vested interests harmful to other people or to future generations (French, 1992; Renner, 1999; Cassen, 1997; Folch, 1998; Giddens, 1999).

On the other hand, this planetary political integration which our survival seems to depend on also generates the fear of a cultural homogenisation which is already in progress: that is to say, *the fear of cultural impoverishment*. However, this destruction of cultures cannot be attributed to a political integration which has not yet occurred. It is just another consequence of a purely commercial integration. A democratic order at a planetary level could contemplate the protection of the environment and the defence of biological and cultural diversity, without excluding intercultural exchanges. A fully democratic worldwide political integration constitutes, then, a prerequisite which will help to slow the current physical and cultural planetary degradation.

The ensemble of measures just discussed, appears nowadays to be associated with the need to universalise human rights. The next section is dedicated to clarifying this relationship.

4. Sustainable development and human rights

Though unconnected they may seem, there is in fact a close relationship between solving the problems that threaten life on Earth and universal human rights.

A.19. *Enumerate which are, in your opinion, the fundamental human rights, trying to establish their connection with the attainment of a sustainable society.*

Comments A. 19: It may seem strange to establish such a direct relationship between human rights and sustainable development. For this reason, we shall try to clarify what is understood nowadays by *human rights*, a concept which has been growing and now contemplates three "generations" of rights (Vercher, 1998).

We can refer, firstly, to *democratic civil rights (personal opinion, freedom of association…) for everybody, without social, ethnic or gender limitations*. They constitute a condition *sine qua non* for citizens' decision-making about current and future environmental and social problems (Folch, 1998). They are known nowadays as "first generation human rights", because they have been the first rights to be demanded and obtained (not without conflicts) in a growing number of countries. In this respect, we must not forget that the 'Droits de l'Homme' of the French Revolution (to mention a well known example) excluded women explicitly; women only achieved the right to vote in France after the Second World War. Nor must we forget that such basic rights are systematically violated every day in many countries making real development impossible: as Amartya Sen (1999), one of the most active leaders in the fight against underdevelopment, has said, "no long term development is possible without freedom".

We refer, secondly, to *economic, social and cultural rights* or "second generation human rights" (Vercher, 1998; United Nations Development Programme, 2000).) as:

- The universal right to a satisfying job, overcoming insecure situations to which hundreds of millions of human beings (including more than 250 million children) are submitted;
- The universal right to an adequate dwelling in an appropriate physical and cultural milieu;
- The universal right to appropriate nourishment, both quantitatively (avoiding the under-nourishment of billions of fellow humans) and qualitatively (avoiding unbalanced diets);
- The universal right to health. This requires resources, research and education in order to fight infectious diseases (cholera, malaria, AIDS…, which are still ravaging many third-world countries) and the new 'industrial' and behavioural illnesses (such as tumours, depression…). It is necessary, above all, to promote healthy milieus and habits, as well as solidarity with handicapped people;
- The universal right to family planning and free enjoyment of sexuality (the only limitation being the freedom of others), overcoming the cultural and religious barriers which condemn millions of women to submission;
- The universal right to an education of quality, *throughout* one's life, without social, ethnic or gender limitations;
- The universal right to culture, in its widest sense, as a supporting axis for personal and collective enrichment and development;
- The universal right to investigate any kind of subject (the origin of life, genetic manipulation…) without ideological limitations (as, for instance, those which prohibited Galileo's works or nowadays oppose cloning research) but with a suitable degree of social control. This control must prevent the hasty application of insufficiently tested technologies, taking into consideration the social and environmental consequences.

Finally, we refer to "third generation human rights", known as *solidarity rights* "because they tend to preserve the integrity of the whole population" (Vercher, 1998). They incorporate the right to life in a suitable environment, the right to peace, and the right to a sustainable development for all people and future generations:

- *The right of all human beings to an environment appropriate to their health and welfare.* As Vercher (1998) states, the incorporation of this right as a fundamental human right derives from an unquestionable fact: "if the degradation of the environment goes on at the current rate, its maintenance soon will be the most fundamental question of survival for everybody, anywhere… The later we recognise this situation, the bigger will be the necessary sacrifices and difficulties which need to be overcome to achieve an appropriate recovery".
- *The right to peace,* which involves the prevention of particular or vested interests (economic, ethnic, cultural…) prevailing over general interests and values.
- *The right to a sustainable economic and cultural development* of all peoples. This involves, on the one hand, the questioning of present extreme economic inequalities between different human groups and, on the other hand, the defense of cultural diversity and cultural crossbreeding (against racism and ethnic or social barriers).

Vercher insists on the fact that these third generation rights "can only be achieved by the harmonious effort of all actors of the social scene". We can understand, then, the link we have established between sustainable development and the universalization of human rights. And we can also understand the need to proceed towards a real globalisation, with democratic institutions at a planetary level capable of guaranteeing this ensemble of rights.

The *ensemble* of these rights appears to be a requisite (and, at the same time, an objective) of a sustainable society; *they are all interconnected*. We cannot conceive, for instance, of the interruption of the demographic explosion without the recognition of the right to family planning and free enjoyment of sexuality… and these are connected also to the right to education.

In short, then, achieving sustainable development is synonymous with universalising human rights in their widest sense. This requires:
- The creation of democratic institutions, *at a planetary level*, capable of preventing the imposition of particular interests harmful to other people or future generations;
- The orientation of scientific-technological development towards the attainment of technologies favourable to sustainable development;
- The promotion of an education capable of countering the usual tendency to behave on behalf of particular interests in the short term.
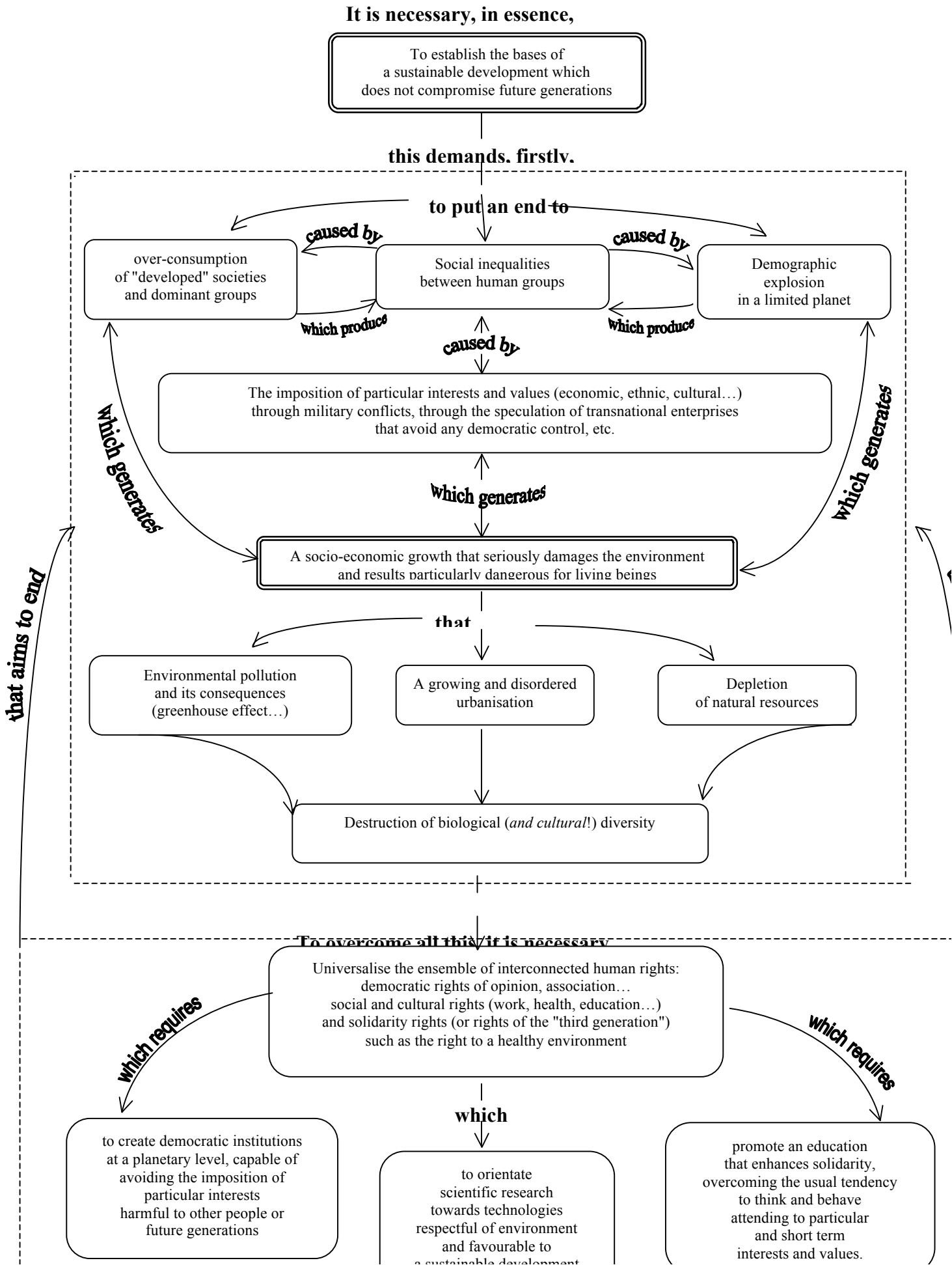
5. Summing up and perspectives

To end this collective reflection about the current "planetary emergency" (Orr, 1995) and possible "alternative futures" (Hicks & Holden, 1995) it seems appropriate to undertake some global activities such as this:

A.20. ***Draw a diagram that provides a global view of the problems which characterise the current situation of planetary emergency, its causes and possible measures to be adopted, trying to highlight the close relationship between these different aspects.***

Comments A. 20: The development of a diagram, as this activity proposes, is one of the most efficient ways to globalise the ensemble of aspects contemplated throughout the workshop, showing the close relationship between problems, causes and measures to be taken in order to reach a sustainable development. Holding a poster session to discuss the different proposals enables us to examine this overview more carefully and helps each group to regulate its own work. **Figure 1** shows one of these diagrams which incorporates contributions made by different teams. We do not mean to present it as "the correct model", but as one open to discussion in the poster session. In fact, only if one team has already devised its own scheme will it be able to profit from other teams' schemes. But undoubtedly a diagram such as this shows quite a sound understanding of the problems we are studying.

Figure 1. Problems and Challenges which Characterise the Current Situation of Planetary Emergency

It is necessary, in essence,

To establish the bases of
a sustainable development which
does not compromise future generations

this demands. firstly.

to put an end to

over-consumption
of "developed" societies
and dominant groups

caused by

Social inequalities
between human groups

caused by

Demographic
explosion
in a limited planet

which produce

caused by

which produce

which generates

which generates

that aims to end

The imposition of particular interests and values (economic, ethnic, cultural…)
through military conflicts, through the speculation of transnational enterprises
that avoid any democratic control, etc.

which generates

A socio-economic growth that seriously damages the environment
and results particularly dangerous for living beings

that

Environmental pollution
and its consequences
(greenhouse effect…)

A growing and disordered
urbanisation

Depletion
of natural resources

Destruction of biological (*and cultural*!) diversity

To overcome all this/it is necessary

Universalise the ensemble of interconnected human rights:
democratic rights of opinion, association…
social and cultural rights (work, health, education…)
and solidarity rights (or rights of the "third generation")
such as the right to a healthy environment

which requires

which requires

which

to create democratic institutions
at a planetary level, capable of
avoiding the imposition of
particular interests
harmful to other people or
future generations

to orientate
scientific research
towards technologies
respectful of environment
and favourable to
a sustainable development

promote an education
that enhances solidarity,
overcoming the usual tendency
to think and behave
attending to particular
and short term
interests and values.

Another possibility of globalisation we have proposed consists in asking the teachers' teams to construct a network aimed towards analysing to what extent a given material (as, for instance, a science textbook) contemplates the different problems, causes and challenges which characterise the state of the world. **Table 1** shows one of these possible networks (in fact the one we have used to analyse teachers' conceptions) which gives quite an accurate global view of the situation and of the measures to be encouraged.

Table 1. Problems and challenges that characterise the present state and near future of the world

0) The main aim should be to lay the bases of a sustainable development …………………………

This directs our attention towards an ensemble of interconnected aims and actions:

1) To put an end to socio-economic growth, guided by particular interests in the short term, that seriously damages the environment and is particularly dangerous for living beings ……………………

This economic growth produces, among other things, these particular problems:

1.1. A growing, disordered and speculative urbanisation ……………………………………………….

1.2. Environmental pollution and its consequences (greenhouse effect, acid rain, global climatic change…) .

1.3. Depletion of natural resources (fossil energy resources, fertile soil, drinking water…) …………………

1.4. Ecosystem degradation and destruction of biological diversity (cause of illness, famine…) ……………

1.5. Destruction, in particular, of cultural diversity ……………………………………………………

2) To put an end to the following causes (and, at the same time consequences) of an unsustainable socio-economic growth:

2.1. Over-consumption by "developed" societies and dominant groups ……………………………………

2.2. Demographic explosion in a limited planet ……………………………………………………………

2.3. Social inequalities between human groups ……………………………………………………………

2.4. Conflicts and violence associated with these inequalities (military conflicts, Mafia activities, speculation of transnational enterprises which escape any democratic control…) …………………………………………

3) To adopt positive measures in the following fields:

3.1. Political measures at the planetary level capable of promoting and controlling the necessary protection of the social and physical environment, before the current degradation processes become irreversible ………

3.2. Educational measures to overcome the usual tendency to behave attending to particular interests in the short term, making possible changes in personal values and life style choices to promote solidarity …………

3.3. Technological measures to better satisfy human needs without damaging the environment, capable of favouring a sustainable development. This includes, for instance, the search for new alternative energy sources, the improvement of efficiency in food production, the prevention of illness and catastrophes or the diminution and recycling of waste ………………………………………………………………………..

4) To associate the precedent measures with the need to universalise and enlarge human rights ………

4.1. Democratic civil rights (opinion, association…) for everybody as a condition sine qua non for citizens' decision-making about current and future environmental and social problems ………………………………

4.2. Economic, social and cultural rights (to a satisfactory job, to health, to education and culture and reproductive freedom…) ………………………………………………………………………..

4.3 The right, in particular, to investigate any kind of subject (the origin of life, genetic manipulation…) without ideological limitations, but with social control which takes into consideration social and environmental consequences and prevents the hasty application of non-sufficiently tested technologies. ……

4.4. Solidarity rights (the right to a healthy environment, the right to peace and the right to a sustainable development) ………………………………………………………………………………

We end here the description of this workshop, conceived to enrich teachers' perception of the state of the world. In a brief second section of this paper we shall offer some results obtained in the implementation of the workshop. Results which, in our opinion, clearly support the validity of this program of activities and encourages us to extend its application to new groups of teachers in service and in training.

II. Some results obtained in the application of the described workshop

In order to find out to what extent science teachers, in general, have an adequate understanding of the state of the world, we have conceived several experimental designs as, for instance, to pose an open question to teachers in training and in service, about "*problems and challenges that humanity has to face*" (see **Table 2**), in order to see if they make reference to the 19 different aspects concerning the state of the world included in Table 1.

Table 2. An open-ended question aimed at eliciting science teachers' perceptions of the state of the world.

CONTEMPORARY PROBLEMS AND CHALLENGES THAT HUMANITY HAS TO FACE

We live in a time of accelerated changes and growing concern about how these changes are affecting humanity and all life on Earth. This concern about the "state of the world" must have a clear echo in science education and generate studies capable of helping us to make well-founded decisions.

We invite you to participate in one of these studies, by *enumerating the problems and challenges that, in your opinion, humanity faces now and in the near future*. We intend, with your help, to collectively construct an image as complete and correct as possible of the current situation *and of the measures to be adopted in the future.*

The open question has already been proposed to wide samples of science teachers, in service and in training, involved in ordinary science education courses from 1997-2000, from Spain, Portugal and Latin America (Argentina, Brazil, Chile, Cuba, Mexico, Panama) with a total of 327 teachers in service and 521 in training. We have used other designs to elicit teachers' perceptions about the state of the world. For instance, we have asked teachers to make comments about a typical answer to the open question, indicating, very particularly, which other aspects should be contemplated. In this way teachers don't feel that they are being judged (it is they who are asked to criticise) and, besides, they have more time to think about new aspects, beyond the most common ones. Nevertheless, results obtained from these different designs are very similar and we have analysed them together.

Results obtained show, in general, very reductionist views (Gil et al., 2000b; Edwards et al., 2001; Praia et al., 2002; Vilches et al., 2002). We have synthesised them in **Figure 2**, where we can appreciate the low percentages of teachers, both in training and in service, who make reference to essential aspects such as sustainable development (0), over-consumption of "developed societies" (2.1), demographic explosion in a world of limited resources (2.2) or human rights (4). In fact the mean of the aspects mentioned by teachers in service and in training is, respectively, 4.7 and 4.9 (from a total of 19).

Results such as those summarised in figure 2 have shown the necessity for specific formative actions to enrich science teachers' perceptions of the state of the world as a first measure to make possible their effective implication in the treatment of the current planetary emergency. An implication which, as we know, is being requested by international institutions (United Nations, 1992), but that hasn't yet received the expected effective answer. This has been the reason why we have conceived and implemented the workshop we have described in this paper. The first results obtained with 57 teachers in training are quite encouraging. In **Table 3** and in **Figure 3** we can compare the perceptions of science teachers in training who have participated or not in the workshop.

Figure 2. Science teachers' perceptions about the state of the world
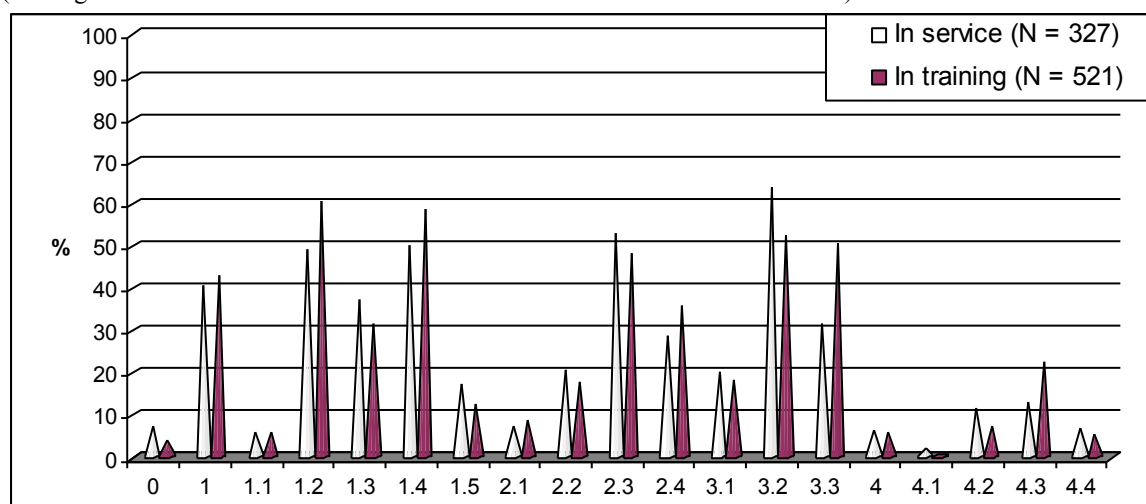(The figures on the horizontal axis relate to the numbered items cited in table 1)

Table 3. Perceptions of experimental (participants in the workshop) and control teachers in training

Problems and challenges	Control N = 521		Experimental N = 57		t_d
	%	(sd)	%	(sd)	
0. Sustainable development	4,1	(0,9)	63,2	(6,4)	9,17
1. Put an end to an aggressive growth	42,8	(2,2)	75,4	(5,7)	5,34
1.1. Disordered urbanisation	5,8	(1,0)	66,7	(6,2)	9,63
1.2. Environment pollution	60,5	(2,1)	94,7	(3,0)	9,34
1.3. Resources' depletion	31,5	(2,0)	93,0	(3,4)	15,59
1.4. Ecosystem degradation	58,4	(2,2)	87,7	(4,4)	6,04
1.5. Destruction of cultural diversity	12,3	(1,4)	57,9	(6,5)	6,81
2.1. Over-consumption	8,6	(1,2)	75,4	(5,7)	11,45
2.2. Demographic explosion	17,7	(1,7)	91,2	(3,8)	17,89
2.3. Social inequalities	48,2	(2,2)	89,5	(4,1)	8,92
2.4. Conflicts and violence	35,7	(2,1)	64,9	(6,3)	4,38
3.1. Political measures at a planetary level	17,9	(1,7)	94,7	(3,0)	22,52
3.2. Educational measures for solidarity	52,4	(2,2)	94,7	(3,0)	11,47
3.3. Technological sustainable measures	50,3	(2,2)	93,0	(3,4)	10,60
4. Universalisation of human rights	5,8	(1,0)	82,5	(5,0)	14,93
4.1. Democratic civil rights	0,7	(0,4)	45,6	(6,6)	6,80
4.2. Economic, social and cultural rights	7,1	(1,1)	45,6	(6,6)	5,75
4.3. Right, in particular, to open investigations	22,3	(1,8)	28,1	(5,9)	**0,93**
4.4. Solidarity rights (to peace…)	5,1	(1,0)	63,2	(6,4)	8,99

We can check the improvement of the perceptions of the participants in the workshop in the majority of the aspects, particularly in those where we usually find the most serious omission such as: references to sustainability, over-consumption, demographic explosion or human rights. The Student's t values of the differences (superior to 4, except for item 4.3) show that the probability that these differences are random is negligible (for t = 2.58, this probability is 0.01).

Figure 3. Perceptions of experimental (participants in the workshop) and control teachers in training
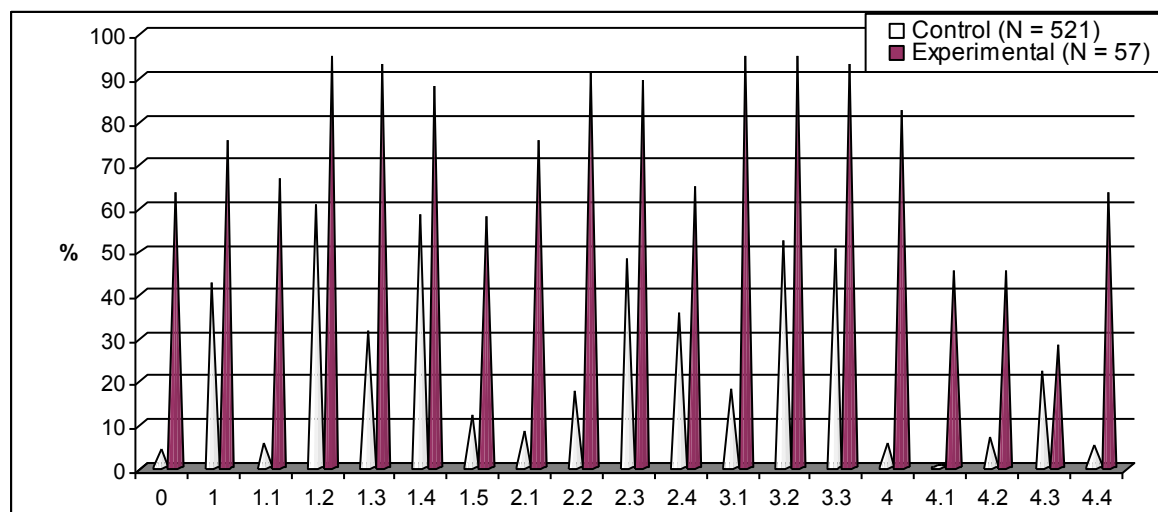
On the other hand, the mean of the aspects mentioned by each teacher in service who has participated in the workshop becomes 14.1 (from a total of 19) as opposed to 4.7 for non trained teachers. The scarce progress obtained in the item 4.3 (about the right to investigate any subject with the only limitation being to take into consideration the social and environmental consequences) indicates the need to dedicate more attention to this crucial aspect. In general, we can appreciate a remarkable improvement in teachers' perceptions of the state of the world, although other formative actions may be necessary for an effective incorporation of this dimension in the ordinary science curriculum.

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