

Evaluating the Environmental Literacy of Israeli Elementary and High School Students

Maya Negev, Gonen Sagy, Yaakov Garb, Alan Salzberg, and Alon Tal

ABSTRACT: The authors conducted a national survey of 6th- and 12th-grade students in Israel to evaluate their environmental literacy, including the dimensions of environmental knowledge, attitudes, and behavior. In this article, the authors present the results of the survey, the correlations between these different dimensions, and their associations with demographic and experiential data. The authors did not find a significant correlation between knowledge and behavior. Ethnic and socioeconomic characteristics were moderately associated with environmental literacy, whereas the presence of an adult who mediated children's relation to nature was strongly related to environmental attitudes and behavior and weakly related to knowledge. The results suggest that the intended objectives of environmental education in Israel have not been achieved. The authors call for additional research to identify ways to improve environmental education in the Israeli public schools.

KEYWORDS: environmental attitudes, environmental behavior, environmental knowledge, environmental literacy, Israeli national survey

Over the past 20 years, researchers have explored the status, delivery, and effects of environmental education (EE) using various types of national surveys. These surveys have primarily related to curriculum needs in K–12 programs in public schools. In several national surveys, researchers have assessed the level of environmental knowledge or attitudes of children in primary and secondary schools (e.g., Barraza & Walford, 2002; Makki, Abd-El-Khalick, & Boujaoude, 2003; Tuncer, Ertepinar, Tekkaya, & Sungur, 2005). Reviewers of research and evaluation studies have pointed out the limitations of surveys that narrowly focus on environmental knowledge or

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specific dimensions of environmental affect (e.g., Hines, Hungerford, & Tomera, 1987; Hungerford & Volk, 1998). In response, researchers have developed broader models of environmental literacy (Marcinkowski & Rehrig, 1995; Simmons, 1995). Relatively few efforts thus far have been made to assess students over this wider range of environmental literacy components (e.g., Chu et al., 2007; Kuhlemeier, van den Bergh, & Lagerweij, 1999). With the present research, we join several ongoing efforts to conduct national-scale comprehensive surveys of environmental literacy¹ with the common objective of identifying strengths and weaknesses in ongoing EE programs.

The environment in Israel is under remarkable pressure and is the subject of increasing public knowledge and concern. The country is located at the meeting point between three continents and contains both desert and populated regions. It is a tiny country² characterized by diverse habitats, including arid, semiarid, temperate, Mediterranean, and subtropical climatic conditions. During the last 60 years, Israel's population has grown dramatically, from 1 million to 7 million residents, mostly through immigration. Furthermore, while the standard of living has reached European levels of prosperity (Orenstein, 2004), the population growth has resulted in a broad range of environmental hazards, notably urban air pollution, massive contamination of ground and surface water, and loss of open spaces to urban development (Tal, 2006). Furthermore, the immigrant adult population of Israelis is likely to have a lower level of familiarity with the local environment and, more broadly, a lower level of environmental literacy.

In response to the growing environmental crisis, the government declared 1994 the national Year of the Environment, during which leaders in Israeli education made a formal commitment to expanding EE in public schools (Israel Ministry of Education, 1999). Following the 2002 World Summit for Sustainable Development in Johannesburg, South Africa, this commitment was renewed as part of a cabinet decision to have all its ministries integrate sustainability into their operational activities (Israel Ministry of Education, 2004b).

In Israel, compulsory education begins in kindergarten and continues through Grade 12, with elementary school ending after Grade 6. Israeli children attend schools within a system that is largely divided into four fairly autonomous tracks: (a) Jewish secular schools, (b) Jewish "national religious" schools, (c) Jewish ultra-Orthodox schools, and (d) non-Jewish schools (Muslim, Christian, and Druze).

Regardless of educational track, the Israel Ministry of Education recommends that elementary school teachers conduct 6 hr of study in the area of science and technology each week, which includes the topic of the environment. This curriculum includes such diverse topics as basic chemistry, earth sciences, biology, and physics (Israel Ministry of Education, 1999, 2004a). Reports from the 2005–2006 school year indicate that, in practice, only 2% of schools meet this standard, with the majority reporting 1.5–3.5 hr of weekly classroom time devoted to sciences. Additionally, although social aspects of environmental issues are officially part of the primary school educational program, the emphasis appears to be heavily on the scientific aspects of environmental issues.

The Israeli high school curriculum is driven by intensive matriculation exams administered at the end of all 3 academic years, with students generally selecting a major in which to focus their studies. The exam results constitute a key criterion for university acceptance. Environmental matters appear peripherally in majors such as biology, but on the whole the ecological emphasis in the curriculum is minimal. At the same time, some Israeli high schools have an environmental sciences major. Students majoring in environmental sciences receive 5 hr of classroom teaching in each week and are expected to participate in an environmental project, which often involves a cleanup activity. Students can choose a more demanding track in which they conduct a field study for which they characterize an ecological system. Although the environmental-sciences major is not yet considered to be among the more prestigious majors for university placement, some 5% of Israel's 100,000 secondary students

select this major (Yisrael Visenshtern, Israeli Central Inspector for Environmental Sciences, personal communication, February 13, 2004).

The current EE program in Israel has been criticized by nongovernmental organizations (NGOs) for its overemphasis on augmentation of knowledge at the expense of teaching environmental ethics and behavior. NGOs and the Israel Ministry of Environmental Protection have recently introduced, on a pilot basis, supplementary enrichment programs that include outdoor educational components and other projects that aim to promote environmental ethics and encourage environmentally friendly behavior. However, although societal interest and investment in EE is substantial and likely to increase, no researchers have comprehensively assessed environmental literacy in Israeli public schools.

Several researchers have attempted to assess aspects of Israeli school students' environmental literacy. Blum (1985) conducted the first survey of environmental knowledge and attitudes among school students in Israel in the early 1980s. He studied 9th graders by using a model based on the British National Survey of Environmental Knowledge and Attitudes of Fifth Year Pupils in England. About 15 years later, Ben-Hur and Bar (1996) assessed the influence of the Israeli government's 1994 Year of the Environment program on the environmental understanding of schoolchildren in a national sample. More recently, Goldman, Yavetz, and Pe'er (2006) considered environmental literacy among students training to become teachers in three Israeli teachers' colleges.

Environmental literacy is considered the paramount objective of EE programs (Disinger & Roth, 1992; Hungerford, Peyton, & Wilke, 1980; Iozzi, Laveault, & Marcinkowski, 1990). Although no formal universal definition exists for *environmental literacy*, Marcinkowski and Rehrig (1995) and Simmons (1995, 1998) have identified general principles common to most environmental literacy definitions. These include environmental and ecological knowledge, clear positions on environmental issues, cognitive skills to analyze environmental problems, and behavior patterns that are designed to limit individual environmental impact or contribute to broader societal efforts to protect the environment. Hungerford and Volk (1998) argued that EE is fundamentally different from other educational disciplines in that it aspires to influence the behavior of the pupils who study it. This is reflected in the behavioral component in most definitions of environmental literacy.

We drafted an operational definition of *environmental literacy* for this research on the basis of an integration of previous definitions (Hungerford & Volk, 1998; Marcinkowski, 1998a; Simmons, 1998). It included three primary categories: (a) *knowledge*, (b) *attitudes*, and (c) *behavior*. Table 1 outlines the components of each category reflected in our survey questions.

We based our research survey on the aforementioned functional definition. Marcinkowski and Rehrig (1995) and Simmons (1995) have suggested alternative approaches to characterizing

TABLE 1. Components of Environmental Literacy Categories in the Present Study

Knowledge	Attitudes	Behavior
Global issues	Awareness	Consumption patterns
National (i.e., Israeli) issues	Willingness to act	Individual conservation
General ecological principles	Sensitivity to environmental issues and affection for nature	Environmental activism
	Sense of responsibility	Leisure involving nature

environmental literacy that include *environmental sensitivity* as a fourth category, one that contains both a behavioral component and a subjective component. In the present study, we largely integrated these elements into the categories of attitudes and, to a lesser extent, behavior. In addition, we characterized experiential aspects of students' environmental encounters. For example, in the survey instrument, we included questions about the mediating role of adults in environmental activities, the extent and type of students' nature outings, and students' ability to show higher level cognitive skills in analyzing environmental problems. In our survey, a subset of shared questions, asked of both 6th and 12th graders, allowed us to directly compare the students in the two different grades.

Method

Participants

In spring 2006, 1,591 6th-grade students in 39 schools and 1,530 12th-grade students in 38 schools completed grade-specific surveys. Participants composed a representative national sample of the formal education system according to demographic data about each school that we obtained from the Israel Ministry of Education. The data was stratified into four groups: (a) town size (3 levels), (b) school quality (4 levels),³ (c) socioeconomic situation (3 levels), and (d) sector (3 types). We divided the country's schools into 108 cells that reflected all the possible combinations of these four categories. We then determined cell weights by summing the number of students in each cell and dividing the result by the total number of students in the formal education system at the grade level. To determine the number of schools to sample within each cell, we multiplied each cell weight by 40 and rounded. We combined cells that received a rounded score of 0, and we summed their scores. In this way, the total sample size was 40 schools. We then randomly selected schools from each cell, with the selection probability proportional to the number of students.

Survey

We collected data by using surveys that we developed for this research. We administered separate surveys to 6th and 12th graders. Although the two surveys had similar designs and overall frameworks, some of the specific questions differed by grade. In the pilot survey, we drew heavily from the Middle School Environmental Literacy Instrument (Wilke, Hungerford, Volk, & Bluhm, 1995), the Secondary School Environmental Literacy Instrument (Nowak, Wilke, Marcinkowski, Hungerford, & Mckeown-Ice, 1995), and Goldman et. al's (2006) teachers-college-student instrument. We prepared the pilot survey in consultation with teachers, students, ecologists, and survey-research experts and modified it after review by an advisory committee comprising 20 experts from the Israel Ministries of Environment and Education, academic experts, NGO representatives, and school teachers. We then tested the pilot survey at four elementary schools and four high schools, resulting in further modifications, including the elimination of one question that contained an extensive case study because of the time constraints imposed by schools' 45-min class sessions.

The surveys contained four sections. The first three sections consisted of closed questions (i.e., Likert scale and multiple choice). The fourth section had open-ended questions designed to allow for assessment of higher level cognitive skills in evaluating environmental issues. The four sections were as follows:

1. *Environmental background information and environmental behavior.* Background questions asked about (a) the identity of an adult whose company the student enjoys when in nature or with whom the student enjoys studying about nature, (b) vegetarianism, (c) access to nature, (d) hours spent outdoors, and (e) ownership of animals. Topics associated with environmental

behavior included (a) water, (b) conserving electricity, (c) recycling, (d) activism, and (e) outdoor leisure activities.

2. *Awareness, attitudes, and willingness to act.* Questions included opinions about (a) nature and the environment, (b) development versus preservation, (c) consumption, (d) personal responsibility, and (e) other specific environmental problems.
3. *Knowledge and its sources.* Questions addressed (a) key global and local ecological and environmental topics and (b) the relative contributions of different sources of information about the environment.
4. *Open-ended questions.* Questions addressed higher order cognitive skills through identification of environmental problems, their sources, and potential solutions. The section also contained experiential questions and inquired about knowledge of local plants and their uses.

Data Collection

A field team trained for the task distributed the surveys and gave the students a standardized explanation that emphasized (a) the importance of eliciting their views to improve EE, (b) the need to take the survey seriously, (c) the anonymity of participants in the survey, and (d) the difference between questions requiring their opinions and those involving objective knowledge. The vast majority of students completed the survey before the 45-min period was over, and there were almost no disciplinary problems associated with survey administration.

Sociodemographic Variables

In addition to the student responses to the aforementioned questions, each student record contained the child's gender and school-level sociodemographic variables, which were provided by the Israel Ministry of Education. These included the (a) size of the community, (b) performance level of the school, (c) socioeconomic standing of the school, and (d) ethnic and religious identity of the school. Individual socioeconomic reporting was limited because of privacy restraints that are part of the Ministry of Education's external testing policies.

Data Analysis

We conducted statistical analysis of the data by using JMP software (version 6). We ensured data quality by examining univariate outliers caused by mistyped questions and by conducting forward and backward checks of a randomly selected subset of data between the input spreadsheet and the survey form. We calculated the statistics reported here by using the aforementioned representative national sample, with each respondent assigned a weight inversely proportional to the probability of selection. We plan to report on more elaborate multivariate and hierarchical statistical analyses in future articles, including analyses that reconfigure the multitude of questions into categories other than the standard triad of knowledge–attitude–behavior.

Reliability and Validity

We considered test–retest procedures but judged them to be inapplicable in the short term because the prior exam would influence the children if repeated shortly thereafter. However, the low variance of summative scales, both within schools and among groups of schools with similar characteristics, provides some assurance of test reliability. As detailed in the Results section, we used Cronbach's (1951) procedure to examine internal consistency of the three dimensions. We partly established construct validity for the knowledge portion of the test by establishing its high correlation with school exam achievement scores. The construct validity of other dimensions is a more complex issue, however, because the coherence and nature of these dimensions, and the relations

among them, are under debate (Courtenay-Hall & Rogers, 2002; Hungerford & Volk, 1998; Kaiser, Wolfing, & Fuhrer, 1999; Kollmuss & Agyeman, 2002; Kuhlemeier et al., 1999; Makki et al., 2003; Marcinkowski, 1998b; Olli, Grendstad, & Wollebaek, 2001; Said, Yahaya, & Ahmadun, 2007; Scott & Willits, 1994; Simmons, 1998; Ungar, 1994). In addition, the very possibility of a cross-culturally stable construct of environmental literacy is debatable (Barraza & Walford, 2002; Deng, Walker, & Swinnerton, 2006; Hershey & Hill, 1977–1978; Johnson, Bowker, & Cordell, 2004; Milfont & Gouveia, 2006; Olli et al., 2001; Van Petegem & Blicke, 2006). For these reasons, the kinds of correlation with related items or lack of correlation with demographic and other variables that would be part of the usual assurances of construct validity (convergent and discriminant) are themselves substantive issues, which we plan to address in more detail in two future articles.

Results

We present first the results of the study by the three general areas of knowledge, attitudes, and behavior. We describe the correlations between these three categories and then report on the analysis of the relations between these three categories and demographic variables along with experiential characteristics.

Knowledge

We assessed the knowledge dimension by 19 and 18 questions in the 6th- and 12th-grade surveys, respectively. Results suggested strong contrasts in the different spheres of environmental knowledge of Israeli schoolchildren. For example, whereas approximately 80% of 6th graders answered questions about bottle-deposit laws and recycling correctly, less than 25% successfully answered questions about the sources of global warming or seasonal bird migration. We conducted factor analyses separately for 6th and 12th grades. The 6th-grade analysis yielded no clearly interpretable factors. The 12th-grade analysis indicated that two distinct areas of knowledge concern recycling and pollution, but it did not clearly indicate other distinct areas.

Although we adjusted many questions to be age appropriate, the six questions shown in Figure 1 were identical in both grades, allowing a direct comparison of environmental knowledge. As expected, knowledge scores were higher in older children, with an especially dramatic difference between the groups for questions about waste management and pollution from transportation. Sixth graders scored about 25% correct in these areas versus 55% for 12th graders.

Attitudes

We assessed attitudes by using a cluster of statements (27 in the 12th grade and 18 in the 6th grade), with degree of agreement ranked by using a Likert-type scale that ranged from 1 (*not at all true*) to 6 (*very true*). A factor analysis of the results did not reveal any readily interpretable factors. As the age-appropriate wording of questions differed slightly between 6th and 12th grade for most of the questions, we did not perform a direct comparison of mean scores. Tables 2 and 3 list the items for each grade that reflected the highest and lowest mean scores or the strongest and weakest attitudes. As indicated by Table 3, 12th graders were willing to disagree more strongly with statements that they ranked as low. Overall, the environmental attitudes of students were positive.

Behavior

Figure 2 shows Likert-scale responses, ranging from 1 (*never*) to 5 (*always*), to the question “How often do you do the following activities?” for the 10 behavior items in common between the 6th and 12th grades. Scores of 6th graders were consistently higher than those of 12th graders, except for the question about saving electricity.

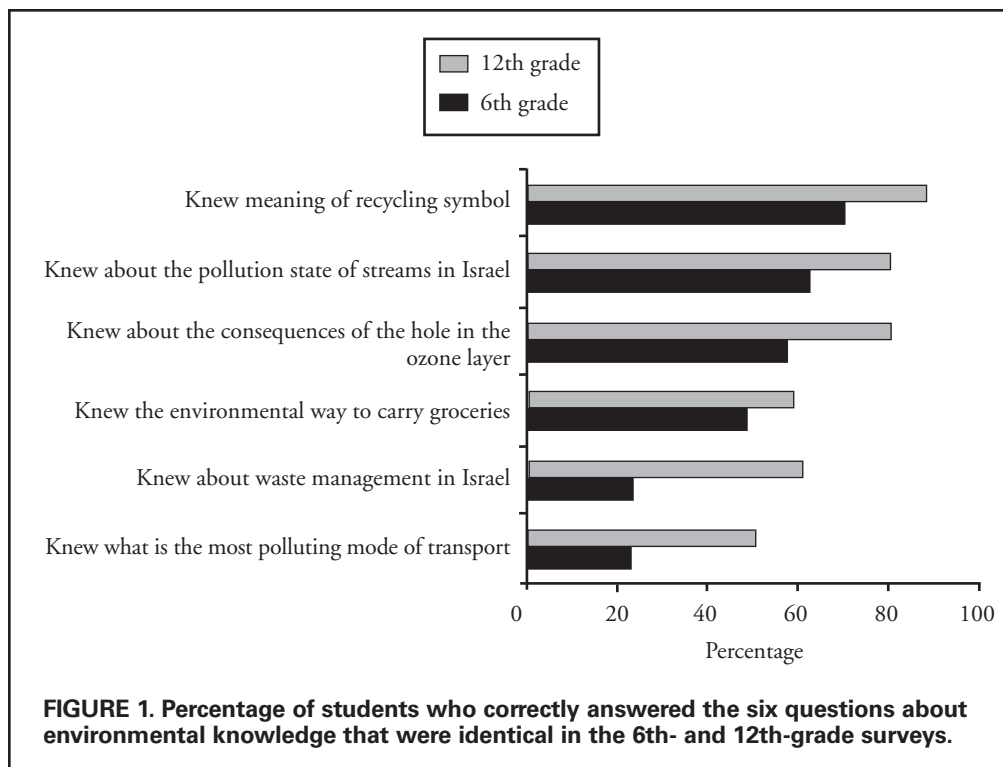


TABLE 2. Items With Which Participants Agreed Most

6th grade			12th grade		
Item	<i>M</i>	<i>SD</i>	Item	<i>M</i>	<i>SD</i>
Everyone can influence environmental quality.	5.10	1.34	I enjoy being in nature.	5.02	1.22
It is important to have gardens in the cities.	5.09	1.31	Factories should be fined for harming the environment.	5.04	1.22
I love animals.	5.14	1.31	It is important that the environment is clean.	5.28	0.96

Note. Students rated each item on a 6-point scale ranging from 1 (*not at all true*) to 6 (*very true*).

The 12th-grade survey contained two additional questions, allowing for a richer factor analysis of the behaviors. This factor analysis⁴ showed a clear-cut pattern of loading on each of the first three factors, which together accounted for just over half of the variance of survey responses. The questions associated with these three factors were related to advocacy (e.g., writing a letter, signing a petition, checking if a product is environmentally friendly), consumption (e.g., saving water, saving electricity, recycling), and outdoor engagement (e.g., hunting, agriculture, spending time in nature),

TABLE 3. Items With Which Participants Agreed Least

6th grade			12th grade		
Item	<i>M</i>	<i>SD</i>	Item	<i>M</i>	<i>SD</i>
There is a need to reduce fuel use in Israel.	3.77	1.66	I prefer public transport because of air pollution.	2.43	1.27
It is important to take care of animals and vegetation, even if they are not useful for human.	3.83	1.94	I am personally responsible for the environment in my community.	2.97	1.52
I want to know more about plants in Israel.	3.74	1.63	The environment should be high on the agenda.	3.00	1.37

Note. Students rated each item on a 6-point scale ranging from 1 (*not at all true*) to 6 (*very true*).

respectively. Although the 6th-grade surveys included a smaller set of questions, the same breakdown occurred in a factor analysis of those surveys.

Correlations Between Knowledge, Attitudes, and Behavior

We formed three summated scales for the clusters of questions about knowledge, attitudes, and behaviors, respectively.⁵ These scales were then normalized to a mean of 0 and a variance of 1. For each grade, we measured the Cronbach's alpha of the questions in each dimension. For the 6th grade, Cronbach's alphas were .63 for the knowledge scale, .78 for the attitudes scale, and .72 for the behavior scale. For 12th grade, Cronbach's alphas were .74 for the knowledge scale, .82 for the attitudes scale, and .80 for the behavioral scale.⁶ Because the 6th- and 12th-grade surveys relied on somewhat different, age-appropriate questions, we did not conduct a direct comparison between scores.

We analyzed the correlations between knowledge, attitudes, and behavior for each grade (see Tables 4 and 5). For the 12th grade, there was no significant correlation between knowledge and behavior, whereas there were moderate correlations between attitudes and knowledge and between attitudes and behavior.⁷ To determine if any particular forms of knowledge were correlated with behavior, we conducted a series of one-way analyses of each of the knowledge questions, which revealed that none had any significant relation to the overall behavior score.

For the 6th grade, correlational analyses revealed that environmental knowledge and environmental behavior were not significantly correlated. However, the correlation between attitude and knowledge among 6th-grade students was twice as high as that for 12th-grade students. Moreover, we identified a significantly lower relation between behavior and attitude. Again, a series of mean comparisons for each of the 19 knowledge questions showed no statistically significant effects on behavior score, except for a knowledge question about the impact of draining the Hula valley (a major wetland in the Galilee that was converted to agriculture in the 1950s). This result, which slightly but significantly corresponded to increased average behavior score— $R^2 = 0.004$, $F(1, 1578) = 6.32$, $p = .012$ —should be taken as suggestive but not definitive, given the screening of effects over 19 variables.

Although knowledge by itself was not significantly related to behavior, when we included both knowledge and attitudes as independent variables in a regression with behavior as a response, we found that both had a significant effect on behavior ($p < .0001$ in all cases) for

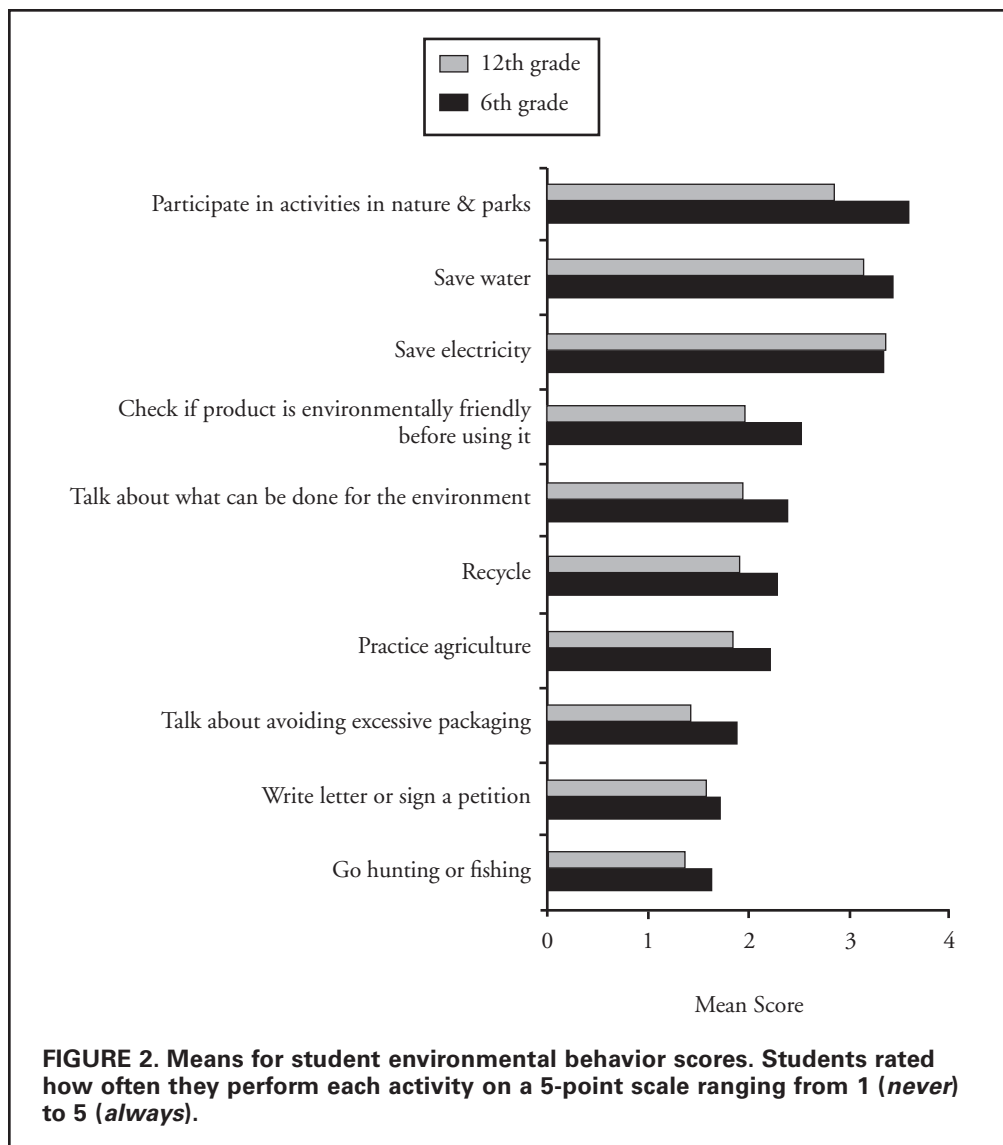


TABLE 4. Correlations Between Knowledge, Attitudes, and Behavior for 12th-Grade Students

Correlated variables	<i>r</i>	<i>n</i>	<i>p</i>
Behavior and knowledge	.04	1526	.0903
Attitudes and knowledge	.23	1526	< .0001
Attitudes and behavior	.56	1524	< .0001

TABLE 5. Correlations Between Knowledge, Attitudes, and Behavior for 6th-Grade Students

Correlated variables	<i>r</i>	<i>n</i>	<i>p</i>
Behavior and knowledge	.0412	1788	.0814
Attitude and knowledge	.4101	1788	< .0001
Behavior and attitude	.3695	1783	< .0001

both 6th and 12th grades, suggesting that there is an interaction effect between knowledge and attitudes that influences behavioral outcomes. In both cases, attitude had a strong positive relation to behavior (a parameter estimate of 0.42 for 6th-grade normalized scores and 0.55 for 12th-grade scores), and, more surprisingly, knowledge had a weak negative relation to behavior (parameter estimates of -0.13 for 6th grade and -0.08 for 12th grade). In other words, with control for attitude, environmental knowledge was correlated with somewhat decreased environmental behavior.

Correlations Between Demographic Variables and Environmental Literacy Categories

We used four demographic factors—(a) ethnic and religious sector, (b) socioeconomic level, (c) town size, and (d) school quality—to develop a representative sample, and we performed statistical analysis using these factors as independent variables. Not surprisingly, given the higher economic status of Jewish people in Israel compared with its Arab residents, students in Jewish schools, whether secular or religious, had higher environmental-knowledge scores than did students in Arab schools.⁸ Attitudes followed roughly the same pattern for the 6th graders, although behavior was similar for Arab and Jewish 6th graders. However, among 12th graders, Arab school students scored higher than did Jewish school students in both attitudes and behavior.⁹

Generally, we found knowledge was higher in wealthier communities. However, attitudes and behavior did not differ significantly by socioeconomic status.

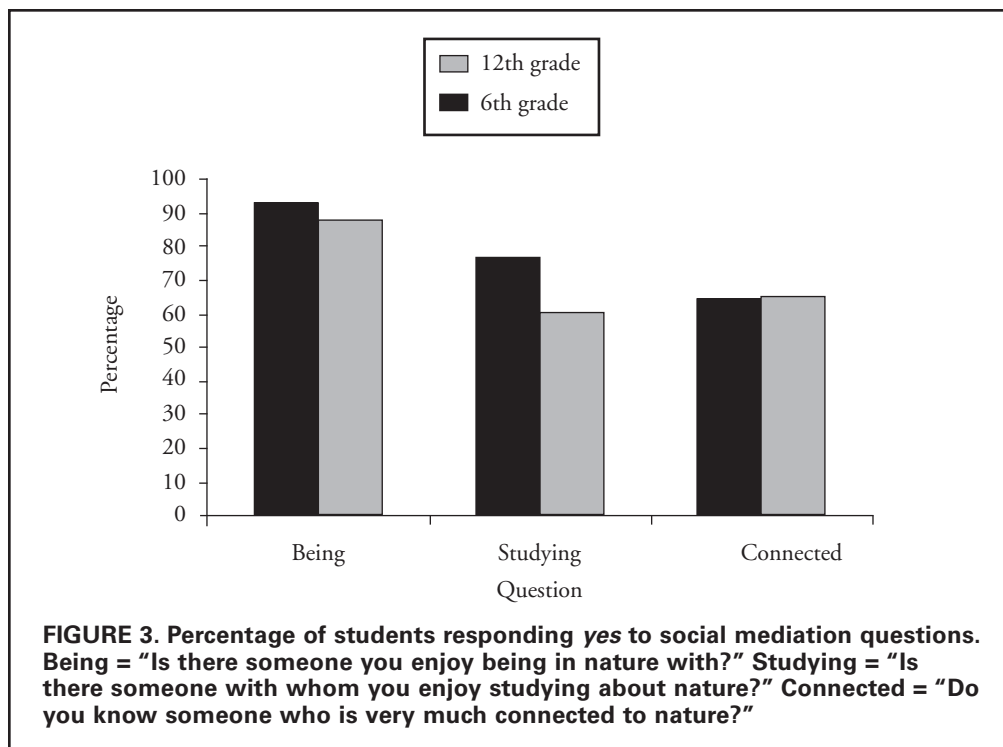
Correlations Between Experiential Characteristics and Environmental Literacy Categories

Our survey asked three questions about the involvement in nature of participants' acquaintances:

1. Is there someone with whom you enjoy being in nature?
2. Is there someone with whom you enjoy studying about nature?
3. Do you know someone who is very much connected to nature?

We followed these yes–no questions with another question identifying that person. We provided nine options, which were derived from emergent categories in an open-ended question in a pilot study. As Figure 3 shows, most students in both grades, and especially those in the 12th grade, reported having such mediation. The breakdown of identity of the mediating individual is presented in Figures 4, 5, and 6. Twelfth graders mentioned friends much more than parents or relatives, whereas 6th graders mentioned friends and parents with roughly equal frequency.

We found large and highly significant effects of the existence of a mediating figure in nature-related settings and outings on attitudes and behaviors. Tables 6 and 7 summarize these effects. From these results, we can infer that, for both 6th and 12th graders, the social component of experiences in nature has little or no effect on environmental knowledge, but these experiences do produce



meaningful impacts on attitudes and behavior. The question about enjoying studying nature with someone was a particularly strong predictor of high scores in behavior and attitudes.

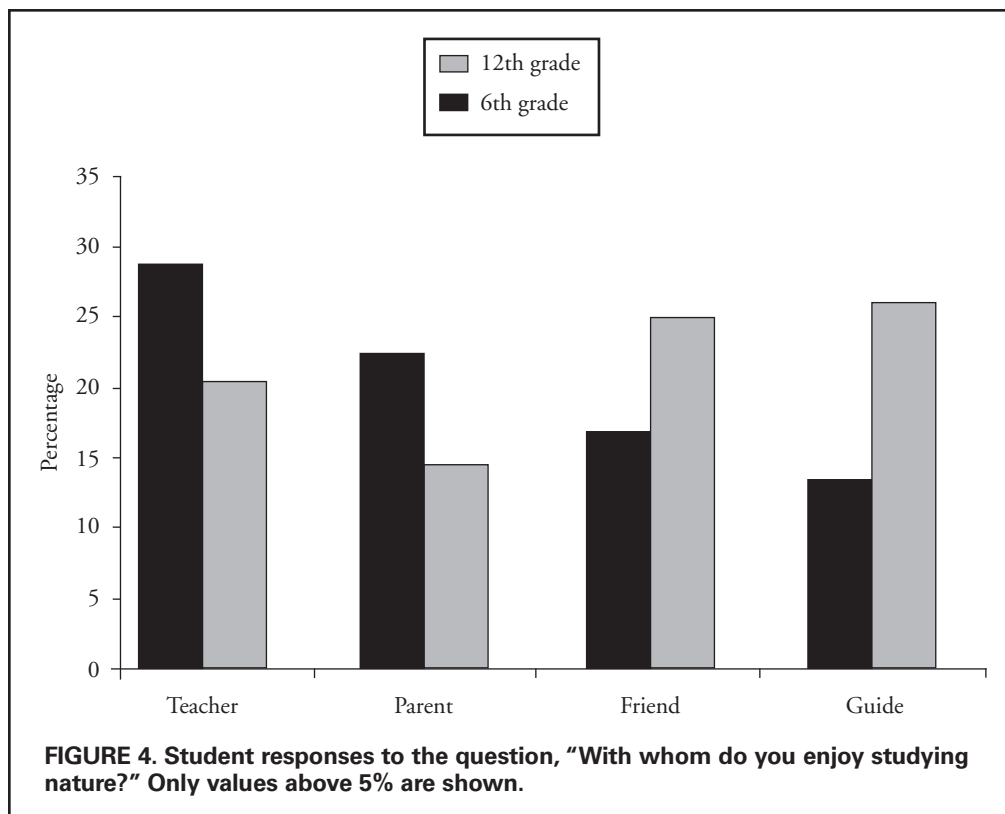
Discussion

Environmental Knowledge, Attitudes, and Behavior

Although the environmental knowledge of 12th graders in our study was higher than that of 6th graders, neither group exhibited impressive scores for that component of environmental literacy. This is striking because knowledge is the environmental-literacy category most emphasized in the Israeli curriculum. The poor results with respect to several key environmental topics may reflect the fact that the actual time spent on EE in schools is far below that recommended by the Israel Ministry of Education (1999, 2004a).

The environmental attitudes of elementary and high school students in the present study were, in general, high. This finding is consistent with research conducted among students in the Netherlands (Kuhlemeier et al., 1999) and Turkey (Tuncer et al., 2005) and is reassuring, considering that we found a positive correlation between environmental attitudes and behavior.

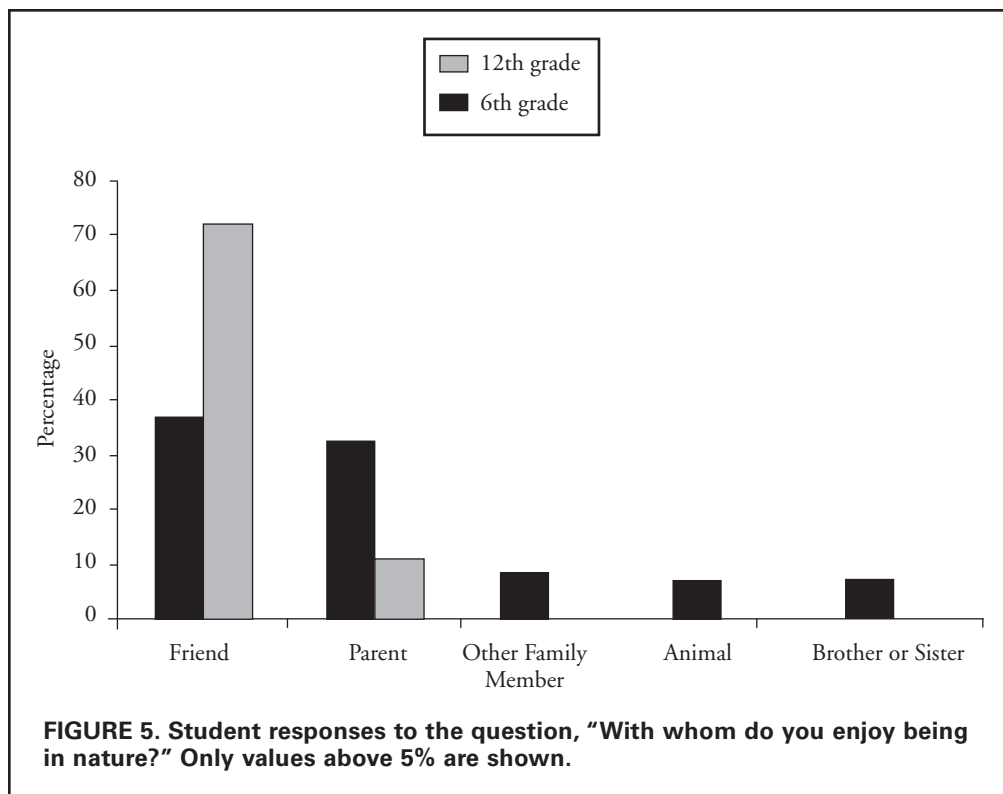
Environmental behavior is regarded as the desired end point of EE efforts (Hungerford & Volk, 1998; Sivek, 2002). In our survey, environmentally positive behavior and attitudes were significantly lower among 12th graders than among 6th graders. One could conclude, on the basis of these result, that as children grow up, they engage less in proenvironmental behavior. Alternatively, one could conclude that current 6th graders enjoy greater opportunities or a greater emphasis on such behavior than did the 12th-grade cohort 6 years ago. If the first conclusion holds, a retesting of the 6th



graders in 6 years should result in lower scores. If the second conclusion holds, the scores should rise to higher levels once the current 6th graders reach 12th grade.

An analysis of behavior showed three distinct components: (a) advocacy, (b) conscious-consumption reduction, and (c) outdoor engagement. These results are especially interesting when considered in light of a recent environmental-literacy survey among students in teacher-training colleges in Israel. Goldman et al. (2006) conducted a factor analysis of behavior items and found "6 categories that represent increasing levels of environmental commitment" (p. 3). Those researchers postulated a "lowest commitment" (i.e., easiest to accomplish; p. 17) category involving "resource-conserving actions with personal financial benefit" (p. 17), which includes conserving water and electricity, similar to our *reduced consumption* category. The financial benefit associated with these activities may explain their popularity; the relatively small effort required and the presence of long-term local media campaigns encouraging these activities (especially water saving) in Israel may also be factors. Environmental behavior measured among Israeli schoolchildren in this study reflects similar patterns, with convenience and economic benefit associated with more common behaviors.

Knowledge scores are somewhat prone to respondent interpretation problems. Moreover, attitudes and behavior questions are prone to additional kinds of bias, such as an inclination to overreport socially desirable behaviors, and problems in accurately remembering and categorizing behavior. For this reason, we plan to complement an in-depth exploration of the findings of this survey with a think-aloud protocol examination of questions and subpopulations of particular interest.



Correlations Between Environmental Knowledge, Attitudes, and Behavior

A key debate in the EE literature revolves around the relations between knowledge, attitudes, and behavior (e.g., Courtenay-Hall & Rogers, 2002; Hungerford & Volk, 1998; Kaiser et al., 1999; Kollmuss & Agyeman, 2002; Kuhlemeier et al., 1999; Makki et al., 2003; Marcinkowski, 1998b; Olli et al., 2001; Said et al., 2007; Scott & Willits, 1994; Simmons, 1998; Ungar, 1994). For both 6th and 12th grades, the overall environmental-behavior scores were unrelated to environmental-knowledge scores and, in fact, were negatively related to knowledge in a multivariate regression that included attitudes. Behavior was strongly related to attitudes in the 12th grade and moderately related to it in the 6th grade. Attitudes and knowledge were strongly related in the 6th grade and moderately related in the 12th grade. With the exception of one question in the 6th grade, we found no single knowledge question to be related to behavior scores. The lack of high correlation between knowledge and behavior has been discovered and considered in other contexts (Kuhlemeier et al.; Makki et al.; Scott & Willits). The fact that our findings are consistent with international findings should be considered by Israel Ministry of Education officials, whose curriculum continues to emphasize knowledge as the central element of environmental literacy.

Correlations Between Demographic Variables, Experiential Characteristics, and Environmental Literacy Categories

The relation of ethnic and socioeconomic factors and of mediating social interactions provides an interesting counterpoint to the findings that showed no relation between environmental knowledge and behavior. For Israeli 6th and 12th graders in the present study, behavior was slightly affected

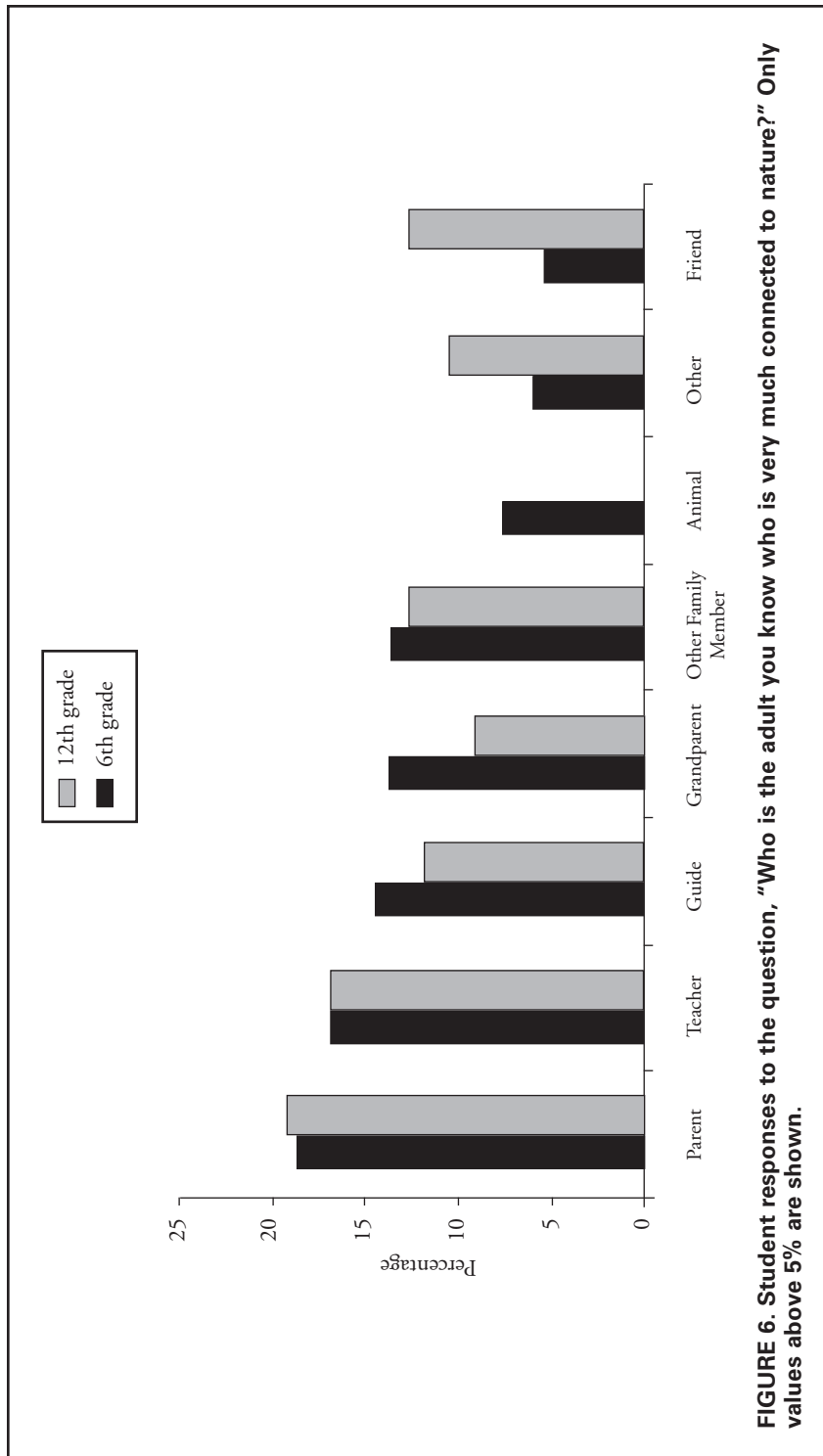


FIGURE 6. Student responses to the question, "Who is the adult you know who is very much connected to nature?" Only values above 5% are shown.

TABLE 6. Effects (Measured in Standard Deviations) of Three Types of Social Interactions on the Environmental Knowledge, Behavior, and Attitude Scores of 6th Graders

Category	Enjoy being in nature with someone		Enjoy studying nature with someone		Know an adult very connected to nature	
	Effect	<i>p</i>	Effect	<i>p</i>	Effect	<i>p</i>
Knowledge	0.22	.0275	0.03	.5996	0.06	.28
Behavior	0.62	< .0001	0.62	.0000	0.40	< .0001
Attitudes	0.86	< .0001	0.62	.0000	0.38	< .0001

TABLE 7. Effects (Measured in Standard Deviations) of Three Types of Social Interactions on the Environmental Knowledge, Behavior, and Attitude Scores of 12th Graders

Category	Enjoy being in nature with someone		Enjoy studying nature with someone		Know an adult very connected to nature	
	Effect	<i>p</i>	Effect	<i>p</i>	Effect	<i>p</i>
Knowledge	0.29	.0003	0.23	< .0001	0.07	.2486
Behavior	0.57	< .0001	0.74	< .0001	0.48	< .0001
Attitude	0.74	< .0001	0.82	< .0001	0.54	< .0001

by ethnic group and socioeconomic category. However, the relation was not always in the expected direction. This is similar to the research of Olli et al. (2001), who found insignificant or negative relationships between income and environmental behavior among adults in Norway. Arab children scored higher in environmental behavior than did Jewish children despite lower knowledge and, in some cases, less formal possibilities for exhibiting environmental behaviors. Moreover, children in the middle socioeconomic group scored higher than did children in the low or high group. As expected, knowledge was generally related to ethnic and socioeconomic affiliation. Attitudes were moderately correlated to ethnic background (inverted for 6th and 12th grades), with some mixed responses to socioeconomic affiliation.

Mediating adults, particularly family members and teachers who set an example of attention and respect for the natural world, contributed to positive attitudes or actions toward the environment. Other researchers have shown this to hold across populations and research methods (Chawla, 1998; Sivek, 2002). Our results confirm this dynamic and show the degree to which attitudes and behaviors are responsive to the presence of a mediating individual. Integration of parents into after-school EE initiatives and encouragement of experiential outings to supplement classroom discussions should be incorporated into the present curriculum.

The Need for Culturally Sensitive Research Instruments

Previous researchers have found that environmental knowledge, attitudes, and behavior vary across cultures and societies (Barraza & Walford, 2002; Deng et al., 2006; Hershey & Hill,

1977–1978; Johnson et al., 2004; Milfont & Gouveia, 2006; Olli et al., 2001; Van Petegem & Blicek, 2006) and that some attitude scales are highly affected by respondent characteristics such as gender, residence, education, income, age, and political orientation (Tarrant & Cordell, 1997). Although we attempted to formulate culturally sensitive questions, the national nature of the survey and the time constraints associated with a 45-min time frame for completion of the survey limited our ability to develop these factors. Future researchers should attempt to broaden the notion of environmental literacy, especially in a multicultural society such as Israel, to reduce cultural bias in surveys as much as possible. Although it is expected that a culturally sensitive approach will be reflected in EE programs, the refinement process should be done in light of the finding of Cheak, Volk, and Hungerford (2002) that similar EE techniques work in cross-cultural situations.

Conclusion

This study offers a snapshot of environmental literacy among Israeli students at the end of their primary and secondary school experiences. The picture that emerges a decade after the advent of a formal EE curriculum is not encouraging. Our findings reveal large gaps in environmental knowledge and a significant drop in environmental behavior among Israeli high school students. Schools appear to have only a modest effect on environmental attitudes and behavior among Israeli children, relative to other factors. Effectively addressing many of Israel's environmental challenges (e.g., litter control, mobile-source air pollution, low levels of recycling, urban sprawl) requires public involvement. Given the increasing severity of these problems and the public's role in solving them, upgrading EE programs in the country's schools should be a central part of future environmental policy efforts at both the national and local levels. This will require additional research about existing and experimental pedagogical techniques in the field and openness to new EE initiatives and curricula.

NOTES

1. Ongoing research, the findings of which have not yet been published, includes the National Environmental Literacy Assessment (NELA) in the United States, conducted by Tom Marcinkowski and colleagues, and Mehmet Erdogan's research in Turkey.

2. Its total land area is 22,000 km², similar in size to that of the state of New Jersey.

3. For the 6th-grade population, quality was determined according to the national achievement survey. For the 12th-grade population, quality was determined according to scores on matriculation exams.

4. Varimax rotation on all principal components had an eigenvalue over 1.

5. Although we included hunting and agriculture in the factor analysis of other behavior questions, we excluded them from the overall proenvironmental behavior index when we found them to correlate with one another and with questions regarding time spent outdoors. We felt that they could not be judged a priori as proenvironmental.

6. Cronbach's alpha is a measure of internal consistency in which 1 indicates that the questions are different forms of the same question (i.e., entirely consistent) and 0 indicates that the questions have no relation to each other (i.e., entirely inconsistent; see Cronbach, 1951).

7. We used a 5% level of significance, so *p* values below .05 are significant.

8. In the 6th grade, the highest scores were found in Jewish secular schools, with an average score of 0.18 standard deviation above the pooled average, followed by Jewish national religious schools, with a score of 0.11 standard deviation below the average. The Arab schools were farther (0.65 standard deviation) below the average, $R^2 = 0.14$, $F(2, 1577) = 124.30$, $p < .0001$. In the 12th grade, however, Jewish national religious schools had a slight advantage in environmental knowledge, with an average score of 0.28 standard deviation above the mean versus 0.20 above the mean for Jewish secular schools; Arab schools again scored considerably below average (0.66 standard deviation below the mean), $R^2 = 0.13$, $F(2, 1527) = 108.79$, $p < .0001$.

9. For attitudes, Arab students scored 0.20 standard deviation above the mean, whereas Jewish students in national religious schools scored 0.08 standard deviation below the mean. Jewish religious schools scored slightly, but not significantly, higher than did Jewish students in secular schools (0.15 standard deviation below the median), $R^2 = 0.02$, $F(2, 1523) = 13.01$, $p < .001$. For behavior, Arab school students scored 0.22 standard deviation above the mean, students at national religious schools scored 0.07 standard deviation below the mean, and students at secular Jewish schools scored 0.2 standard deviation below the mean, $R^2 = 0.03$, $F(2, 1523) = 21.45$, $p < .0001$.

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