ROMANIAN, SPANISH AND US SECONDARY SCIENCE TEACHER PERCEPTIONS OF THREATS TO THE BIOSPHERE

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Abstract: This paper presents the data from a current study involving 41 Romanian secondary science teachers and a previously published study that compared 89 Spanish and 42 US secondary science teachers. All three groups were convenience samples who answered a two part questionnaire that was given in English, Spanish or Romanian, depending on the sample. The overriding question was whether citizens in countries that have different environmental experiences perceive threats to the biosphere differently and teach about different environmental problems/threats in science classes if at all. Five specific research questions were addressed including the following two:

 1) What were some of technological and environmental problems and or threats that were discussed in the 2002 Johannesburg Earth Summit?

2) Can you describe any reasons why you do or do not teach about environmental and technological problems and or threats in your science classes?

The results indicated considerable differences in the three nationalities perceptions of and understanding of threats to the biosphere. Perhaps the most important conclusions were: First, perceptions of environmental threats are based to a large degree on citizens personal experiences with the threat/s in the environment in which they live even when those threats may not be the most urgent global threats; and second, if all citizens, no matter where they live, are to become better informed about global threats to the biosphere faced by the world as a whole, there must be a common global science curriculum that addresses these threats.

Key words: intercultural education, science education, environmental education

1. Introduction

It has become clear that all countries of the world need to begin addressing the many technology based global environmental problems/threats that are causing harm to the biosphere and that if not addressed soon may reduce the ability of the earth to support life as we know it. Global climate change is the most obvious and perhaps most pressing of these threats. In the continuing efforts to get all countries to agree on plans to decrease carbon dioxide and other greenhouse gas emissions, the recent UN sponsored Bali Climate Change Conference with 180 countries represented, was the latest step (UN, 2007). Earlier UN sponsored world environmental conferences in Rio de Janeiro in 1992 (The Earth Summit)[1], Kyoto in 1997 (UN, 1997) and the Johannesburg UN Summit in 2002 (UN, 2002) also addressed environmental problems/threats.

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[1] The Rio Earth Summit influenced all subsequent UN conferences, which have examined the relationship between human rights, population, social development, women and human settlements — and the need for environmentally sustainable development (UN, 1997).

 The Kyoto protocol was an international and legally binding agreement to reduce greenhouse gas emissions worldwide that came into force in February 2005 after being ratified by 174 nations. The intent of the pact was to reduce greenhouse gases emitted by developed countries to at least 5% below 1990 levels by 2008-12. It was never signed by the US and Australia and President George W. Bush said it would hurt the US economy. The first commitment period to the Kyoto protocol will expire in 2012 and a new pact is urgently needed that must include the US, China and India. According to the UN scientific report from the Intergovernmental Panel on Climate Change (IPCC) it is clear beyond doubt that climate change is a reality which poses a serious threat to the future development of the world's economies, societies and ecosystems (Aldred, 2007).

2. Background

The above information makes it clear that human efforts that address the need for environmental sustainability have been underway for many years. In fact the World Conservation Union addressed environmental issues as early as 1948 in a conference that included 181 countries. Within its mission, societies throughout the world were encouraged to conserve the integrity and diversity of nature and insure that the use of natural resources was equitable and ecologically sustainable (IWCU, 1948). The UN first addressed these issues in 1972 in Stockholm (UN, 1972). In those early days, the US was very supportive of environmental protection. Indeed, the first clean water act in the US was passed in 1972, catalyzed by the burning of the Cuyahoga River in Cleveland in 1969. Within 10 years many other clean water acts were passed and it is only recently that the Bush administration has tried to dilute the clean water and clean air laws passed under previous Republican administrations. The first US clean air act was passed in 1970 to give the Environmental Protection Agency (EPA) the right to regulate vehicle emissions. It was strengthened in 1990. As a result lead was taken out of gasoline and catalytic converters were required on all cars (Arms, 2004).

At that time (the early 1970s) the US was a world leader in government policy as well as science curriculum that addressed environmental issues in high school. In fact, in 1972, one author recalls two teachers, one each in science and social studies, in a high school where he was teaching in Baltimore County, Maryland who team taught a Science, Technology and Society (STS) course for their social studies and science classes. One author was also involved in teaching a new chemistry course with everyday applications, Interdisciplinary Approaches to Chemistry (IAC) which in the Environmental Chemistry Module addressed the need for less pollution and more use of clean, alternative energy sources. Unfortunately it is no longer in print but a later chemistry course, ChemCom, or Chemistry in the Community (2002), has carried on the IAC tradition because it also addresses chemistry based environmental problems/threats. Chem Com has had limited success because of its' lack of acceptance by many chemistry teachers who want a more rigorous, though less applicable to society, approach. The BSCS Green version (1992) of Biological Science, An Ecological Approach, is one of the few science texts with an environmental sustainability theme that has continued for many years, now approaching 50.

We can only wonder why science programmes that had STS applications did not expand and become more popular in schools. If they had, perhaps today we would have reached a critical mass for an environmentally literate public. Such a critical mass of citizens might be able to exert the political pressure needed to overcome the unsustainable economic interests that continue to degrade the environment. For example, we know that alternative energy sources such as geothermal, wind and solar used when possible, would be much better than fossil fuels for air quality, reduced greenhouse gases and reduced water and land pollution, but we continue to build new coal fired power plants even though we know their effects on climate change and human health. It is not just a US problem because the same types of vested interests win out in China, Spain, Russia and other countries of the world. In the US, part of the problem is a general ignorance of and rejection of science by many citizens when it does not fit into their religious or ideological beliefs. According to the National Science Board (NSB) 'Many Americans remain ignorant about much of science, the board said; for example, many are unable to answer correctly when asked if the Earth moves around the Sun (it does). But they are not noticeably more ignorant than people in other developed countries except on two

subjects: evolution and the Big Bang. Although these ideas are organizing principles underlying modern biology and physics, many Americans do not accept them' (National Science Board, 2008).

The current US federal administration has compounded the problem by regularly putting political ideology ahead of empirical evidence from science research (Union of Concerned Scientists, 2008). We can only surmise how much influence political ideology and conservative religious beliefs have on what science teachers decide to teach or leave out. Moreover, misinformation and legal challenges by large corporations, e.g. the fossil fuel industry, have put economics ahead of science and successfully undermined attempts to regulate them, e.g. reduction of carbon dioxide, for years. Currently the US government thrust is again for more education in Science, Technology, Engineering and Mathematics (STEM) education to motivate more students to pursue careers in these areas to counter the Chinese 'threat' for technological dominance. Instead, the US and the rest of the world should probably be putting resources into environmental science literacy for all citizens if the world is to address pressing science and technology based threats to the biosphere (Dean C., 2008).

In the 2005 Human Development Index (HDI) which includes income (GDP per capita), life expectancy, education (combined primary, secondary and tertiary) and adult literacy, Romania ranks from 26th (97.3 % literacy) to 76th (Life Expectancy) out of 177 countries (Human Development Index, 2005)

 Educational System in Romania: The educational system was revamped in 2000 to be more in line with societal needs. Education is a national priority, free up to university, democratic and open to all citizens. It is compulsory for 10 years from age six. This includes four years of primary, four years of gymnasium, and two additional years of lower secondary. After 10 years of education, students who qualify have two additional years of upper secondary for more specialized vocational or other training. Students take a national examination after the first eight years to determine in which type of school they will continue study. Those who pass the national exams go on to lower secondary after which they must pass a second national examination to enter upper secondary. Upper secondary education can lead to higher education if the final national exam is passed. Romanian higher education is now in the process of conforming to the Bologna Accord which specifies a three year undergraduate degree. Some students may study an additional two years for a master's degree. Regarding education goals, one challenge cited by the Ministry of Education pertinent to this paper is the provision of sustainable development through judicious exploitation of resources and environmental protection.

How does the above information and opinion relate to this paper? We can see that some industries are beginning to invest in more environmentally friendly technologies to reduce production costs, especially those based on petroleum, and improve sales but a better educated public could accelerate this process and perhaps give it an ethical dimension as well. If we truly want a sustainable world, as science educators we should ask how our science teaching can address the original message of the Rio Earth Summit - nothing less than a transformation of our attitudes and behavior will bring about the necessary changes. Without environmental sustainability, or living within the earth's carrying capacity without further degradation, life as we know it will not continue even in the short run, as measured by human life spans, and certainly not in geological time frames. It will require a world effort and the US, given our huge rate of consumption, needs to become a political and educational leader just as we were in the early 1970s.

The data in this paper address knowledge of the most recent UN Summit in Johannesburg and attitudes of Romanian, Spanish and American secondary science teachers regarding what environmental science problems/threats are taught in science classes, if at all. Comparisons of Romanian science teacher attitudes to both Spanish and American secondary science teachers from an earlier published article (Guisasola, J. et al., 2007) are presented in the results and discussion and conclusions. The overriding question is whether citizens in countries that have different environmental experiences perceive threats to the biosphere differently and teach about different environmental problems/threats in science classes if at all. Specific research questions that will be addressed are as follows:

1) What were some of technological and environmental problems and or threats that were discussed in the 2002 Johannesburg Earth Summit?

2) Can you describe any reasons why you do or do not teach about environmental and technological problems and or threats in your science classes?

3) How much coverage do you give to technological and environmental problems/threats in your science classes in an average semester?

4) In the context of the science classroom and in the order of your goals and objectives, what do you think is important to teach in science classes?

5) What are the science teachers' priorities for the eight environmental science problems/threats described in the survey?

3. Methodology

Subjects*:* The subjects were 41 Romanian and one Hungarian secondary science teachers who taught one or more of the following subjects: Biology (n= 15), Chemistry (n=12), Physics (n=1), or Geography (n=5). One teacher taught informatics. Thirty-two of the teachers were females and nine were males. They ranged in age from 20-60 with the largest age groups from 36-40 (n=8) and 46-50 (n=7) and 51-55 (n=7). Thirty-five of the subjects had bachelor's degrees, three had a master's and three had doctorates. Most of the teachers had degrees in their teaching area. Most of the teachers had many students ranging as high as 300 for a teacher who taught classes in grades 6-12 and a low of 70 students for a 12th grade teacher. In general most teachers taught grades seven through 11 with a few teaching below grade seven and one who taught only grade 12. All but five subjects taught in the city of Cluj-Napoca.

The Instrument*:* A questionnaire (see Appendix) was designed in two parts. The first part was comprised of the four open ended questions. The answers to the questions were used to determine what ideas the teachers held regarding their teaching of the environmental and technological problems. Question three of part one required teachers to check a range. Question four of part one had five sub questions that required teachers to rank themselves on a scale from 1-10 regarding the importance they gave to each sub question**.** The current questionnaire was first piloted with a small sample of teachers in Spain and afterwards used in a study that comprised both Spanish and American secondary science teachers. None of the teachers indicated any problems in understanding the meaning of questions.

Part two required the science teachers to rank the eight global environmental science problems/threats according to the importance they gave to them and the priority they felt they should have in public policy. A space was provided on the left margin for ranking them and teachers were instructed to rank them from 1 (most important) to 8 (least important). When ranking the threats, teachers were asked to rank the top three first (1- 3) and the three least important threats (6 -8). Last, they were asked to rank the two middle threats with numbers (4-5). The results of the ranking were analysed by determining the average rank of each threat.

The content validity of the questionnaire and its relevance to the goals was verified by the professional expertise of the researchers and qualified and experienced members of faculty in science and science education. Before the questionnaire was used in Spain, members of the faculty of science and science education completed it and made suggestions that were taken into account in writing the last version of the questionnaire. The questionnaire was translated from English to Romanian to gather the Romanian teacher data. A native Romanian university faculty member with fluent English skills did the original translation which was back translated into English by another native Romanian faculty member with fluent English. A US faculty member compared the original and back translated English versions and additional revisions were made in the Romanian translation based on this comparison after discussion with both of the Romanian faculty members.

4. Results

Question One: What were some of the technological and environmental problems and or threats that were discussed in the 2002 Johannesburg Earth Summit? Among the Romanian science teachers, 10 teachers (24%) did not answer the question. Twenty-five (28%) of Spanish teachers and 25 (57%) of US teachers did not answer it. The Romanian teachers who answered the question (21) pointed out

very general problems as did the US (17) and the Spanish (64) teachers. The Romanian and Spanish teachers gave the most answers (highest percentage) regarding problems related to contamination of the planet. The Romanian teachers gave the highest percentage of responses directed at climate change and biodiversity. Nine of the Romanian teachers indicated detailed information about the Johannesburg Earth Summit and gave detailed explanations of the effort to reach a new agreement. Nine of the US teachers gave fairly detailed answers and appeared to know what they were talking about, but nine also gave very sketchy or limited information that could not clearly be tied to the Summit. A considerably higher percentage of Spanish (48%) and US teachers (57%) gave responses that addressed sustainability.

Among the teachers who replied, the responses were grouped in the following way (see Table 1):

Table 1. *Romanian, US and Spanish teacher responses regarding issues discussed in the Johannesburg Earth Summit*

Type of Response	Romanian teachers N = 41	Spanish Teachers N=89	American teachers N = 42
A. Problems related to contamination of the Planet:	18 (34%)	42 (47%)	16(38%)
A.1. Ozone layer	1	5	0
A.2. Emissions of gases	8	14	2
A.3. Greenhouse gases	9	14	7
B. Measures undertaken towards the sustainable development and limited resources of the planet.	14 (26%)	43 (48%)	24 (57%)
C. Unjust distribution of the natural resources and possible ways to equitably distribute them.	4	20	0
D. Climatic change and biodiversity.	8 (15%)	12 (13%)	0
E. Biodiversity, clean water and sanitation, economic security, ratification of the agreement.	2 / 9	0 / 0	11 / 0
Totals	**53**	**117**	**51**

Question Two*:* Can you describe any reasons why you do or do not teach about environmental and technological problems and or threats in your science classes? Thirty-two Romanian teachers gave

reasons for why they teach about environmental and technological problems. Three teachers said it is important for mankind or society to understand these problems. Four teachers said it is important to inform and or educate students about environmental problems. Three teachers said it is part of the curriculum. Six teachers did not answer the question or said there is no reason for why they do not teach about these issues. Most teachers gave reasons for why they did not teach about them and the most common reason (n=17) was that it is not in the state curriculum. Eleven teachers said they do not have time (See Tables 2 and 3).

Many more Spanish and US teachers gave reasons for why the issues should be taught. Nearly one-half of the Spanish teachers (n=43) gave arguments that the problems of the planet belong to everyone and education about them is necessary for survival of future generations. Among the US teachers, 18 supported the idea that the issues affect our lives and future and that they are important to the health of the planet. Forty Spanish teachers also said it is necessary to teach the values of democracy and solidarity which lead to responsible attitudes in the treatment of the problems of the planet. Nine US teachers said the problems must be understood by future leaders and students must be informed to be good citizens, including voting. Also, all of us are part of a global community and citizens of the earth and the issues are important to all of us (see Table 2).

Table 2. *Reasons why Romanian, Spanish and US teachers teach the issues*

Reason Given	Romanian Teachers (N=41)	Spanish Teachers (N=89)	American Teachers (N=43)
Problems belong to all of us and understanding is needed for survival. Future health of humans depends on it.	3	43	18
Needed for democratic values, informed citizens/voters, understanding by future leaders	6	40	9

Thirty-seven of the Spanish teachers indicated that they do not teach this type of science and that they only mention the problems in a superficial way. Seventeen of the US teachers either gave no answer to the question or said they do not address the issues for various reasons. Eight of the Spanish teachers said they had not had sufficient training to be able to explain these matters. None of the US teachers cited a lack of training for not teaching the issues. Ten Spanish teachers said that there is no time to explain such subjects given that the syllabus is very wide. Thirteen of the US science teacher cited no time, the curriculum was too broad or the science standards did not include these issues. Nineteen Spanish teachers said environmental issues should not be part of the science curriculum. Eight US teachers did not answer the question (see Table 3).

Table 3. *Reasons why Romanian, Spanish and US teachers do not teach the issues*

Reason Given	Romanian Teachers (N=41)	Spanish Teachers (N=89)	American Teacher (N=43)
Not in the curriculum or part of the standards	17	19	6
Lack of time	11	10	7
No answer given or various reasons why not	6		17
Lack of training	0	8	0
Do not teach this type of science	-	37	-

Question Three*:* How much coverage do you give to technological and environmental problems/threats in your science classes in an average semester? All Romanian teachers devoted time to technological and environmental problems/threats during the school year. Twenty-four per cent of the teachers devoted time at least once a week and another 46% devoted time at least once a month. In general, the biology and geography teachers seemed to devote a little more time with eight teachers in biology and geography indicating time daily or once a week. When compared to Spanish and US science teachers, the Romanian science teachers in general devoted more time each semester. A higher per cent of Spanish and US science teachers devoted more time daily (see Table 4).

Table 4. *Time dedicated to technological and environmental problems/threats by the Romanian, Spanish and US science teachers*

Time Dedicated	Romanian Teachers (N = 41)	Romanian Teachers by Subject	Spanish Teachers (N = 89)	American Teachers (N = 42)
None	0		2 (2.2%)	1 (2.3%)
Once or twice during the course	10 (24.0%)	3 biology, 4 chemistry and 2 physics	9 (10.0%)	4 (9.5%)
Once a month	19 (46 %)	6 biology, 3 physics, 7 chemistry and 3 geography	45 (50.5%)	10 (23.8%)
Once a week	10 (24 %)	6 biology, 2 chemistry	20 (22.5%)	17 (40.5%)

		and 2 physics		
Daily	2 (5 %)	2 geography	13 (14.6%)	10 (23.8%)

Question Four: In the context of the science classroom and in the order of your goals and objectives, what do you think is important to teach in science classes? In this question, four propositions were given in a positive way to determine teacher opinions regarding their most important reasons for teaching science in secondary education. The four propositions addressed the following: Procedural aspects of scientific research (5a), the need to know concepts and laws for future studies (5b), priorities of the attitudinal aspects of the curriculum (5c), and the necessity of teaching science to produce citizens capable of making decisions in contemporary society (5d). Teachers were asked to evaluate the four different propositions with a ranking of 0 to 10 with 10 being the highest agreement and 0 the lowest agreement. The Romanian teachers actually used a five point scale which was transposed to a 10 point scale for comparisons to Spanish and US teachers.

Two of the four propositions or reasons for teaching science were quite highly valued by the Romanian science teachers. As measured by means, the most highly valued reason or goal was proposition 5d, (M=6.99), the acquisition of scientific literacy in order to become informed citizens in present day society. It was closely followed by 5b, (M=6.77), learning the concepts and theories, to reach a level of understanding that allows them to continue their studies successfully. The least valued proposition was 5a, (N=6.03), discovering how scientists work to evaluate scientific-technological problems. All three groups of science teachers gave the most value to proposition 5d, the acquisition of science literacy to become an informed citizen. The least valued proposition for Romanians and US teachers was 5a, discovering how scientists work to evaluate scientific-technological problems. The least valued proposition for Spanish teachers was 5c (5a was very close), acquiring the democratic values of the current social environment (see Table 5).

Table 5. *Romanian, Spanish and US teacher evaluations of the four propositions*

Evaluations (from 0 to 10) of the science teachers	**Romanian Teachers** **N = 41** **(Mean)**	**Spanish Teachers** **N = 89** **(Mean)**	**American Teachers** **N = 42** **(Mean)**
5a. To discover how scientists work to evaluate scientific-technological problems.	6.03	7.37	7.17
5b. To learn the concepts and theories, to reach a level of understanding that allows them to continue their studies successfully.	6.77	8.08	7.35
5c. To acquire the democratic values of the current social environment.	6.43	7.35	7.75
5d. To acquire scientific literacy in order to become informed citizens in present day society.	6.99	8.55	8.75

Question Five: What are the science teachers' priorities for the eight environmental science problems/threats? The top three technological and environmental threats indicated by the Romanian science teachers in descending order were Environmental Pollution, Depletion of Natural Resources and Human Health and Disease. The top three for the Spanish teachers were World Hunger and Food Resources, Depletion of Natural Resources and Conflicts and Violence. The top three for the US teachers were Depletion of Natural Resources, Ecosystem Degradation and Environmental Pollution. The least important problems/threats for Romanian science teachers were World Hunger and Food Resources (8) and Sustainable Development (7). Land Use (8) and Human Health and Disease (7) and were the least importance to the Spanish teachers. World Hunger and Food Resources (8) and Sustainable Development (6 or 7) and Conflicts and Violence (6 or 7) were the least important to the US teachers. In the sample size of 41 Romanian science teachers, only 30 were used. The other 11 teachers did not use all eight rankings when ranking the problems/threats.

When the three nationalities of teachers were compared, Depletion of Natural Resources was the most agreed upon priority. It was number one by the US teachers and number two by both the Romanian and Spanish teachers. The Romanian teachers ranked Environmental Pollution as number one and the Spanish and US teachers ranked it as sixth and third respectively. The Spanish teachers ranked World Hunger and Food Resources as number one and the Romanian and US teachers ranked it last. The Americans ranked Ecosystem Degradation as number two and the Romanian and Spanish teachers ranked it fifth (see Table 6).

Table 6. *Means and rankings by country of the eight problems/threats*

Problem/Threat	Romanian Teachers (N=30) Mean (Rank)	Spanish Teachers (N=89) Mean (Rank)	American Teachers (N=42) Mean (Rank)
Conflicts and Violence	4.19 (**6**)	3.78 (**3**)	5.69 (**6 or 7**)
Depletion of Natural Resources	2.77 (**2**)	3.70 (**2**)	2.59 (**1**)
Ecosystem Degradation	3.33 (**5**)	4.68 (**5**)	3.09 (**2**)
Environmental Pollution	2.29 (**1**)	5.03 (**6**)	3.24 (**3**)
Human Health and Disease	3.10 (**3**)	5.11 (**7**)	4.94 (**5**)
Land Use	3.24 (**4**)	6.36 (**8**)	4.09 (**4**)
Sustainable Development	4.54 (**7**)	3.95 (**4**)	5.69 (**6 or 7**)
World Hunger and Food Resources	5.14 (**8**)	3.52 (**1**)	6.57 (**8**)

4. Discussion and Conclusion

Regarding Question One, (24%) of the Romanian teachers did not answer the question but this was still less than the per cent of Spanish and US teachers. The Johannesburg Earth Summit placed emphasis on sustainable development as a world priority and given the fact that in the year 2000 the Romania Ministry of Education made sustainable development and environmental protection educational priorities, one might expect most science teachers to be informed about the priorities of the 2002 Johannesburg Earth Summit since it was dedicated to global, sustainable development. Since Romania recently became a member of the EU, it is possible the science curriculum may now put more emphasis on environmental problems/threats such as sustainable development and global climate change, to be more in line with EU countries such as Spain.

Thirty percent of the Spanish and (57%) of the US science teachers did not answer the question. The lower than expected response rate of all three groups of teachers indicated that many science teachers in all three countries have no current knowledge about the agenda of the Johannesburg Earth Summit. The Summit not only addressed specific issues on sustainable development (water, energy and air quality) but also dealt with specific scientific and technical development related to environmental sustainability. Partly related to the US teachers limited responses may be US leadership at the highest level. The US government downplayed the summit (Dunn, 2002) with attempts to undermine some of the agenda for fear it would make the US look bad. The part that dealt with global climate change was especially significant, perhaps because President Bush has had such a dismal record on environmental issues in general and the fact that he broke his pre election campaign promise to sign the Kyoto Agreement after being elected. Until very recently, when the evidence has become irrefutable, his administration in alliance with the fossil fuel industry, has undermined what scientists said about global climate change and other science based environmental issues (science integrity, www.ucsusa.org, 2008)**.** His 2008 State of the Union address gave lip service to the need to reduce carbon emissions but with still no agenda to back it up. In contrast, in Spain, the program of the new socialist government included observance to the protocol of Kyoto and Spain has begun to take steps towards compliance, with the approval of the majority of the population.

Question Two dealt with reasons why science teachers teach or do not teach about environmental and technological problems and or threats in their science classes? In general, the Romanian science teachers gave reasons why they do not teach about these issues in class and the most common reasons were: Environmental education is not in the national curriculum and lack of time. This seems reasonable since Romanian students must be prepared to pass an examination to continue study and teachers would be expected to emphasize science content that might be on that examination. If science questions that require an understanding of global environmental problems/threats such as global climate change are not part of the syllabus, it is unlikely they will be taught in the curriculum.

When compared to the Spanish and US teachers, more US teachers indicated that they did not have time to bring in environmental and technological problems/threats. A number of them mentioned directly that the standards made it difficult to have the time to connect science to societal issues. This is the first year (2008) that the science exit exam will be required for high school graduation and it is probable that teachers will be held accountable for how their students do on this exam. As a result it is expected that more and more of them are now teaching to the test and leaving out essential connections to society. These connections might enable students to see the value of learning science as a means to understand science and technology based societal issues that may threaten the biosphere.

More Spanish teachers mentioned lack of training as a reason for not teaching about environmental problems/threats. Neither the Romanians nor the Americans gave this as a reason. Nearly all of the Romanian teachers had degrees in their teaching areas and we might expect them to feel comfortable with the subject they teach. But, 26 of the US teachers who were teaching grades 7-8 and nine did not have degrees in science teaching areas and we might expect them to feel less comfortable teaching

science topics they were not trained to teach. In general, older teachers in any country would be expected to have less training in subject matter that deals with environmental problems/threats than younger teachers who may have graduated after threats to the biosphere became more prevalent in society and were added to teacher training courses. Twenty-three of the Romanian teachers were 36 or older (56%) and perhaps they had less training than younger teachers regarding how to teach science in the context of society and the environmental impact of modern technologies on the biosphere and environmental sustainability.

In regard to reasons why Romanian science teachers teach about environmental and technological problems and threats, nine teachers (22%) gave one or more reasons. The reasons involved the fact that environmental problems belong to all of us and understanding is needed for informed citizens in a democratic society and the survival of all of us. Forty-three (48%) Spanish and 18 (41%) US teachers gave these same reasons. Forty Spanish teachers and nine US teachers mentioned that this knowledge is needed for democratic values, to be informed voters and understanding by future leaders. For the Spanish and US teachers, the evidence indicates that both groups of teachers had similar thoughts about the need to conserve the planet for everyone, including future generations. Apparently nearly one-half of the science teachers in both those countries saw the teaching of science and its related environmental problems/threats as a utilitarian need. This has historical origins in the US going back to the 19th century when biology and health were both put in the school curriculum because of social relevance (DeBoer, 1991). The reason for the different perceptions of the Spanish and US teachers may also be related to their much longer democratic tradition than Romania. In a democracy, an understanding of these problems is a responsibility of informed citizens. One last point regarding Spanish science teachers pertains to the Spanish Secondary Scientific Education Reform (12-16 years old) which in 1997 stated the need for scientific and technological literacy of students.

Question Three dealt with how much coverage science teachers give to technological and environmental problems/threats in an average semester? The results indicate that all of the Romanian science teachers in the survey give some time to these issues even if they may not be part of the national curriculum in their content areas. A higher percentage of Spanish and US teachers said they covered technological and environmental problems/threats on a daily basis than the Romanian teachers. Given the fact that Romanian teachers have to follow a set curriculum that may not include this type of science content, it is surprising that so many of the teachers bring the issues in regularly. This may also become a problem for US teachers in the classes that must be taught to address the science standards to prepare students to pass the high school science exit exam. In the US, attempts are being made in science teacher training classes to try to get teachers to design lessons that use more science and technology based current events aligned with the science content standards when teachers must follow a curriculum that contains little environmental science content. The hope is that this will help teachers connect science to everyday issues thereby helping students to see science as relevant and perhaps more interesting as well. It may also encourage more students to pursue STEM careers which is currently a big push by the federal government (Robinson, 2008).

Question Four dealt with the most important personal goal science teachers have when they teach science. The most important goal of the Romanian as well as the Spanish and US science teachers was helping students become science literate to become better informed citizens. This is one of the two main goals of science education in the US (National Research Council, 1996) and in both the US and Spain the content and process skills in the national and some US state science standards are aimed at helping student become science literate. The results from this question seem to contradict the results of educational practice that the teachers say they practice. In question two, only three Romanian science teachers addressed the need to teach science that has applications to environmental problems and future human health, needed by all of us for survival on the planet. Forty of the Spanish teachers questioned did not teach subjects related to scientific literacy such as the scientific-technological and environmental problems of the earth and over one-half of those who made reference to these matters recognized that it was done in a superficial and hurried manner (question two). Likewise, 17 of the US teachers did not answer the question at all or gave reasons for why they cannot emphasize content areas that involve science literacy. The results of questions two and four, when analyzed together, seem to indicate that a significant difference exists between the good intentions of Romanian, Spanish

and US teachers (question 4) and the reality of practice in the classroom (questions two). Perhaps Romanian, Spanish and US science teachers think they are addressing science literacy if they teach the prescribed curriculum or science standards. One US author and many of his colleagues believe that the standards do not make the necessary overt connections to societal issues to help students become science literate. The students may be able to recall science concepts but they are not able to make applications and connections of this information to society in a true STS fashion (Yager and McCormick, 1989).

The second main goal of science teaching for the Romanian and Spanish teachers was the learning of concepts and theories to continue successful studies. In both Romania and Spain this may be in agreement with preparing students for university studies. In Spain, prior to secondary science education standards reform, this was the primary reason for teaching secondary science (Gil, Furió and Gavidia, 1998). The second main goal for the US teachers was the acquisition of democratic values. This would fit with the goal of science literacy if students are to be informed citizens on issues that require some knowledge of science for intelligent voting. For example, whether citizens should approve more coal fired power plants that do not sequester carbon dioxide when the effects on global climate change through burning fossil fuels is understood by voters.

Question Five required the three nationalities of science teachers to prioritize the eight environmental threats by ranking them from 1-8. The Romanian teachers ranking of Environmental Pollution as number one may be related to the legacy of communism when environmental protection and preservation were secondary to production. Romania still has severe land, water and air pollution left over from communist economic policies. Depletion of Natural Resources was ranked second. Perhaps Romania is now confronted with shortages and having to pay the market price with the loss of subsidized goods under the former communist economic system which has now become more pay as you go capitalism. As a result, they must now compete in the EC and the world market for resources and other commodities. Human Health and Disease was ranked third and again under communism health of citizens may not have been a priority of the government, but, perhaps it was, but now under the new economic system, health costs may have become more the responsibility of individuals and not the government.

Regarding the priorities of the Spanish teachers, it was surprising that World Health and Food Resources was ranked as the first priority. An explanation may reside in the problems Spain continues to encounter with the influx of African refugees to Spain and the attempts by the government to stop the illegal immigration. Most of the refugees are destitute without gainful employment and little food for their families. They are seeking a better life and in many cases they are from countries where the current EC subsidized fishing industry has taken away their livelihoods with the cooperation of corrupt African governments and the resulting EC corporate fishing in West African waters. The catch is sold in the expensive European fish markets. The second priority, Depletion of Natural Resources, may be related to a lack of resources, especially water, as Spain continues to develop in the EC. The division of land happened a long time ago and does not seem to be a cause of concern, although matters such as property speculation, desertification, irrational use of water etc, should all be motives for greater concern. The third priority, Conflicts and Violence, may be related to the terrorists' attacks in Spain as well as the continuing conflicts in nearby Africa and the refugees they produce who try to enter Europe through Spain.

The results of the rankings of the US teachers indicate that Depletion of Natural Resources, Ecosystem Degradation and Environmental Pollution are all priorities. Water is a very big problem in the part of the US the teacher sample was from, and there is real fear that continued development will decrease the quality of life both through resource depletion, degraded resources and increased air, water and land pollution. Land use is also seen as a priority. Continued development around Lake Tahoe and growth in California have degraded the water and air quality there as well as in some of the most scenic areas of the Sierra Nevada mountains. Many more bears, coyotes and cougars are now seen and captured and relocated or killed from newly developed areas as humans continue to take over what was formerly habitat of wild animals. Food Resources and Conflicts and Violence were not seen as priorities, in spite of growth taking away prime crop land in the California central valley, and the war

in Iraq which poses no sacrifice to people outside the military. There has been a lot of news about obesity in both adults and school age children, but is appears that there is no transfer to what is going on in much of the underdeveloped world. Most foreign news deals with the economy and Iraq so issues such as starvation and conflict in the Congo or Darfur region of Sudan rarely make the news.

Before concluding, one important limitation of the data should be mentioned. The Romanian data was collected over a year after the US and Spanish data and the increased emphasis on global climate change and its' effects was much more prevalent in the news when the Romanian teachers completed the survey. Further research will survey another US sample of science teachers to determine if attitudes about the eight/problems threats have changed.

In conclusion, several statements can be made regarding cross national secondary science teacher perceptions and knowledge of environmental and technological problems/threats that degrade the biosphere.

First, it is apparent that in all three countries, secondary science teachers had little knowledge about the 2002 UN Earth Summit in Johannesburg, a world summit to address sustainable development. The fact that so many teachers did not answer this question or provided vague or inconclusive answers may indicate how little importance even secondary science teachers, give to world threats to the biosphere such as global climate change.

Second, it appears that science content that addresses threats to the biosphere must be a part of the required curriculum and teachers must be trained for and given the time to teach that curriculum. In fact, for most students, it probably should be the only science curriculum. Only then will a critical mass of voters increase the prospect for awareness of the importance of these problems and threats and gain the necessary knowledge needed to act on them through voting and pressure on elected representatives.

Third, teachers and students must understand that threats to the biosphere affect all life. In a finite world, we are all in this together and what we do now impacts future generations. Therefore, the standards and the prescribed science curriculum must include 1) the science behind the threats to the biosphere and 2) methods in pre service and in service science teacher training that address how to connect and apply essential science concepts, process skills and science habits of mind to an understanding of these threats.

Fourth, the data indicates that the most important goal of all three nationalities of science teachers is to help students become science literate to become better informed citizens and voters. If this is true, it is apparent that all science teachers must do more to carry out this goal in the actual teaching that occurs in their science classes.

Fifth, it appears that the rankings are directly related to personal experiences of the citizens in each country. Unless global environmental problems and threats directly impact citizens in a given country, the citizens may not really perceive the damage they may doing to the biosphere on a global level. This is a strong reason for making science and technology based global environmental problems and threats an essential part of the science curriculum in all countries and assessed with high stakes tests. Maybe the next UN Earth Summit should address a common environmental science curriculum that addresses global biosphere threats and is required teaching in every country.

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Appendix

Part I

As citizens of the world, we face many public policy problems related to the technological and environmental changes that affect humanity and the rest of life on Earth. We invite you to reflect on the relationship between the science that you teach and the problems and challenges that, in your opinion, humanity faces now and will face in the near future.

Please answer the following:

1. What were some of technological and environmental problems and or threats that were discussed in the 2002 Johannesburg Earth Summit?

2. Can you describe any reasons why you **do or do not teach** about technological and environmental problems and or threats in your science classes?

Please **circle** the number you most agree with for the following questions:

3. How much coverage do you give to technological and environmental problems / threats in your science classes in an average semester?   Circle the number that best applies.

       1   2   3   4   5
     None   Once or twice   Once a month   Once a week   Daily

4. In the context of the science classroom and in the order of your goals and objectives, what do you think is important to teach in science classes?

    ** Value from 10 (full agreement) to 0 (full disagreement)

a. Science classes must teach students how scientists work so students can assess better the everyday technological and environmental problems/ threats they face   _____ 1-10

b. Science classes must teach scientific concepts and theories thoroughly enough to enable students to pursue further studies of everyday technological and environmental problems and or threats. _____ 1-10

c. Science classes must teach information that enables student to acquire the democratic values needed in the social environment in which they live._____ 1-10

d. Science classes must teach students the essential scientific and technological literacy needed by informed citizens in contemporary society. _____ 1-10

Part II

Global Environmental Problems / Threats

There are many public policy problems confronting citizens throughout the earth. The priority that governments and citizens give to the problems can vary in different countries. We would like you to rank the following global environmental problems / threats according to how important you think they are and the priority they should have in public policy.

Many of the nine (A-I) problems / threats are related to one another. This makes selection of one problem over another somewhat difficult. With this understanding, we ask that you do your best to

rank the most significant problem and or threat with a number 1, the second with number 2 and so on to number 8. It might be easiest rank the top three first (1-3), the bottom three second (6-8) and the middle two last (4-5).

A_____Conflicts and Violence (regional inequalities in the world, cultural and religious differences, increased access to war technologies including chemical, biological and nuclear agents, terrorism, Mafia activities, trans national enterprises which escape democratic control, etc.)

B_____Depletion of Natural Resources (Water, Minerals and Land; water and energy conservation, efficiency and reuse, alternative energy, loss of watersheds, water distribution, deforestation, desertification, reclamation, soil erosion, urban development etc.)

C_____Ecosystem Degradation (loss of biological diversity**,** extinction of plants and animals, wildlife habitat loss, ecological services, affects on human health, etc.)

D_____Environmental Pollution and its Consequences (Air and Atmosphere Quality, vehicle and power plant emissions, acid rain, global climatic change; Water Pollution, ground water contamination*,* human and industrial waste disposal, Land Toxicity, waste dumps, toxic chemicals, effects on human health, etc.)

E_____Human Health and Disease (infectious and non-infectious disease, antibiotic resistance, stress, diet and nutrition, exercise, mental health, pollution, etc.)

F_____ Land Use (The demographic explosion, a finite planet, population growth, resource degradation and depletion, carrying capacity, etc.)

G_____Sustainable Development (world economics and politics, loss of ecosystems and environmental degradation, corporate expansion, World Trade Organization, etc.)

H____World Hunger and Food Resources (processed food, genetically engineered foods, corporate agriculture, cropland conservation, etc.)