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Environmental Problems, Causes, and Solutions: An Open Question

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In a national evaluation of environmental literacy in Israel, (Negev, Sagy, Garb, Salzberg, & Tal, 2008), the authors included both multiple choice questions and open questions. In this article the authors describe the qualitative analysis of the answers to an open question regarding a local environmental problem. Most participants specified solid waste, open spaces, or air pollution as the main issues. The perceived solutions were generally at the governmental level, including planning, infrastructure, legislation, and enforcement. The authors describe relations in these responses between the problems, their causes and solutions, and between the quality of these answers and the general environmental literacy of the participants. The authors end with a discussion of the special contributions and potential of open-ended questions for environmental education research.

Keywords *environmental literacy, Israeli national survey, open question, qualitative research*

The 1977 Tbilisi Intergovernmental Conference on Environmental Education (EE), is considered as the defining milestone in the field of EE (Sarabhai, Pandya, & Namagiri, 2007). The conference recommendations include an emphasis on the importance of knowledge and understanding of environmental problems, their causes and solutions, locally and globally (UNESCO, 1978). Specifically, the recommendations include a call for *"...integrated perception of the problems of the environment..."*, and *"...knowledge, values, attitudes, and practical skills to participate in a responsible and effective way in anticipating and solving environmental problems. ..."* The declaration further includes five categories of EE objectives, virtually all of them relating to environmental problems. Specifically, the objectives relate to awareness and knowledge regarding environmental problems, skills for identifying and solving these problems, and an opportunity to be involved in resolving them (UNESCO, 1978).

Over the past 20 years, researchers worldwide have explored the environmental literacy of school students, including knowledge, attitudes, and behavior (Barraza & Walford, 2002; Chu et al., 2007; Kuhlemeier, van den Bergh, & Lagerweij, 1999; Makki, Abd-El-Khalick, & Boujaoude, 2003; McBeth, Hungerford, Marcinkowski, Volk, & Meyers, 2008; Tuncer, Ertepinar, Tekkaya, & Sungur, 2005). While the knowledge dimension in such surveys is typically evaluated via closed, multiple choice questions, some surveys also include open questions regarding environmental problems. Such surveys include the American MSELI (Middle School Environmental

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Literacy Instrument), (Wilke, Hungerford, Volk, & Bluhm, 1995) and SSELI (Secondary School Environmental Literacy Instrument) (Nowak, Wilke, Marcinkowski, Hungerford, & Mckeown-Ice, 1995), as well as a Danish survey (Mogensen & Nielsen, 2001). Open questions and qualitative analysis enable researchers to capture unexpected phenomena and nuances that would otherwise evade closed questions (Smith-Sebasto & Walker, 2005).

According to Bloom's taxonomy of educational objectives, there are three types of educational activities: cognitive, affective, and psychomotor (Bloom, 1956). The cognitive, or mental skills, include a hierarchy of six orders: (1) knowledge, (2) comprehension, (3) application, (4) analysis, (5) synthesis, and (6) evaluation. Usage of multiple-choice questions typically enables an examination of the lowest order cognitive skill, i.e., knowledge (including the ability to arrange, recognize, and recall). Usage of open questions is particularly well suited for capturing higher order cognitive skills, such as comprehension, (including the ability to describe, identify, and restate), application (including the ability to demonstrate, interpret, and solve). Certain usage of open questions, for example in a case study, also enables an examination of the highest order cognitive skills: analysis, synthesis, and evaluation (Dori & Herscovitz, 1999).

The answers to open questions cannot be analyzed solely within quantitative methods, as the raw answers cannot be translated into numbers. Therefore, open questions may be analyzed by qualitative methods. Certain methods combine the richness of qualitative analysis and precision of quantitative analysis of the data, for example "grounded theory" (Glaser & Strauss, 1967; Strauss & Corbin, 1990; Strauss & Corbin, 1998) and "thematic analysis theory" (Boyatzis, 1998; Strauss & Corbin, 1998). Both methods include coding of sections within the text, according to codes which are modified until saturation. This occurs when analysis of further texts does not require further refinements of the codes.

Several researchers in environmental education (EE) used "grounded theory" (Smith-Sebasto & Walker, 2005; Tilbury & Walford, 1996). However, qualitative analysis of open questions regarding environmental problems is still largely absent from the EE literature. One exception is a Danish survey distributed to ninth and twelfth grade students (Mogensen & Nielsen, 2001), which included questions regarding environmental problems and their causes. The problem that the students reported most was pollution (17%), and the cause of environmental problems repeated most was *"lack of awareness or inappropriate behavior"* (30%) (Mogensen & Nielsen, 2001, p. 34). While the categories in our research are somewhat different, we will discuss the similarities between the results below.

Furthermore, several researches conducted *quantitative* research of closed questions regarding environmental problems. For example, the Stockholm Environment Institute (www.sei.se) published a series of papers on environmental problems and the urban household in several countries. According to the Institute's paper "Environmental Problems and the Urban Household in Third World countries" (McGranahan, 1991), the core environmental problems faced by the urban poor are (1) water and sanitation, (2) air pollution, (3) food contamination, (4) solid waste disposal, (5) pests and pesticides. While Israel is a developed country (Orenstein, 2004), we will compare these third-world environmental problems to the environmental problems chosen by the Israeli students who participated in our research.

In another survey, consisting of closed questions, on citizens of Sao Paulo's perceptions of environmental problems and their solutions (Jacobi, Kjellen, & Castro, 1998), 63% of the participants said that air pollution is a problem in their neighborhood; 39% complained about

contaminated streams and rivers nearby; 39% cited noise pollution; 37% said they suffer from problems with water supply and quality; and 29% complained about solid waste in the neighborhood. For most problems the great majority of the participants thought that the solution should be governmental (more than 87% for water, sewage, and air pollution problems). Regarding solid waste, 71% thought the solution is governmental, 17% thought the solution is on the community level, and 12% thought it is at the individual level. The governmental solutions preferred were either direct, such as investment in infrastructure, and enforcement, or indirect such as education and information. As the survey methodology and age group of the participants differ, a direct comparison between the Sao Paulo research and the current research is not possible. However, we will point out some striking similarities between the results of the two researches.

METHOD

Participants

We collected the data during a national environmental literacy survey we conducted in spring 2006 (Negev et al., 2008) wherein 1,530 twelfth grade students completed the survey. These students composed a representative national sample of the formal education system along key sociodemographic axes: ethnic-religious group, socioeconomic status, town size, and achievements on matriculation exams

Survey

For a detailed description of the survey and data collection, see Negev et al. (2008). The survey contained four sections. The first three sections consisted of closed questions (i.e., Likert scale and multiple choices). The fourth section had three types of open-ended questions: (1) identification of environmental problems, their sources, and potential solutions; (2) questions about experiences in and feelings toward nature and the environment; and (3) questions regarding local plants and their uses.

Regarding a local environmental problem we constructed the question as shown in the Appendix, and designated each subquestion one line of an A4 page for the answer (see Appendix).

Data Analysis

We typed the answers into a Microsoft Excel spreadsheet, and designed a coding form in Microsoft Access that imported the data from this spreadsheet. This eased the scoring, as well as the dynamic creation of, and coding with the thematic categories. We produced these categories through an iterative process inspired by grounded theory (Glaser & Strauss, 1967; Strauss & Corbin, 1990; Strauss & Corbin, 1998), and described below. We conducted statistical analysis of the data by using JMP (SAS) statistical software. We calculated the statistics reported here by using the representative national sample described in a previous paper (Negev et al., 2008).

Nonresponse and Sample Representativeness

Of the 1,530 valid completed questionnaires in the national survey, 41.3% of the children did not complete any of the three open questions related to environmental problems. An additional 90 questionnaires, comprising 5.9% of those surveyed, had partial answers. In order to assess whether this substantial nonresponse rate was systematically biased, we performed a nonresponse analysis that compared the characteristics of respondents and complete nonrespondents. This was important in order to know whether our findings from an analysis of responses on these questions remained as a representative of the population as a whole, or had been degraded by the systematic bias in nonresponse regarding this set of questions.

The nonresponse analysis of demographic variables consisted of a series of bivariate comparisons of the two subgroups (respondents and nonrespondents) on key variables: town size, exam quality, socioeconomic status, sector, and gender. We performed a Chi-square test of differences between response/nonresponse groups for the first four variables, and a Fischer's exact test for gender. Two of the five tests were significant at the .05 level: exam quality (χ^2 likelihood ration $34.5, p < .0001$) and socioeconomic status (χ^2 $8.81, p = .01$). On closer analysis of the differences in the response rate for different exam quality levels (high, mid-high, mid-low, and low) it was revealed that more students in the mid-low scoring schools did not respond, and a greater number of students in low-quality schools did respond, with the total of these two groups remaining constant. Similarly, the main contribution to the Chi-square score in the comparison of the three socioeconomic groups was from an underrepresentation of the high socioeconomic groups.

While statistically significant, these effects were not substantial. Children in the mid-low schools represented 18.2% of the population and 14.5% of the answers, while the top socioeconomic class represented 49.2% of the population but 46.2% of the respondents. Thus the findings described in this article can be said to remain representative of the demographic composition of the population as a whole.

At the same time, we might expect that the students that did not respond to the open questions would have lower levels of environmental literacy and motivation than those that did. This was, indeed the case. Comparisons of the mean scores on the three primary literacy components were made using t tests, and these were all significant, as described in Table 1.

We can see that respondents had a somewhat higher average behavior score than nonrespondents, and markedly higher knowledge and attitude scores. At the same time, only between 1% and 4% of the variance in these scores was accounted for by respondent status. To summarize, while the analysis that follows is representative of the population along key demographic dimensions, it is only to a small degree, a picture of the more knowledgeable and motivated children.

TABLE 1
Comparisons of Mean Scores of Environmental Literacy between Respondents and Nonrespondents

Dimension	*Difference (in Z score units) between respondents and non-respondents*	*DF*	t *ratio*	*Prob* < t	R^2 *of ANOVA*
Knowledge	0.33	1528	6.48	<.0001	0.027
Behavior	0.18	1524	3.63	<.0001	0.009
Attitude	0.43	1524	8.38	<.0001	0.044

Reliability and Validity

We ensured data reliability by conducting forward and backward checks of a randomly selected subset of data between the input spreadsheet and the original completed questionnaire forms. Two of us coded all the twelfth grade answers to the questions we describe in this article. For each question, the two coders formulated initial categories independently of each other, based on the same initial subset of fifty randomly chosen surveys. The coders then compared and discussed their results, and modified the categories to reflect a consensual understanding of the categories and the information they included. The coders repeated this process three times with different randomly chosen subsets, until the categories were saturated (coding of further answers did not require modification of the categories), and the definitions of each was unambiguous enough so that the coders agreed on the coding entirely. Once we achieved saturation, we coded any unique answers as "other." We gave each survey an index number, and once we had finalized the categories, one coder coded the odd index numbers of the entire sample, and another coder coded the even index numbers surveys. Once we completed the coding, we compared the frequencies of the two categories, and found no statistically significant differences between coders, indicating that inter-rater reliability was high.

Coding Procedure

Coding categories for the environmental problems, locations, causes, and solutions

We coded the environmental problem according to type. At the beginning we had around 30 categories. Later we reduced this to 12 categories, based on criteria of similarity and frequency of occurrence (lumping rare categories into conceptually adjacent ones). For example, at the beginning we had different types of open spaces problems: natural (for example: *"lack of plants"*), agricultural (e.g., "*cutting orchards*"), and municipal (*e.g., "building on open spaces"*), which we combined into a single general "open spaces" problem type. Similarly, various water pollution categories, such as pollution of fresh water and pollution of the sea, we merged into a general "water pollution" problem. At the beginning we had three air pollution problems: stationary, mobile, and smoking. Then we combined stationary and mobile sources into a general "air pollution" problem, not including smoking. Some students specified smoking as an air pollution problem, others as a smell pollution problem. We created a "smoking" category, but found that it was rarely given as an answer, so we excluded it and marked smoking as "other" (a possible reason for the rarity of this answer is that we asked about a local problem). Further categories which rarely appeared we also coded as "other.". This process resulted in twelve **problem categories**, as follows:

1. Air pollution: from mobile or stationary resources (not including smoking, which is marked as "other")
2. Water pollution: pollution of fresh and sea water, by industrial and domestic waste
3. Sewage: deficiency in sewage and drainage infrastructure
4. Solid Waste: an aesthetic or ecological hazard, waste bins and waste collection
5. Noise: regarding volume, location or time
6. Smell: every disturbing smell (not including smoking)

7. Open spaces: reduction or neglect of nonbuilt spaces
8. Cellular radiation: from antennas and phones
9. Animals: street animals, pests, pets waste, invasive species, and species extinction
10. Water shortage: shortage of fresh water
11. Infrastructure: absent or faulty infrastructure
12. Other (specified, but not one of the categories)

In a similar process, we coded the cause of the problem according to type and according to its appropriateness. This process results in six **cause categories**, as follows:

1. Society: people (the general public or individuals)
2. Institutional: a certain body or agency
3. Development: a disruptive process of growth or change
4. Industry: a certain sector of production or company (including agriculture)
5. Other
6. Not specified

This process also resulted in four categories of the appropriateness of the cause:

1. Not appropriate: clearly not connected to the problem and/or its cause
2. Very general: a restatement of the problem, or a category that is formally correct but so broad that it is useless
3. Appropriate: a reasonable cause
4. Exact: some elaboration (of agent, time, location or mechanism) of a reasonable cause

We coded the location of the problem according to two indicators, matching it to the students' hometown, which we obtained in the first part of the survey. The two indicators were (1) relevancy to the place of residence (coded "yes" if relevant); and (2) specific place: defined more accurately than the town's name (coded "yes" if specific).

We coded the solution according to type, resulting in eleven **solution categories**:

1. Legislation and enforcement: a law, method of enforcement or penalty
2. Planning: control of the amount and location of land uses
3. Infrastructure: construction or maintenance of facilities and infrastructure
4. Simple reduction: reduction or stoppage of the source of the problem, with no alternative
5. Education: actions to raise awareness and knowledge
6. Voluntary change: request the problem source to reduce it, with no obligation
7. Activism: civilian action (individual or through NGOs)
8. No solution: The students thinks there is no solution to the problem
9. Replacement technology: less environmentally harmful technologies, procedures or products
10. Not specified
11. Other

We further coded the suitability of the solution, coded "yes" if it reduces or stops the problem or its source. The solution question yielded some exceptionally sophisticated answers, and therefore we coded also sophistication: "yes" for accurate, detailed or original solutions which expressed knowledge.

Finally, we coded each question in an overall evaluation. This was the hardest section on which to achieve compatibility between the two coders, because it was subjective. We finally achieved compatibility by designing the following four categories, which were detailed enough to eliminate subjectivity. We marked students who did not answer this question at all by "0-empty."

1. Deficient: some element clearly not satisfactory or very general
2. Satisfactory minus: reasonable (but not excellent), in all respects, except the solution which is "no solution," "simplistic reduction," or "not specified"
3. Satisfactory: reasonable (but not excellent), with a reasonable solution ("legislation and enforcement," "planning," "infrastructure," "education," "voluntary change," "activism," or "substitution")
4. Excellent: displays some exceptional knowledge, imagination, flair, insight, or a very high level of accuracy

RESULTS

Distribution of Environmental Problems, Causes, and Solutions

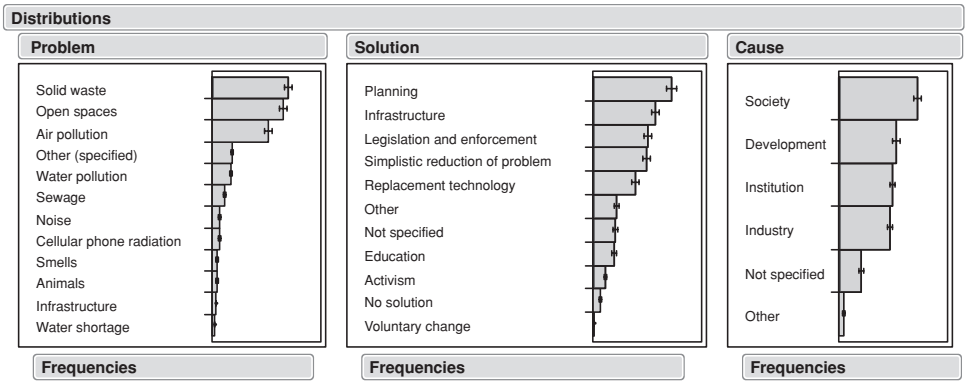
Figure 1 shows the distribution to categories of the problem, cause, and solution. The three most frequent environmental problems are solid waste (26%), open spaces (25%), and air pollution (20%). Then there is a clear cut, and the next three problems are sewage, air pollution, and other specified problems at 5% to 7% each. All the other problems were mentioned only by 3% of the students or less.

The most popular solutions are planning (21%), infrastructure (16%), legislation and enforcement (14%), and simplistic reduction of the problem (11%). The most popular causes for the problems are society (30%), development (21%), institution (20%), and industry (19%). See the sections below for examples, translated from the Hebrew and Arabic, *italicized*.

Environmental Problem by Solution

Figure 2 shows the environmental problems specified, and the solutions chosen to each problem. The most popular problem is "solid waste" (for example, the answers: "*dirty streets,*" "*dirty beaches,*" "*polluting forests and natural places,*" "*throwing waste"*), and the most frequently chosen solution to this problem is "infrastructure" (33%) (for example, "*situate more garbage bins in the streets*" and "*improve garbage collection*"). Other popular solutions to the "solid waste" problem included "education" (18%) (for example, "*a school cleaning day of the streets*") and "legislation and enforcement" (17%) (for example, "*financial penalty,*" "*enforcement by the municipality,*" "*designate an inspector*").

Figure 2 further shows that the chosen solution to the "open spaces" problem is overwhelmingly "planning" (for example, "*plan in advance where to have green spaces and where to build*," "*prohibit building in the valley area*" and "*build tall buildings*"). The solution to the "air pollution" problem is typically "replacement technology" (for example, "*alternative energy*" and "*put filters on power plants' chimneys*"). While the solutions to the "water pollution" problem are diverse and include mainly "infrastructure" ("*improve the sewage system*") and "legislation



Frequencies

Level	Count	Prob
Total	935	1.00
Solid waste	246	0.26
Open spaces	230	0.25
Air pollution	182	0.20
Other (specified)	67	0.07
Water pollution	60	0.06
Sewage	43	0.05
Noise	25	0.03
Cellular phone radiation	24	0.03
Smells	18	0.02
Animals	18	0.02
Infrastructure	13	0.01
Water shortage	10	0.01

Frequencies

Level	Count	Prob
Total	884	1.00
Planning	182	0.21
Infrastructure	143	0.16
Legislation and enforcement	128	0.14
Simplistic reduction of problem	122	0.14
Replacement technology	98	0.11
Other	55	0.06
Not specified	53	0.06
Education	49	0.05
Activism	30	0.03
No solution	19	0.02
Voluntary change	5	0.01

Frequencies

Level	Count	Prob
Total	868	1.00
Society	256	0.30
Development	184	0.21
Institution	173	0.20
Industry	164	0.19
Not specified	73	0.08
Other	17	0.02

FIGURE 1 Distribution of types of environmental problems, solutions, and causes.

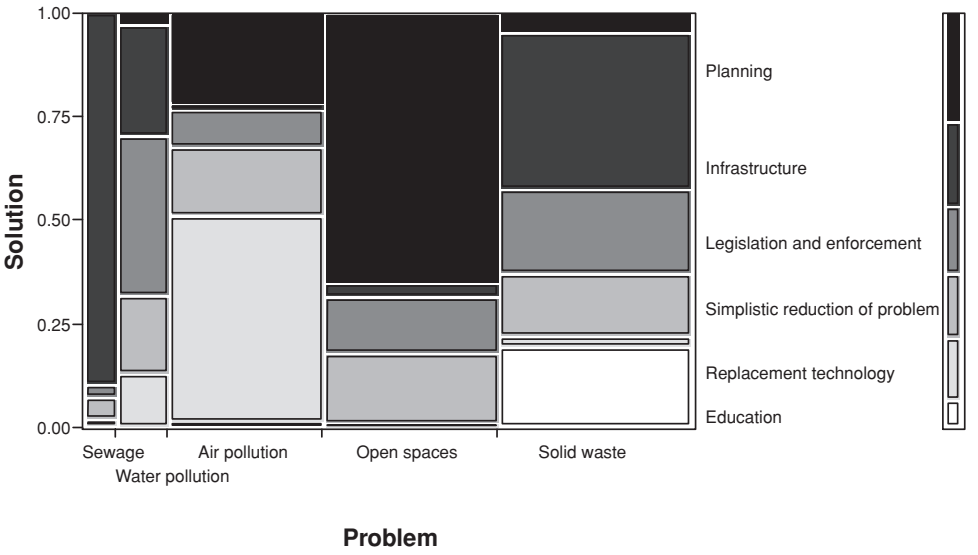


FIGURE 2 Environmental problem by solution (showing problems and solutions that at least 5% of the students chose).

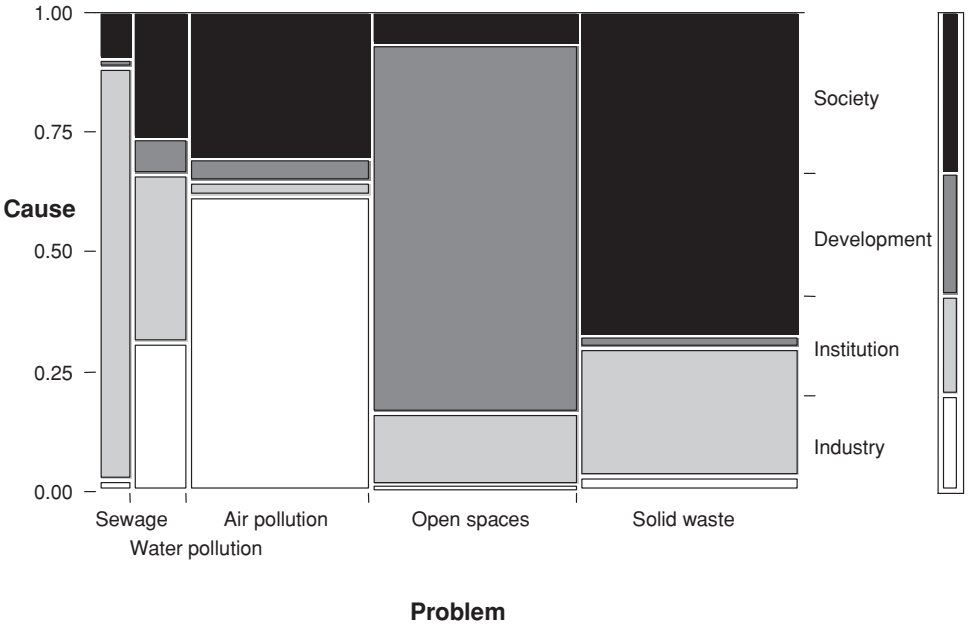


FIGURE 3 Environmental problem by cause (showing problems and causes which at least 5% of the students chose).

and enforcement" ("*stronger punishment on polluting factories*"), the solution to the "sewage" problem is overwhelmingly "infrastructure" ("*make a more efficient sewage system*").

Environmental Problem by Cause

Figure 3 shows the environmental problems specified, and the causes chosen for each problem. In most cases, there is a clear-cut dominant cause associated with each problem. According to 60% of the students, "society" is the cause behind the "solid waste" problem (for example, "*people litter*" and "*people don't care about their environment*"). According to 67%, "development" is the cause for the "open spaces" problem, with answers such as "*building houses and roads.*" Most students (62%) who specified "air pollution" (for example, "*air pollution,*" "*polluted air*") claimed that the cause of this problem is "industry" ("*the factories at the bay,*" "*factories, industries,*" "*poison gases emissions from the factories' chimneys*"), and almost all the students who specified "sewage" (64%) claimed the cause was "institutional" ("*neglect of infrastructures,*" "*faulty planning of the sewage system*").

Environmental Cause by Solution

Figure 4 shows the relation between the cause of the problem chosen, and the solution specified for this problem. When "development" (for example, "*building houses*") is the cause, most students (58%) thought that "planning" is the solution ("*tall buildings,*" "*high density*" or "*banning on building in open spaces*"). When the cause of the problem is "institutional" ("*no recycling bins*"),

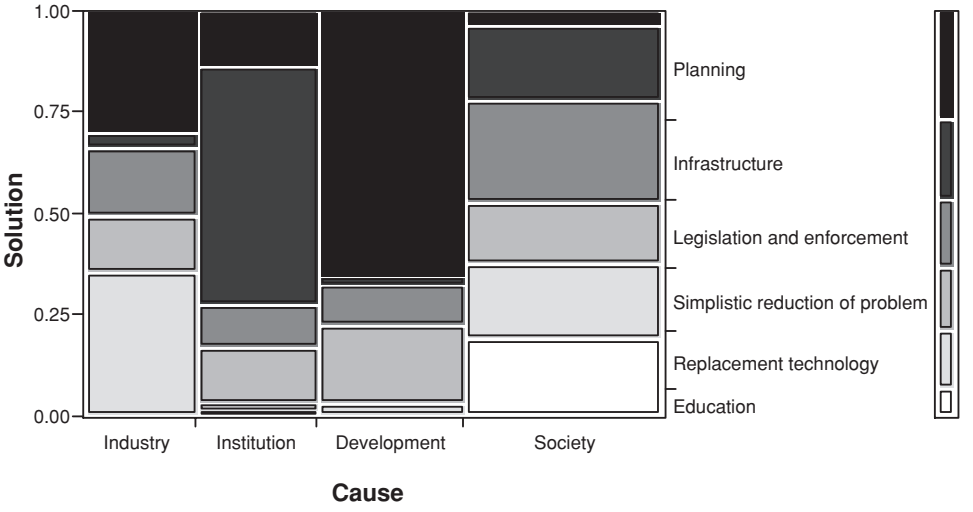


FIGURE 4 Relation between the cause of the problem chosen, and the solution specified for this problem.

most students (45%) thought that the solution lies in "infrastructure" ("*place recycling bins in the streets*"). When the cause of the problem is "industry" (for example, "*a power plant*"), the most commonly chosen solutions are "replacement technology" (29%) ("*alternative energy sources,*" "*solar energy*") and "planning" (23%) ("*locate factories far away from towns*").

The Relation between the Quality of Answer and General Environmental Literacy

We evaluated the quality of the identification and analysis of the environmental problem, by two measurements: an overall grade, and the sophistication of the solution. The overall grade ranged from 1–4. After elimination of the students who did not answer the question at all (whom we graded "0-empty"), the percentage is as follows: 18% of the students "1-deficient," 14% of the students "2-satisfactory minus," 63.5% of the students "3-satisfactory," and 5% of the students "4-excellent." We further tagged as "sophisticated" exceptionally accurate, detailed, or original solutions that expressed knowledge; 2.5% of the students gave a "sophisticated" answer. Table 2 illustrates the kind of answers receiving each of these valuation grades.

We analyzed these answers to understand their relation to the overall environmental literacy (the knowledge, attitudes, and behavior evaluated in close-questions in the same survey). The analysis shows that doing exceptionally well in one of these two measures (a score of "4-excellent" and/or tagged as sophisticated) is a very good predictor of having a significantly higher score on all of the environmental literacy components. In other words, if individuals do exceptionally well in defining a local problem, they are likely to be high scorers in all of the literacy domains. This result is striking given that the literacy domains are not well correlated with one another in other ways (Negev et al., 2008). Scoring exceptionally low on the overall score predicts lower knowledge scores, but is not substantially related to lower attitude and behavior scores.

TABLE 2
Examples by Quality of Answer

	Problem	*Location*	*Cause*	*Solution*
1-Deficient	Air pollution	The Center*	Factories	No solution
	Noise	Rishon Le'Zion	The construction in front of my house	none
	Garbage and trash that people throw in the streets	Jerusalem	People don't care about dirtiness	(empty)
2-Satisfactory	Salination of underground water	The Center-Coastal Plain	Overpumping of ground water	Not to pump so much
	Dirty environment	Gush Dan	People throw garbage on the floor	Increase the number of garbage bins and fine the people who cause dirtiness
	Absorbing radiation of cellular antennas	Yizrael Valley, Ramat Yishai	The antenna is placed next to residence	Place the antenna away from residence
3-Excellent	Pollution of underground water	The Coastal Plain	Excessive fertilizing with chemical fertilizers	Reduce the chemical fertilizing and switch to organic fertilizers
	A lot of construction and destruction of natural areas	Be'er Sheva	The development of the city Be'er Sheva	Decrease the building of private houses and build higher buildings
	A lot of air pollution	Pardes Hana	Rabin Power Plant in Hadera	Use natural gas instead of coal, and improved filtration of the matter that is emitted from the chimneys.

*In Israel, "The Center" refers to the central, most populated part of the country.

DISCUSSION

Types of Problems, Solutions, and Causes

Israel is a small and highly condensed country, with numerous environmental problems (Tal, 2002). However, 71% of the participants in the survey indicated one of three environmental problems: solid waste, open spaces, and air pollution.

The three most popular solutions were planning, infrastructure, and legislation (composing in total 51% of the answers). According to the classification of Jacobi et al. (1998), these solutions are direct action at the governmental level. Education, an indirect governmental action, was chosen by 5% of the participants, whereas community and individual solutions were rare (for example, 3% chose activism).

Although the solutions to local environmental problems are mainly governmental, according to the participants this is not the case regarding the causes of the problems. Thirty percent of the participants claimed that "society" (the general public or individuals) was the cause of the problems they stated. This finding is similar to that of Mogensen and Nielsen (2001). They found that in Denmark 30% of ninth and twelfth grade students thought that the cause of environmental problems was "lack of awareness or inappropriate behavior" (p. 34). The participants in our

survey rated institution, development, and industry as the other main causes (each chosen by approximately 20%). While institution is strictly governmental, development and industry are influenced by governmental decisions, but often driven by the private sector.

Relations between Environmental Problems, Solutions, and Causes

Regarding certain environmental problems, most participants agreed on the preferred solution. For example, the solution for the sewage problem is overwhelmingly infrastructure (81%), and the solution for the open spaces problem is planning (54%). Other problems such as water pollution and solid waste were not given one overwhelming solution. Solid waste was the only problem which a significant percentage of students (18%) thought should be solved via education.

Regarding the relation between the problems and the causes, there was one, unique, popular cause for almost every problem: solid waste is caused by society, open spaces are harmed by development, air pollution is the result of industry, and sewage problems are caused by faulty infrastructure.

Finally, the relation between the cause and the solution is mixed. It is very clear that participants, who specified the cause as development thought that planning is the solution. Similarly, those who specified the cause as institution recommended an infrastructure solution. However, when the cause to the problem is industry or society, the solutions are diverse. Especially with society, the participants were divided almost equally between five different solutions.

The Relation to General Environmental Literacy

The participants who gave exceptional or sophisticated answers have good environmental knowledge, attitudes, and behavior. This finding is in line with Bloom's (1956) hierarchy of cognitive skills, according to which knowledge skills are the basis for higher order cognitive skills. Participants with exceptional high-order skills (such as the ability to identify, describe, and solve a problem) had good low-order cognitive skills as well.

Comparison to International Research on Environmental Problems

A comparison of the five most acute environmental problems in urban households in the third world (McGranahan, 1991), and the five most chosen environmental problems by Israeli twelfth grade students in this survey, shows that the students complain about three of the five environmental problems typical to the third world: water and sanitation (in our survey, 6% chose water pollution and 5% sewage), air pollution (20%), and solid waste disposal (26%). In a future article, we conduct sociodemographic analysis in order to identify whether these problems are articulated equally in all sectors of society. Israeli students did not complain about the two other main third world problems: food contamination and pests and pesticides. Rather, 25% of the Israeli students complained about problems relating to a lack and neglect of open spaces.

Our results cannot be directly compared to the Sao Paulo (Jacobi et al., 1998) survey, as the demographics and methods of the research differ. However, it is possible to make a general comparison in regard to the type of solution for each problem. In Sao Paulo, the majority of the survey participants thought that it was the government's responsibility to solve air pollution, water, sewage, waste, and air pollution problems (89%, 88%, 87%, and 71%, respectively). Similarly, in

our survey, the majority of the students thought that it was the responsibility of the government to solve these problems. The government is in charge of the varied solutions chosen by the students: planning, infrastructure, legislation and enforcement, replacement technology, and education. In Sao Paulo, the two other solution types—community and individual—were much less chosen (composing together 11%, 12%, 13%, and 29% of the answers, respectively). In our survey, the percentage of the students choosing solutions other than governmental (voluntary change or activism) are negligible, and in all cases are less than 5%.

In the Danish study (Mogensen & Nielsen, 2001), 17% of the participants identified pollution as a problem. In our study we had more specific categories for pollution, air pollution alone chosen by 20% of the students, and water pollution by 6%. Moreover, both the Danish participants and the Israeli participants thought 30% of the causes to the environmental problems they chose were societal, with a lack of awareness or inappropriate behavior being named specifically.

The Contribution of Qualitative Research

Our incorporation of open questions into a major national survey comprised primarily of closed questions was demanding, but rewarding. It allowed us to map the landscape of problems, solutions, and assessments of origins of environmental problems as they are perceived by the respondents themselves, rather than on the basis of categories and questions we had set in advance. By getting open-ended answers and thematizing these into categories that emerged from the answers themselves, in a grounded approach, we have far greater confidence that we have captured the perceptions of our population. One might have done this iteratively, with a pilot study that established main categories and then closed questions regarding these. However, for a national survey of a heterogeneous population, a large enough pilot survey would approach the size of the our survey. Our study provides the key categories and dimensions of concern and solution that can be drawn on for future work, including for specific subpopulations. In fact, a recently completed analysis (which we plan to discuss in a future article) shows the extent to which these categories and, more probingly, the relation between them vary in different ethnic and other subgroups. This confirms the importance of a broad initial mapping based on emergent categories.

Based on our experience, we encourage other research to attempt this hybrid methodology, in which some open questions are coupled to a larger statistically representative survey, so as to gain the best of both worlds: getting some of the depth and openness of qualitative methods, while still being able to say something about the distributions of responses in a larger and in our case nationally representative population. These questions are likely to have a somewhat higher nonresponse rate especially among the students who are less motivated, as we have shown. And the iterative thematic coding does take time. However, it yields a richer set of categories and a degree of confidence in them that is not otherwise possible.

Moreover, we suggest that future surveys include further open questions regarding the participants' role in solving the issue, the likelihood of doing so, and the locus of control. The richness and flexibility of the data yielded by even our brief open questions suggests the further potential of other qualitative methods, such as observations and interviews. Our research thus supports the evolving claim in the literature that qualitative research is fundamental to the practice of EE (for example, Hart & Nolan, 1999; Smith-Sebasto, 2000; Smith-Sebasto & Walker, 2005, Volk & Cheak, 2003). Artful combinations of time-consuming qualitative studies (including those on smaller subpopulations) with broader more conventional surveys would seem to provide an

optimal balance of depth of understanding with inferential power. Particularly in pilot programs and in diverse populations, qualitative research enables fine tuning that cannot be achieved solely by closed questions. Also, the open-endedness and depth of qualitative research can contribute to the design, implementation, and evaluation of programs by helping focus these on the environmental issues that occupy the program participants.

CONCLUSION

This study offers a snapshot of the local environmental problems that twelfth grade students in Israel choose to report in an open question. It further describes the varied causes and solutions that the students relate to these problems. The grounded theory enabled for a categorization, which emerged from the data, resulting in 12 problem categories, 6 cause categories, and 11 solution categories. The picture that emerges is that solid waste, open spaces, and air pollution problems were foremost in the students' perceptions. A clear relationship emerges between problems and their causes and solutions. Some of the findings are similar to those obtained in related surveys in Brazil and Denmark. The fact that only 60% of the students who participated in the survey answered the open question raises doubts concerning the knowledge of the remaining 40% of the students regarding environmental problems in their locality. This stresses the importance of including local environmental issues in the curriculum in the Israeli education system.

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APPENDIX: Survey Question

Write an environmental problem that exists in your local area, and specify the location, cause, and possible solution of the problem.

Problem: _____

Location: _____

Cause: _____

Solution: _____