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How do learners in developed and developing countries relate to environmental issues?

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Abstract
The present study was carried out in the framework of earlier research on environmental education for sustainability, using data collected in the ROSE Project. Attention was focused mainly on students' responses to sections and items related to environmental issues, regarding their countries' degree of development.
The research questions dealt with: (a) students' visions for the future of the environment, (b) students' personal engagement in the environmental protection issue, (c) students' interest in learning about environmental challenges, (d) students' interest in a future job as linked to environmental protection, and their relation to their countries' degree of development.
The findings showed that students in medium and low developed countries are more:
- concerned and optimistic about environmental problems;
- personally and collectively involved in environmental issues;
- interested in learning environmental topics;
-interested in seeing their future jobs dealing with environmental protection.
The conclusion is that it is important to develop environmental science education programs based on each country's own cultural, educational, and economic context. These is compatible with a 'place-based pedagogy' that promotes a narrative of local and regional politics adjusted to the particularities of where people actually live and linked to global development trends that impact local places.
Keywords: *Relevance of science education, developed and developing countries, environmental issues.*

Introduction

Given that many environmental problems (and their solutions) are science-related, there is clearly a role for school science education regarding the future of the environment. The attention paid to the mutual relationship of environmental education with science education is primarily driven by such issues such as worldwide deforestation, global warming, ozone depletion, oil spills, rapid population growth, and alterations of habitat (Kortland, 1997; Robinson, 1999). Clearly, addressing such

issues during science courses may help produce environmentally literate citizens that are able to understand the basic environmental problems and act accordingly.

We see science education as having a key role in preparing young people to cope and deal responsibly with the emerging environmental challenges. Rule (2007) posits that in addition to intellectual skills, science attitudes include emotional components like curiosity and openness to new experiences. Accordingly, students' emerging attitudes to science – including natural and environmental science – generate feelings that may influence lifelong attitudes and behaviors. Kaiser et al. (2007) found that " people's attitudes do become traceable from people's behavioral reports and, possibly, even from people's overt behavior" (p. 250).

According to Schultz et al. (2005), we use the term environmental concern to refer to the affect associated with environmental problems and the term environmental attitude to refer to the collection of beliefs, affect, interests, and behavioral intentions a person holds regarding environmentally related activities or issues. From this perspective, students' environmental concern and their declared engagement in environmental issues are aspects of their environmental attitude, while students' visions for the future of the environment are an aspect of their environmental concern.

Nowadays, there is a general consensus that environmental education should pay particular attention to students' attitudes and interests, because their level of knowledge and comprehension seems to increase with their concern (Schleicher, 1995). Ballantyne and Packer (1996) found environmental conceptions to be very important in the adoption of attitudes and environment-related behaviors. These conceptions vary between individuals according to their own beliefs, environmental knowledge and experience. Many students appear to have misconceptions of certain environmental issues (Wals, 1992). There is a large body of literature on the relationships between knowledge, attitudes and behavior toward the environment, but findings continue to be mixed regarding relationships among these variables. Objective knowledge has been found to have significant relationships with environmental behavior (Bartkus et al., 1999). Kaiser et al. (1999) found that "environmental knowledge and environmental values are significant preconditions of ecological behavior intentions" (p. 12). However, a study conducted by Kuhlemeier et al. (1999) among secondary school students found that the relation between environmental knowledge and behavior was weak but had a substantial relation with environmental attitudes. Similarly, Bradley et al. (1999) found a significant relationship between environmental knowledge and attitudes among high school students.

Concerns for the Environment in Developed and Developing Countries

The issue of students' attitudes toward environmental issues has been evaluated by a number of authors, but few systematic studies on environmental concern and attitudes across cultures or countries have been done. According to Inglehart (1990), the shift toward environmentalism in the Western world was linked to a post-materialist shift in cultural values; in other words, industrial development and a high standard of living were believed to be a prerequisite for the existence of positive environmental attitudes. Thus, it was presumed that high levels of environmental concern existed

only among people in developed countries. This assumption has been challenged by the results of an international survey on environmental values conducted by Dunlap et al. (1993). The survey's results showed that citizens of many developing nations were highly concerned about the state of the environment. Other multinational studies (Schultz & Zelezny, 1999; Rauwald & Moore, 2002) and studies in the Baltic States (Gooch, 1995), Turkey (Furman, 1998; Yilmaz et al., 2004), Mexico (Corral-Verdugo & Armendariz, 2000), and Zimbabwe (Van Petegem et al., 2007) have found similar results. While Swedish (Schreiner & Sjøberg, 2005) and English students (Jenkins & Pell, 2006) seemed to be somewhat alienated about environmental issues, Zimbabwean (Van Petegem et al., 2007) and Malaysian students (Said et al., 2007) held much more positive attitudes toward environment.

Clear differences in the perception of the human-nature relationship were found by Van Petegem & Blieck (2006) between Belgian and Zimbabwean adolescents. The two groups shared an ecological view in which they were aware of the negative impact humankind has on nature, but only Zimbabwean students felt dominant about nature and believed they have the right to use nature for their needs.
Sarigöllü (2009) formulated several hypotheses claiming that there should be differences in environmental attitudes between what he called:
- "collectivist cultures in which individuals believe the will of the group determines member's beliefs and behavior" (p.370), and "individualist" cultures in which individuals believe mainly on the self-determination of each individual.
- "past-oriented cultures" that value customs and tradition and "believe that preserving history and nature is important" (p. 371), and "future-oriented cultures (that) give less importance to conserving the nature and the past" (p. 371).
Sarigöllü (2009) carried out a comparative study to test these hypotheses and found that Turkish people (collectivist and past-oriented) were significantly more concerned about the environment than Canadians (individualist and future-oriented).
As Ignatow (2006) claimed:

Instead of thinking of environmentalism in terms of a unitary worldview associated with some demographic fragment of society, we should by now recognize that concern for the environment is both remarkably widespread … and culturally diverse… Concern for the environment is thus shaped by social conditions within nations. (p. 456)

Most of the existing hypotheses regarding environmental attitudes were tested in or derived evidence from the research in developed countries. We think there is a need for studying and comparing students' environmental attitudes and interests in developed and developing countries as indicators for environmental behavior, in order to identify what contributions school science education can make in improving these attitudes.

The present study was carried out in the framework of earlier research on environmental education for sustainability, using data collected in the ROSE Project. ROSE, the Relevance of Science Education, is an international comparative research project meant to gather and analyze information from the learners about several factors that have a bearing on attitudes to science and technology (S&T) and their

motivation to learn S&T. Examples are: A variety of S&T-related out-of-school experiences, their interests in leaning different S&T topics in different contexts, their views on school science, their views and attitudes to science and scientists, their future hopes, priorities, aspirations, and their feeling of empowerment with regards to environmental challenges.

The research questions were:
- Are students' visions for the future of the environment related to their countries' degree of development?
- Is students' personal engagement in the environmental protection issue related to their countries' degree of development?
- Is students' interest in learning about environmental challenges related to their countries' degree of development?
- Is students' interest in a future job as linked to environmental protection related to their countries' degree of development?
We concentrated on empirical findings from analysis of the ROSE survey data addressing the issues above and comparing students' environmental attitudes and interests in developed and developing countries.

Method
The ROSE survey was conducted in 2003 and 2004. To the relevant questions students gave their responses on four-point Likert scales with categories of 'Not interested'-'Very interested,' 'Disagree'-'Agree,' 'Not important-Very important,' and 'Never-Often.' Students were requested to indicate their response to each item by marking the appropriate box; the data entry was measured on a scale from 1 to 4. The ROSE questionnaire, which was developed by an international advisory group of researchers in science education, comprises about 250 items. To handle this amount of material and to elevate the discussion from responses to single items to a more general level, questionnaire items were merged into composite variables or clusters, each of which constituted one index. The indexes are latent variables not directly observed, but developed from a set of observed variables (the questionnaire items). The indexes are simply average item scores; each index contains a different number of items. Combinations of theoretical perspectives, the initial ideas of the questionnaire developers, exploratory factor analysis, and reliability analyses using Cronbach's alpha led to the structure of the current indexes: "What I want to learn about"; "My future job"; "Me and the environmental challenges"; "My science classes"; "My opinion about science and technology"; "My out-of-school experiences" and "Me as a scientist" (the only open item). More details about the ROSE instrument, its theoretical background and its development can be found in Schreiner and Sjøberg (2004), especially chapters 3 and 6, which include piloting the Norwegian version of the questionnaire, three different international trials, and measures of validity, reliability and credibility of the English version, including factor analyses. In the present article attention is focused mainly on students' responses to sections and items related to environmental issues: students' attitudes to environmental challenges, their interest in learning about environmental topics and in having their future job related to environmental protection. This study comprised 36,728 students from 34 different countries, most of them 15 years old, that is, the whole valid analyzable ROSE sample[i]. The sample represents the population of

compulsory last-year students in the different countries, as detailed by each of the national coordinators at http://www.ils.uio.no/english/rose/network/ international-partners.html.

For all of the analyses we used the Human Development Report (HDR) (UNDP, 2003) published annually by the United Nations Development Program (UNDP). In each HDR the countries are ranked according to the Human Development Index (HDI), which was developed in 1990 by a team of United Nations Development Program (UNDP) researchers and has been used and refined since 1993 by the UNDP in its annual report. The HDI is a composite of three basic components of human development: health, education and standard of living. Health is measured by life expectancy, education is measured by a combination of adult literacy (two thirds weight) and mean years of schooling (one third weight), and standard of living is measured by purchasing power, based on real GDP per capita adjusted for the local cost of living (purchasing power parity). Table 1 shows the Human Development Index for the countries analyzed in this paper.

Table 1: The Human Development Index in 2003 of the 34 countries analyzed (UNDP, 2003)

HDI rank	Country	HDI value	HDI rank	Country	HDI value
High human development			38	Estonia	.853
1	Norway	.963	48	Latvia	.836
2	Iceland	.956	57	Trinidad Tobago	.801
6	Sweden	.949	Medium human development		
8	Ireland	.946	61	Malaysia	.796
11	Japan	.943	62	Russia	.795
13	Finland	.941	84	Philippines	.758
14	Denmark	.941	94	Turkey	.750
15	U. Kingdom*	.939	127	India	.602
17	Austria	.936	131	Botswana	.565
20	Germany	.930	138	Ghana	.520
21	Spain	.928	139	Bangladesh	.520
23	Israel	.915	144	Uganda	.508
24	Greece	.912	145	Zimbabwe	.505
26	Slovenia	.904	Low human development		
27	Portugal	.904	147	Swaziland	.498
31	Czech Republic	.874	149	Lesotho	.497
36	Poland	.858			

* England, North Ireland and Scotland

In a previous study, Stefansson (2006) calculated the correlation coefficient between the HDI value of all the participating countries in the ROSE research and the respective national means of 58 scale items from the ROSE questionnaire intended to shed light on children's perceptions of science, scientists and the science classroom and future job priorities. The correlation calculations showed that 41 of the 58 items had significant correlations at the 0.01 level to the HDI. Sjøberg and Schreiner's (2005) study showed a strong relationship between the HDI for a country and the responses to questions measuring what students want to learn about of the ROSE questionnaire. They found that the Pearson product moment correlation between the

national average score across all these 108 items and the corresponding HDI was r = .85 ($p < .01$) indicating a very strong inverse relationship.

In this article HDI serves as an indicator of the level of development in a country: High HDI for European countries, Japan, Trinidad-Tobago and Israel, Medium and Low HDI for African, Asian and Baltic countries.

Instrument Design

1. The first parts of this study refer to the section of the questionnaire headed "Me and the environmental challenges". This consists of 18 statements prompted by the question "To what extent do you agree with the following statements about problems with the environment (pollution of air and water, overuse of resources, global changes of the climate, etc.)?" These statements intend to examine to what extent the students feel empowered to deal with the environmental problems. As stated by Schreiner and Sjøberg (2004):

In order to be empowered to meet the environmental problems, a person must:
- be motivated for action towards the problems
- have hope and visions for the future
- have a general feeling that s/he can influence the future development
- be interested and engaged in the environmental issue
- think that environmental protection is important for society (p. 59)

The different statements ask whether students:
- have hope and visions for the future
- feel personally or collectively involved
- think that environmental problems are overstated, or that solving them is somebody else's job

As explained by Schreiner and Sjøberg (2004), the development of the items which were analyzed in this study, "was inspired by literature about alienation, powerlessness, meaninglessness, and normlessness (e.g., Seeman, 1972) and measurement scales reviewed in Measures of Social Psychological Attitudes (Robinson et al., 1991)." (p. 66)

(a) Are students' visions for the future of the environment related to their countries' degree of development?

Beliefs about what is in store for the future contribute to the meanings one gives to the present (Bell, 1997). Knowing the young people's images of the future, we can better understand their present motivation, choices and actions. Students' images of the future are consequently of interest to science and environmental educators (Lloyd & Wallace, 2004; Palmer, 1998).

The ROSE data give us the opportunity to separate environmental problems from other future challenges of the globe. What can our data say about youth's view of the future in respect of the environmental challenges? Are they optimistic or pessimistic?

Findings

Two items were intended to tap into respondents' future images of the environment:

- D2: Environmental problems make the future of the world look bleak and hopeless, and
- D7: We can still find solutions to our environmental problems[ii].

Since they show different weak inter-item correlations in different countries (e.g., from 0.06 in the Israeli data to 0.46 in the Slovenian data), we decided not to merge the items into one composite variable, but to report single-item scores to try to understand and validate them. Of these two items, D2 most directly addresses the environmental problems and the future of the world. On average the students in all the countries agree (or even agree strongly, like Bangladeshi, Indian and Ugandan students) with the statement that the future of the world looks bleak and hopeless due to the environmental problems (item D2). Despite that, item D7 displays a very hopeful profile with a mean value greater than 3 for most countries, meaning that students in all countries agree strongly that we can still find solutions to our environmental problems. Nevertheless, looking at the relationship of students' responses for these two items with the HDI, we see that:

1. For D2, an inverse relationship with a Pearson product moment correlation of $r = -.674$ ($p < .01$), that is, the higher the level of development in a country, the lower students' agreement that the world looks "bleak and hopeless" due to the environmental problems, and
2. For D7, an inverse relationship with a Pearson product moment correlation of $r = -.486$ ($p < .01$), that is, the higher the level of development in a country, the lower students' agreement that we can still find solutions to our environmental problems.

The responses to the two items show that, in all the countries students were concerned but nevertheless hopeful for the future of the environment, though students in developing countries seem to be more concerned and more optimistic than their counterparts in developed countries.

(b) Is students' personal engagement in the environmental protection issue related to their countries' degree of development?

Today we face ecological risks created by our own interference with nature, social development, and development of science and technology. Many environmental problems are generated through human decisions and actions, but they are still diffuse in origin. Since possible disasters are detached from individual responsibility, it is unclear who are responsible for finding answers to the problems and taking action accordingly (Beck, 1999).

Some items seem to have in common a lack of concern for the environmental issue indicating that environmental problems are overstated (D3: Environmental problems are exaggerated, and D8: People worry too much about environmental problems, with Cronbach's alpha coefficient from 0.37 to 0.62 for the different countries)[iii].

Findings
Students' responses show that, in most countries the students disagreed with statements indicating that environmental problems are overstated, although none of them disagreed strongly (except Austrian and Japanese). Malaysian and Botswanan students were neutral in this respect, while students from Ghana, Lesotho, Malaysia, Philippines and Uganda tended to agree. Looking at the relationship of students' responses with the HDI, we see that there is an inverse relationship with a Pearson product moment correlation of $r = -.626$ ($p < .01$), that is, the higher the level of development in a country, the less students agree that environmental problems are overstated.

(c) Other items describe another aspect of lack of concern, namely distancing the individual from environmental problems, and sharing an expression that solving these problems is somebody else's job (D1: Threats to the environment are not my business, D11: It is the responsibility of the rich countries to solve the environmental problems of the world, and D13: Environmental problems should be left to the experts, with Cronbach's alpha coefficient from 0.47 to 0.63 for the different countries).

Findings
Students' responses show that in almost all countries the students disagreed with statements indicating that someone else had to solve environmental problems, while Latvian students were fairly neutral about it. When we look at each of the items separately, we see that in all countries the students disagreed less strongly with the statement that rich countries have to solve the environmental problems of the world, while Indian, Japanese and Latvian students tended to agree with it (mean D11 = 2.70, 2.67 and 2.74 respectively). Looking at the relationship of students' responses with the HDI, we see that there is a weak direct relationship with a Pearson product moment correlation of $r = .368$ ($p < .05$), that is, the higher the level of development in a country, the more students agree that solving environmental problems is somebody else's job.

(d) By contrast, there are items which describe a tendency to become involved in the issue (D5, D6, D7, D10 and D12), that is, suggesting that environmental problems can still be overcome, a belief that every individual can make an important difference, and evincing some willingness to act. According to Hungerford and Volk (1990) environmentally responsible behavior [e.g., recycling as personal choice or political activism] is gradually developed, among other ways, by empowerment variables like internal locus of control and intention and ability to act for the environment (Uitto et al., 2004), moving from personal responsibility toward more distant positions on environmental challenges.

Accordingly, we differentiate personal involvement (items D5: I am willing to have environmental problems solved even if this means sacrificing many goods, and D6: I can personally influence what happens with the environment, with Cronbach's alpha coefficient from 0.43 to 0.65 for the different countries) from collective involvement (items D7: We can still find solutions to our environmental problems, D10: People should care more about protection of the environment, and D12: I think each of us can make a significant contribution to environmental protection, with Cronbach's alpha coefficient from 0.56 to 0.79 for the different countries).

The statement of item D5, “I am willing to have environmental problems solved even if this means sacrificing many goods”, represents the strongest personally responsible statement for the environment (cf. Palmer & Neal, 1994) and internal locus of control. In most countries students' differential degree of involvement can be seen in the wide gap between their stated willingness to sacrifice goods (D5) and their less personally compromised readiness to collective involvement (see Figure 1).

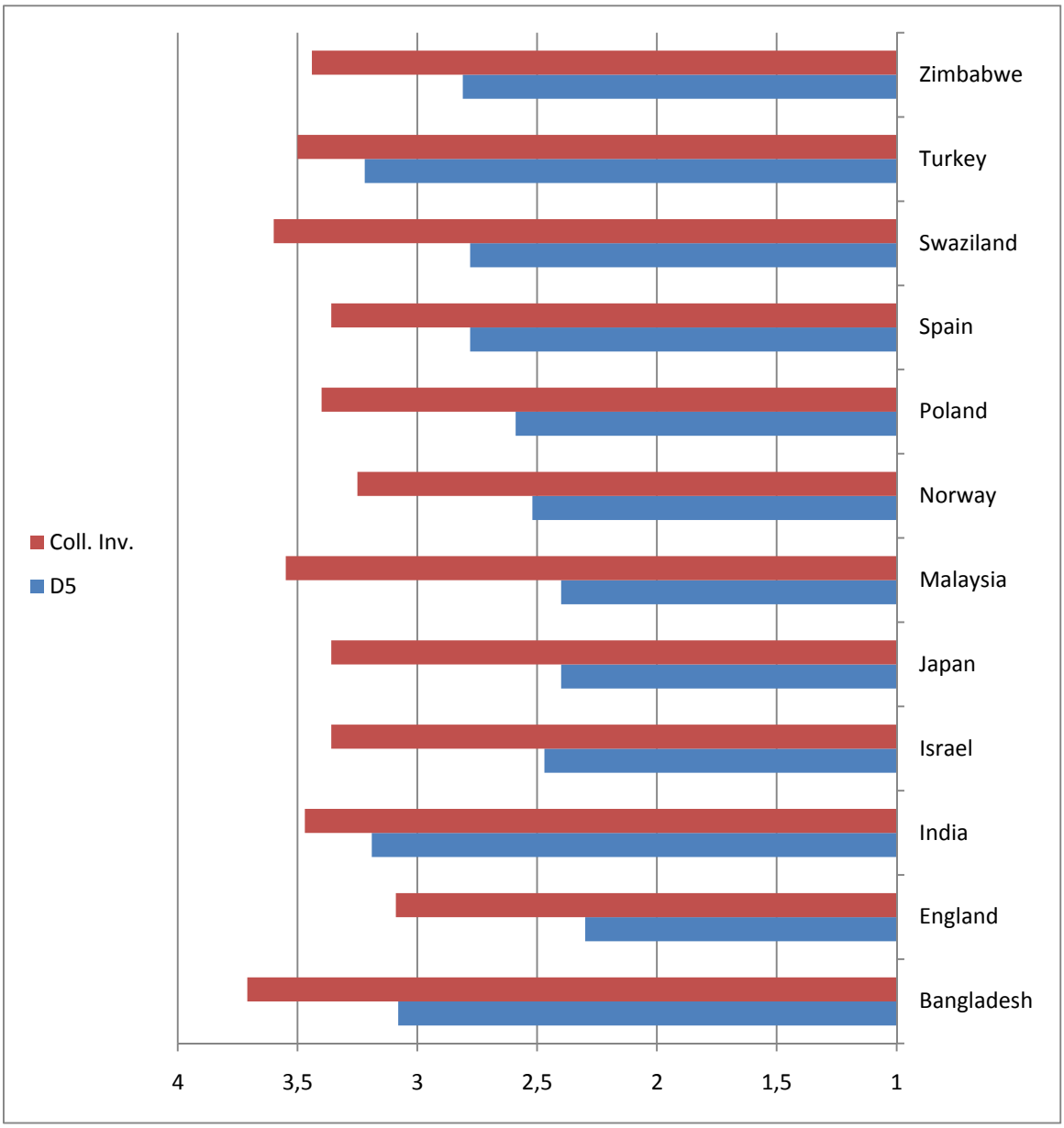
Findings

Students' half-heartedness on the issue may be confirmed by the scores for the 'Involvement' variables. On the one hand, a mean score between 2.5 and 3.25 shows little conviction about statements conveying personal involvement in the environmental issue, British students being negative about it. Looking at each item separately, we see that Finnish students believed that they could personally influence what happened with the environment more than they were willing to sacrifice their goods. Latvian and Turkish students indicated willingness to sacrifice their goods more than a belief in their personal influence, and all the others agreed with the two statements to the same degree. On the other hand, a mean score between 3 and 3.8 for all countries shows a greater conviction about statements conveying collective involvement in the environmental issue.

For the item (D5) and for personal and collective involvement, we got an inverse relationship with the HDI:

1. The higher the level of development in a country the less students are ready to "sacrifice their goods" [Pearson product correlation moment of $r = -.658$ ($p < .05$)].
2. The higher the level of development in a country the less students are personally involved [Pearson product correlation moment of $r = -.444$ ($p < .01$)].
3. The higher the level of development in a country the less students are collectively involved [Pearson product correlation moment of $r = -.571$ ($p < .01$)].

Figure 1: Comparison of students' means of statement D5 and of variable "Collective Involvement".



The conclusion we may draw from these four groups of items (lack of concern – environmental problems are overstated and solving problems is somebody else's job, personal and collective involvement in environmental issues) will nevertheless be that students generally recognized the severity of global environmental issues, believed they must become involved in them, and supported international action to address them. Students in developed countries expected such efforts to generate solutions, but were determined that these should have minimal impact of their own future lifestyles.

Is students' interest in learning about environmental challenges related to their countries' degree of development?

It is interesting to examine the above results in light of the responses of the same sample of students to another section of the ROSE questionnaire dealing with students' learning preferences. Students were invited to indicate how much they "want to learn about" a series of subjects given in 108 statements, as diverse as "How the eye can see light and colors" and "Eating disorders like anorexia or bulimia". As with the rest of the ROSE questionnaire, responses were given on a four-point Likert-type scale, in this case from "Not interested'" to "Very interested", scored as 1 and 4 respectively. Twelve of the 108 items address environmental protection:

- E3: The ozone layer and how it may be affected by humans.
- E4: The greenhouse effect and how it may be changed by humans.
- E5: What can be done to ensure clean air and safe drinking water.
- E6: How technology helps us to handle waste, garbage and sewage.
- E14: The possible radiation dangers of mobile phones and computers.
- E15: How loud sound and noise may damage hearing.
- E16: How to protect endangered species of animals.
- E17: How to improve the harvest in gardens and farms.
- E19: Organic and ecological farming without use of pesticides and artificial fertilizers.
- E20: How energy can be saved or used in a more effective way.
- E21: New sources of energy from the sun, wind, tides, waves, etc.
- E33: Benefits and possible hazards of modern methods of farming.

Findings

For this group of 12 items, Cronbach's alpha coefficient ranged from 0.76 to 0.89 for the different countries. When merging these items to one composite variable, most developed countries' students scored low, absolutely and relatively, meaning that they did not regard environmental protection as a matter of particular interest. German, Japanese and Latvian students gave a rather neutral score, while students in developing countries seemed willing to learn about environmental issues. Looking at the relationship of students' interest in learning about environmental issues with the HDI, we got a strong inverse relationship with a Pearson product moment correlation of $r = -.866$ ($p < .01$): the higher the level of development in a country, the lower the students' interest.

This result appears to support the finding that the higher a country's development level, the lower interest its students express in learning about school science and technology-related topics (Sjøberg, 2000, 2002; Sjøberg and Schreiner, 2005). In any event, in developed countries environmental challenges were among the least interesting of all science topics (Lavonen et al., 2005).

Is students' interest in a future job as linked to environmental protection related to their countries' degree of development?

In view of the preceding results it was interesting to examine how far the sample of students related their future job to environmental issues. In another section of the ROSE questionnaire students were invited to indicate how important several issues were for their potential "future job". This was done through a series of 26 statements as diverse as "Working with animals" and "Controlling other people". Here too,

responses were given on a four-point Likert-type scale, in this case from "Not important'" to "Very important", scored as 1 and 4 respectively. One of the items referred explicitly to "working in the area of environmental protection". Results show a mean score close to 2 which implies that on average students in most developed countries saw no importance in linking their future job with environmental protection. Japanese, Spanish and Malaysian were fairly neutral, while students in most developing countries expressed that this would be important for them. In terms of the HDI, we see a strongly inverse relationship with a Pearson product moment correlation of $r = -.829$ ($p < .01$): the higher a country's development level, the lower the importance its students ascribe to their future jobs dealing with environmental problems.

Findings

While care is needed in drawing inferences from the data, the results indicate that in developed countries, students have less interest in learning about the environmental topics and are less inclined to link their future jobs with environmental protection, than their counterparts in the medium-developed and the developing countries.

Hierarchical Cluster Analysis

We explored the overall similarities between countries in all the variables considered in this study, by a hierarchical cluster analysis. A hierarchical cluster analysis creates a hierarchy of clusters which may be represented in a tree structure called a dendrogram. The root of the tree consists of a single cluster containing all countries, and the leaves correspond to individual countries. An agglomerative algorithm in which one starts at the leaves and successively merges clusters together was used, and an Euclidean distance was used as a measure of similarity between pairs of countries. The choice of which clusters to merge or split is determined by a linkage criterion, which is a function of the pair wise distances between countries. Results from the hierarchical analysis are presented in a dendrogram. The dendrogram in Figure 2 shows how similar or close the countries and country clusters are to each other: the branches depict how clusters are formed at different stages in the analysis and the distances between the clusters; the distance along the horizontal axis from the point at which the clusters come into existence to the point at which they come together into a larger cluster represents the distinctness of the clusters – the distinctness tells us how different one cluster is from its closest neighbor. The most compact a cluster is, that is, the further to the left the branches merge, that is, the more compact a cluster is the more similar the countries are (for instance: Norway, Iceland and Sweden; Scotland, England and North Ireland; Swaziland and Zimbabwe). By reading the dendrogram from the right towards the left, we see that the meta-cluster contains two main clusters: the upper one including high HDI countries, that is, most European countries plus Japan, and the lower one, the majority of the Medium and Low HDI Oriental and African countries. As the length of the branch of these two clusters is relatively long, they can be perceived as two distinctive clusters of countries. A similar result was obtained by Sjøberg and Schreiner (2005) while reporting on students' interest in learning science topics.

Conclusion

The most salient feature of this analysis is a sharp distinction between high developed countries from one side, and medium and low developed countries from the other side. Following, we performed a MANOVA that showed us that for all the variables included in this study, there is a significant statistical difference between this two groups (Wilks' lambda = .247, F value = 9.55, p value < .01).

T-test

Finally, we carried out t-tests for each of the variables and found that there are statistically significant differences between high developed countries from one side, and medium and low developed countries from the other side for all of them, except for the variable "solving environmental problems is somebody else's job" (see Table 2).

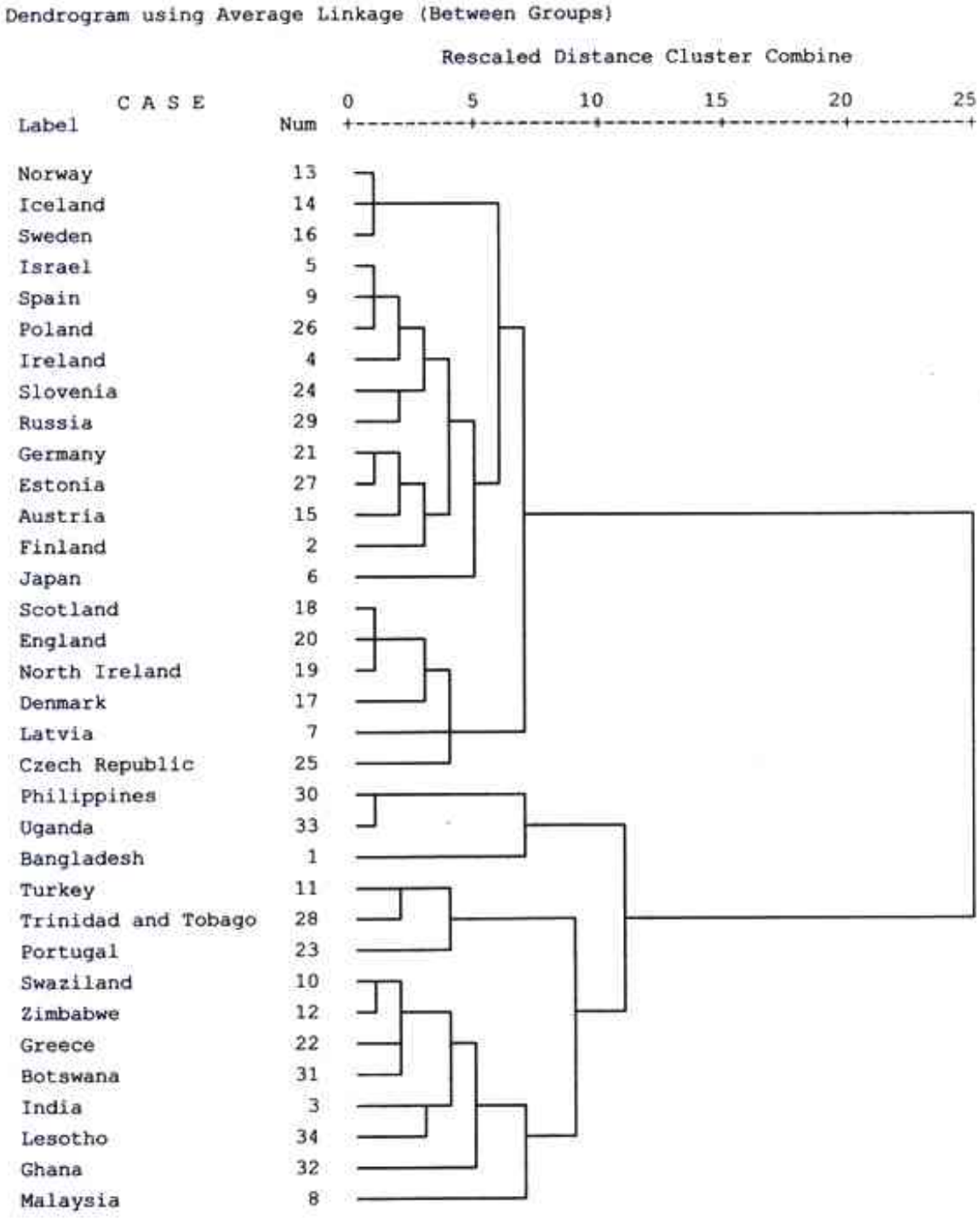
Conclusion

Students in medium and low developed countries are more concerned and optimistic about environmental problems; more personally and collectively involved in environmental issues; more interested in learning environmental topics and more interested in seeing their future jobs dealing with environmental protection.

Table 2: T-tests results for the comparison between high developed vs. mid and low developed countries (DF = 32)

Variable	High HDI (mean)	Low and Mid HDI (mean)	t value	p value
D2 - Environmental problems make the future of the world look bleak and hopeless	2.76	3.16	5.92	< .0001
D7 - We can still find solutions to our environmental problems	3.27	3.52	3.52	.0013
Environmental problems are overstated	2.08	2.53	4.62	< .0001
Solving environmental problems is somebody else's job	2.00	1.77	-2.03	.051
Personal involvement	2.66	2.85	2.51	.017
Collective involvement	3.29	3.54	4.18	.0002
Interest in learning about environmental challenges	2.41	3.01	8.61	< .0001
B4 - Working in the area of environmental protection	2.17	2.99	6.68	< .0001

Figure 2: Hierarchical cluster analysis of variables concerning environmental issues, for all countries.



Limitations

ROSE is by design an explorative and pragmatic project. As stated by Schreiner (2006):

> ROSE is … explorative in the sense that the nature of the data material invites examination, investigation and generation of hypotheses more than it invites confirmation, explanation and falsification/verification of hypotheses. And pragmatic in the sense that, both methodologically and conceptually, the data must be studied in a practical and sensible way, rather than by connecting the data to fixed theories, hypotheses, definitions and principles. (p. 19)

According to Jenkins and Pell (2006) we should be cautious when analyzing the results of the ROSE survey. They claim

> It would be rash to assume…that when students respond to the statements about environmental challenges in the ROSE questionnaire, each has precisely the same understanding of what constitutes such a challenge and is thus capable, in principle, of attaching a common priority to addressing it. … In addition, an indication by a student that he or she wishes to learn about an environmental topic is not the same as an expression of willingness to make the effort and intellectual commitment required to achieve the necessary degree of understanding. Nor can it be assumed that in indicating their level of interest in learning about an environmental topic, students are making what might be called a fully informed choice. (p. 776)

Other limitations of this research are methodological. First, the samples in this study were 15 year old junior high school students, so although the samples were not representative of the countries as a whole, they were comparable samples of students across all countries.

A second methodological limitation is the complexity of linguistic and conceptual differences across cultures. It is always the case in cultural research that the ideas and words included in surveys have slightly different meanings in different cultures.

Finally, though the data in this study was collected six or seven years ago, several recent studies (Bun Lee, 2008; Said et al., 2007; Sarigöllü, 2009; Van Petegem & Blieck, 2006; Van Petegem et al., 2007; Wray-Lake et al., 2010) show that students' attitudes toward the environment remained stable both in developed and developing countries.

Issues Arising

Despite these caveats, the findings presented raise several issues for those with a practical or research interest in environmental science education at school level.

1. The findings from the sample of school students show a very similar pattern of responses across the industrialized countries, as seen previously in Schreiner and Sjøberg (2003), Anderson (2006) and others, while dealing with students' interest in learning school science topics. Given the diversity of educational, economic and social background among the participating countries, we see the powerful influence of these factors in shaping attitudes and opinions. Issues perceived meaningful to young people in a country may depend on its culture

and its material conditions. Accordingly, young people's values, views, aspirations and ways of understanding themselves, their surroundings and the world are linked to the culture in which they grow up (Schreiner & Sjøberg, 2007).

2. Students' views in all countries about the issues of environmental challenges suggest that such issues cut across cultures (see Szagun & Pavlov, 1995), so environmental matters are a global concern for students. This is seen in the light of the fact that many of them from different cultures continue to show optimism about the future of the globe and believe in their personal and collective abilities to help in solving environmental problems (see Schreiner & Sjøberg, 2003; Bonnet & Williams, 1998).
3. The environmental challenges faced by developing countries are similar to, but many times more serious than, those in the developed world. Most of the 14 countries members of the Southern African Development Community (SADC) are faced with severe problems of poverty and malnutrition, natural resource degradation, including land degradation, pollution and waste, and health problems such as HIV/AIDS (SADC Regional Environmental Education Program, 2004).
4. People in developing countries lack access to many services crucial to a high quality of life. For instance, 1.2 billion people – 1/5 of humanity – have no access to clean drinking water, 2 billion people have no electricity, and approximately 3 billion people do not have adequate sanitation services (Kyle, 1999). In several African developing countries, millions are HIV-positive; in 2000, 40% of deaths of people aged between 15 and 49 were due to HIV/AIDS. By 2015 orphans are likely to constitute over 10% of the population (Coombe, 2001; Malcolm, 2002).

This may explain the fact that, when referring to environmental challenges, students in developing countries show:

- more concern and involvement,
- more readiness for personal sacrifices, and
- a greater belief in their personal contribution.

In addition, students in underdeveloped countries show much more interest than their counterparts in the industrialized countries in learning some aspects of environmental matters through school science, and probably through learning they may develop attitudes and skills conducive to environmental preservation. This appears to place students in underdeveloped countries in a better position in their attempts to help solve the current environmental problems, which has become one of the major challenges confronting many developing countries.

5. The findings of this study indicate significant differences in students' environmental attitudes and interests in developed and developing countries. These differences suggest implications for both planning and conducting environmental science education programs.

Educational implications

So, what should be the implications for environmental science education? The response to this question will be different according to the country's culture and level of development. Results from the international ROSE material shows that in average youth from all countries (e.g., Anderson 2006, Jenkins & Pell 2006, Lavonen et al., 2005, Sjøberg & Schreiner 2005, Stefansson 2006) wish to be involved with something they find important and meaningful, but we know that cultures put different meanings in the concept 'important and meaningful'.

We think it is important to develop environmental science education programmes that are based on each country's own ecological, cultural, political, educational, and economic context (UNESCO, 1980, 1985). For instance, environmental science education for developing countries should be different from that for advanced countries, because the variables that affect environmental literacy vary from country to country.

(a) Implications for developed countries

The ROSE data have been used extensively to report environmental attitudes of students in developed countries such as England (Jenkins & Pell, 2006) and Norway (Schreiner & Sjøberg, 2005), presenting recommendations for school education.

The main issue in developed countries is to enhance students' concern for an involvement in environmental problems, and to increase students' interest in learning environmental topics. Skjåk and Bøyum (1993) found that the predominant factor motivating for environmental protection involvement in Western individualized societies is the perception of risks, and mainly personal risks. Schreiner and Sjøberg (2005) have argued that one of the main goals of environmental science education for empowering students in developed countries to act responsibly with the environmental issue should be stimulating students' awareness of what future they would prefer, that is visualizing the alternatives and the aims one wants to work towards. They suggested that, in addition to going through students' knowledge about the subject, the educational process should address questions such as (according to Hicks & Holden, 1995):

- What and why do we think, feel, hope and fear in relation to the environmental problems?
- What would things look like in a more sustainable future? What are the possible manners of action to achieve that?
- How shall we implement our plans of action in school, at home and in the community?

(b) Implications for developing countries

Against that, environmental science education in developing countries may rely on the more positive attitudes shown by youngsters: it should enhance future citizenry's capacity to find ways to provide the missing services that are crucial to a better quality of life in ways that are environmentally sound, socially equitable and economically affordable.

In recent years a number of African and Asian developing countries have tried to work out contextually realistic science programs. However, as reported by Gray (1993), much of this has been under the auspices of aid programs, sometimes employing expatriates who lack contextual 'touch' and carry with them a Western culture mind-set. As he stated:

> My fear is that developing countries will, once again, simply follow developments in the First World, but in their own particular way, whether they have resources to support the change and whether it is contextually relevant or not. Evidence of this is already in South Africa … where they are presently engaged in a major process of curriculum reform (p. 262)

Falgout and Levin (1992) claim that for developing country students, the importance of knowledge lies in its application, results and products, whereas Western schools tend to regard as a virtue the learning of knowledge for the sake of knowledge. In many developing countries, the official school view is a product of Western culture, inasmuch as the local education system remains tied to its original source. In particular, science programs often are taken directly, with little or no adaptation, from Western nations' science programs. Curriculum developers often fail to recognize that both students and teachers are part of a local culture that, while undergoing significant change, persists in cherishing certain traditions and practices. The important cultural milieu into which the curriculum is to be placed is often ignored (Waldrip & Taylor, 1999).

Van Damme and Neluvhalani (2004) claim that the 1992 Earth Summit's aftermath and its view that indigenous knowledge could play a positive role in development and in responses to environmental issues and risks, displayed a turning point away from past negative perceptions on indigenous knowledge to those of "indigenous knowledge playing a purposeful and pivotal role in processes of sustainable development" (p. 355) in African countries. Thakadu (1997) recommended that "indigenous knowledge should form the basis of environmental conservation education" (p. 97), and that it should be a vital component in every subject matter, "made possible by the fact that the holistic nature of indigenous knowledge gives it a broad spectrum of coverage in all spheres of life" (p. 99).

Van Damme (1999) highlighted the role of adults in enriching the curriculum and argued for a contextualizing of schools in communities. She also argued for the need "to bridge gaps and provide space in schools for adults to interact with learners about indigenous environmental knowledge learnt at home (Van Damme & Neluvhalani, 2004, p. 360).

According to that, Mueller & Bentley (2009) report about a Ghanaian curriculum reform now taking place which focuses on the community and ecosystems as the context of education. They explain

> This curriculum reflects an acknowledgement of the effect of conserving and protecting Ghanaian intergenerational knowledge and skills concerning the natural systems, including those of preserving ceremonies, personal expectations, narratives, beliefs, and values. (p. 53).

Also of importance in the incorporation of indigenous knowledge into formal education is the inclusion of traditional methods of teaching and learning (oral transmission methods) and the use of local community resource persons (particularly the elders who are considered repositories of indigenous knowledge in communities) (Shava , 2005).

This has been recently corroborated by Glasson et al. (2006) who explored the many challenges of teaching children to live in a sustainable society within the context of the primary education system in Malawi, and by Mirzoyan and Mirzoyan (2008) in their report about a general education reform project in Armenia, arguing against constructivistic approaches in science teaching.

These recommendations fall far away from the situation in Western industrialized countries, as described by Schreiner and Sjøberg (2003) and others, in which there is a loss of grand narratives and a fall of autorities, that is, "traditional values and norms have lost their position, and ideologies, parents, teachers, scientists and politicians have a weakened function in guiding youth" (Schreiner & Sjøberg, 2003, p. 4).

We think that developing countries need to have greater confidence in their ability to produce curricular programs that are in vein with their culture, with their needs, and with the interests and motivation of their students. They need to develop educational policies that are authentic, relevant and affordable in their own particular countries.

These implications are compatible with a 'place-based pedagogy' that "foregrounds a narrative of local and regional politics that is attuned to the particularities of where people actually live" and stays "connected to global development trends that impact local places" (Gruenewald, 2003, p.3).

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[i] Several surveys were removed from the data analysis for failing to follow instructions or leaving a large portion of the survey blank.

[ii] The item "I am optimistic about the future" was not included in this analysis since it is not explicitly worded with regard to the environment and it is weakly, negatively, correlated with the item "Environmental problems make the future of the world look bleak and hopeless" for all countries, though they both were meant to tap students' global future image in relation to environmental problems.

[iii] The item "Environmental problems can be solved without big changes in our way of living" was not included in this analysis since it weakens significantly the inter-item correlation for all countries.