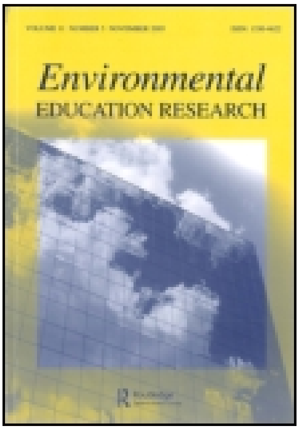

Environmental Education Research
Publication details, including instructions for authors and subscription information:
http://www.tandfonline.com/loi/ceer20

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Michael D. Kaplowitz & Ralph Levine
[a] Michigan State University, USA

Available online: 19 Jan 2007

Environmental Education Research,
Vol. 11, No. 2, April 2005, pp. 143–160

How environmental knowledge measures up at a Big Ten university

Michael D. Kaplowitz* and Ralph Levine
Michigan State University, USA

The reported research examines the level of environmental knowledge of Michigan State University students relative to the results of a biannual national study of the environmental knowledge of the general population of the United States. While the university students were found to possess higher levels of environmental knowledge than the general public, the students' overall environmental knowledge, on average, was deficient with only 66% of them receiving a passing grade. The findings suggest a positive correlation between academic level, field of study and environmental knowledge.

Introduction

Around the time of the first Earth Day, educational efforts increasingly began to be seen as means for increasing individuals' environmental knowledge and, in turn, effecting change and addressing environmental problems (Stapp, 1969; Ramsey & Rickson, 1976). The value and importance of environmental education has been endorsed both in the United States and internationally (e.g. United Nations Educational, Scientific and Cultural Organization, 1975, 1978; North American Association for Environmental Education, 1999). Despite this, 'two-thirds of adult Americans consistently fail simple tests of environmental knowledge' (National Environmental Education and Training Foundation, 2002, p. 10).

While attention has been paid to the role of environmental education in elementary and secondary school curricula, few researchers have focused on the role of universities as means for increasing people's environmental knowledge (Orr, 1995; Wilke, 1995). Currently, only 12% of four-year institutions of higher learning in the United States require environmental and ecological learning (Wolfe, 2001). There has been relatively little research on universities' role as explicit and implicit environmental educators. Much previous literature in this area tends to have focused on comparisons of knowledge levels of students with different majors (e.g. Synodinos, 1990;

* Corresponding author. Department of Resource Development, 311a Natural Resources, Michigan State University, East Lansing, MI 48824, USA. Email: kaplowit@msu.edu

ISSN 1350-4622 (print)/ISSN 1469-5871 (online)/05/020143–18

DOI: 10.1080/1350462042000338324

Shetzer *et al.*, 1991; Benton, 1994; Dunaway, 1999). For example, a recent study of university students in Finland revealed biology, forestry and history students to be among those most knowledgeable about the environment while students in health care and pre-school teacher training were among those scoring lowest (Tikka *et al.*, 2000). However, there appears to be a gap in understanding the basic relationship between university students' level of environmental knowledge and that of the general public.

This paper reports on an examination and evaluation of the levels of environmental knowledge of undergraduate, graduate and professional students at Michigan State University (MSU), a research-intensive university in the United States, and compares those levels of environmental knowledge to that of a national sample of adults. Using a set of questions that has become a generally accepted measure of levels of environmental knowledge in the United States, the reported research investigates relationships between students' environmental knowledge and their demographic characteristics (e.g. college/major, age, gender). Moreover, this paper compares the levels of environmental knowledge for students at MSU to the results of a recent national study of such knowledge. After briefly describing Michigan State University, this paper goes on to explain the research design and methods used, present the results of the study, discuss some implications of the analyses, and conclude with some final comments and suggestions.

Michigan State University (MSU)

Michigan State University is a land-grant institution founded in 1855 in East Lansing, Michigan. Land-grant universities in the United States are designated by their states or the US Congress to receive funding for agricultural experiment stations and fulfill a democratic mandate for openness, accessibility and service to people. Many of these institutions have joined the ranks of the nation's most distinguished public research universities. MSU is the eighth largest university by enrollment in the United States. MSU currently enrolls about 43,000 students and offers a full range of academic disciplines with over 100 programs at undergraduate, Master's, doctoral and professional levels. The MSU campus covers 5000 acres, the majority of which is comprised of agricultural areas for research and teaching.

In 2000, MSU agreed to use its campus researchers and staff to develop a watershed plan for the campus that would comply with Phase II of the federal Clean Water Act concerning stormwater management (Witter *et al.*, 2001). The goal of this collaborative effort was not only regulatory compliance, but the establishment of an integrated research, teaching and outreach approach for helping the university examine its environmental footprint and develop a sustainable watershed plan. This campus-wide collaborative effort became known as MSU-WATER (Watershed Action through Education and Research). A part of this integrated research, teaching and outreach effort was an assessment of MSU students' watershed knowledge, perceptions and use. This paper is based on data collected as part of the assessment of students' watershed knowledge and uses. More information on MSU-WATER may be found in Witter *et al.* (2001).

Research questions

The reported research examines the environmental knowledge levels of Michigan State University students—undergraduate, graduate and professional students. Specifically, the research tests whether MSU students' environmental knowledge is comparable to that of a 2000 national sample of adults (National Environmental Education and Training Foundation & Roper Starch Worldwide, 2001). Since no formal environmental education requirements exist at MSU, the research also examines whether environmental knowledge levels of MSU students vary by students' college of major study and other demographic characteristics. Underlying this work are questions about the adequacy of current approaches at the majority of US universities and colleges to supplement environmental education being provided at primary and secondary schools. The question of the adequacy of US primary and secondary school environmental education is not addressed in this study.

Method

Questionnaire design

The reported research is based on a campus-wide survey of MSU students. The researcher used an iterative design process to develop a watershed knowledge, attitude and use questionnaire. While the majority of the survey questions were specific to Michigan State University and the Red Cedar River watershed, 12 'environmental knowledge questions' were included in the instrument and form the basis for the reported research (see Appendix). These 12 environmental knowledge questions were taken from the National Environmental Education and Training Foundation (NEETF) and Roper Starch Worldwide (Roper) survey of adult Americans (National Environmental Education and Training Foundation & Roper Starch Worldwide, 1997, 2001) and were included in their entirety in the MSU survey instrument. The NEETF and Roper studies define adults as individuals of 18 years-old or older. Each of the 12 questions' answer choice set was designed to have one correct answer choice, one conceivable but incorrect choice, and two implausible choices (National Environmental Education and Training Foundation & Roper Starch Worldwide, 2001). Each set of answer choices also included a 'don't know' choice. Altogether, the MSU-WATER student survey contained 10 brief sections of questions with a total of 56 items to be completed by respondents. Readers may access a facsimile of the survey questionnaire at www.msu.edu/~kaplowit/msu-water.pdf (accessed 2 Feb 2005). Results from the substantive watershed questions as well as a study on response rates for the alternative implementation modes used in the study are reported elsewhere (e.g. Kaplowitz *et al.*, 2004).

Target population

The target population for the study was MSU undergraduate, graduate and professional students enrolled for the academic year 2001–2002. At the time of the study, MSU had about 44,000 students enrolled. The MSU Registrar's Office provided the research team with random samples of students drawn from the university's current enrollment records—one sample list was used for a hardcopy survey mode and four sample lists were used for different web-based survey modes. The sample lists were drawn to contain the same proportion of undergraduate, graduate and professional students; were stratified to reflect the same proportionate distribution across MSU's colleges; and were mutually exclusive with no student being in more than one list. Because of financial constraints (i.e. printing and mailing costs), the sample size for the hardcopy mode was to be 3000 while the sample sizes for the four web-based modes were to be about 4500 each. The total sample size was to be about 21,000, just under half of MSU students. A student laborer's key punch error in the registrar's office resulted in a slightly smaller set of samples, 2594 for mail surveys and four web-mode samples of about 4324 each for a total sample of 19,890 students. The researchers verified that the key punch error did not adversely impact the stratified, random and mutually exclusive nature of the sample lists. In the end, almost 20,000 MSU students were asked to participate in the survey.

Implementation

During November 2001, 19,890 MSU students received an MSU-WATER survey by either email or by US mail. The questionnaire was implemented using a Dillman (2000) 'Tailored Design' approach. All potential respondents received a 'cover letter' that provided them with information regarding the purpose of the survey and their rights as a study participant. The web-based instrument was virtually an exact copy of the written instrument except that respondents scrolled down and 'clicked' to fill in their responses to the closed-ended questions instead of turning pages and using a pencil or pen to fill in ScanTron® 'response bubbles.'

The recipients of the mail questionnaire received four contacts: a preliminary postcard, a hardcopy survey with cover letter explaining the purpose of the study, a follow-up/reminder postcard and a replacement hardcopy survey with cover letter to non-respondents. The web-based survey participants were contacted using one of the following four approaches: (1) just an email 'cover letter' explaining the survey with a hyperlink to the instrument; (2) a preliminary postcard followed by an email 'cover letter' with hyperlink to instrument; (3) a preliminary postcard, an email 'cover letter,' and a follow-up/reminder postcard; or (4) the email 'cover letter' with link to the instrument followed by a reminder postcard.

This paper on respondents' environmental knowledge is based upon the pooled data from all the implementation modes. The substantive responses to the questionnaires obtained using the five implementation modes were tested and found to be equivalent. Likewise, a one-way ANOVA was used to test for the effect of item non-response on overall response rate. There were no significant differences between modes for item non-response, and no further discussion of this portion of the analysis appears in this paper.

Grading scale

For the reported research, the environmental knowledge of MSU students is measured using the items and grading scale utilized by NEETF and Roper (2001). As Table 1 illustrates, the NEETF and Roper survey calculates letter grades based on respondents' percentage of correct answers. NEETF and Roper present their survey results as part of a 'report card.' The NEETF and Roper survey categorized scores of greater than 70% (grades A, B and C) as passing scores, measures of adequate environmental knowledge. Therefore, this research groups results as A, B, C or, for scores below 69% (NEETF/Roper grades D or F), as inadequate levels of environmental knowledge. While different grading scales may be preferred for statistical or other analytical reasons, the reported research uses the scale developed and repeatedly used in the NEETF and Roper environmental report cards.

Results

Response rate

For this study, returned surveys were scored as responses if they were completed or partially completed. The response rate for this analysis was calculated as the number of surveys returned divided by the number of surveys that were sent out and not returned to the researchers as undeliverable. This response rate is the maximum response rate (RR6) as defined by the American Association for Public Opinion Research (2000). The different survey implementation modes obtained a range of response rates from 32% response for the mail questionnaire to 21% for the email-only questionnaire. Analysis of the mode effects on response rate differences may be found elsewhere (Kaplowitz *et al.*, 2004). For this paper, the aggregate 6004 responses result in an overall response rate of 30%. This response rate is significantly higher than the 10% response rate reported for other (web-based) surveys of students at MSU (Mertig, 2001).

Table 1. NEETF and Roper Starch Worldwide national survey grading scale

Letter Grade	Number of Questions Answered Correctly	Percentage Score	Passing or Unacceptable
A	10 or more	90%–100%	Pass
B	9	80%–89%	Pass
C	8	70%–79%	Pass
D	7	60%–69%	Unacceptable
F	6 or fewer	59% or less	Unacceptable

Demographics

Demographic characteristics of the respondents compare favorably with those of the overall MSU student population and those at other universities. It is worth noting that in 2000, 35.5% of people between the ages of 18 and 24 enrolled in college in the United States with 43.3% of high-school graduates enrolling in college (Chronicle of Higher Education, 2003). MSU had the nation's eighth largest student enrollment in fall 2000. While the MSU student sample is not assumed to be representative of the general public, the sample population was representative of MSU students. As Table 2 illustrates, all seven academic levels of MSU students participated in the study roughly proportionately, with more undergraduates responding than graduate and professional students. The age of the respondents as well as the gender of respondents also approximates the MSU population with more respondents under 24 years of age and more female respondents. As Table 2 also shows, the respondents were distributed across colleges roughly in similar proportion to the enrollment data. The MSU Detroit College of Law had the least number of respondents (n = 3), which resulted in this group being excluded from much of the college-level statistical analysis. It should also be noted that the College of Communication Arts and Sciences was inadvertently omitted from the answer choices for the question about respondents' college. Many respondents used their comment section of the survey to note the absence of the College of Communication Arts and Sciences from the choices.

Knowledge items

The survey asked 12 environmental knowledge questions (see Appendix). The first such question (H1) asked respondents to rate their own level of knowledge about environmental issues and problems. The remaining 11 items (H2–H12) asked a specific question and offered five answer choices, one of which was correct. For the purpose of the reported analysis, the answer choices were coded as correct or incorrect for each item. The mean item non-response rate for these 12 items was 1.31% (n = 79, sd = 0.14%). That is, on average, more than 98% of respondents answered the knowledge questions. The most respondents answered item H4 concerning electricity (98.9%), while the fewest respondents answered item H10 concerning hazardous waste (98.4%). For the reported data analysis, non-responses to the knowledge items were categorized as incorrect answers.

The percentage of correct responses received for the 11 environmental knowledge items (H2–H12) are reported in Table 3. The item most often answered correctly by the MSU students was question H10 (87.7% correct) concerning respondents' knowledge that batteries are a household hazardous waste. MSU students also scored well on questions related to household hazardous waste (item H9, 82.8% correct) and biodiversity (item H2, 86.4% correct). The questions on which MSU students least often answered correctly concerned electricity generation (item H4, 55.8% correct) and nonpoint source pollution (item H5, 43.5% correct). Interestingly, question H10 (household hazardous waste) had the largest number of correct responses and the

Table 2. Demographics of respondents

Characteristic	Level	Number of Responses	Percent of Responses	2001 MSU %*
Academic Level				
Undergraduate	Freshman	766	12.76	19.7
	Sophomore	834	13.89	18.1
	Junior	985	16.41	19.4
	Senior	1089	18.14	20.1
Graduate	Master's	1008	16.79	8.4
	Doctoral	987	16.44	6.4
Professional	Professional	253	4.21	3.1
	Missing	82	1.37	4.8
Age	Under 20	539	8.98	79.9**
	20–29	4165	69.37	
	30–39	742	12.36	
	40–49	314	5.23	
	50–59	104	1.73	20.1**
	Over 60	20	0.33	
	Missing	120	2.00	
Gender	Female	3519	58.61	53.7
	Male	2404	40.04	46.3
	Missing	81	1.35	
College Major	Ag. & Nat. Resources	624	10.39	7.7
	Arts and Letters	714	11.89	7.6
	Business	663	11.04	13.4
	Communication Arts	n/a	n/a	8.4
	Detroit Law	3	0.05	n/a
	Education	578	9.63	6.7
	Engineering	577	9.61	10.2
	Human Ecology	226	3.76	4.2
	Human Medicine	115	1.92	1.1
	James Madison College***	110	1.83	2.4
	Natural Science	813	13.54	12.6
	Nursing	80	1.33	1.4
	Osteopathic Medicine	118	1.97	1.2
	Social Science	744	12.39	11.2
	Veterinary Medicine	233	3.88	2.0
	Don't Know	255	4.25	6.0
	Missing/Other	151	2.52	3.8

*MSU Office of the Registrar, Enrollment and Term End Reports. Fall 2001. Available at: http://www.reg.msu/RoInfo/EnrTermEndRpts.asp (accessed 2 Feb 2005).
**MSU data divides student ages into two groups: ≤ 24 years and > 24 years.
***James Madison College is an undergraduate honors college focusing on international relations.

Table 3. MSU and national environmental knowledge results

	Question Topic	MSU Correct	National Correct	Difference	Effect Size
2	Definition of biodiversity	86%	41%	45%*	0.985
3	Motor vehicles largest contributor of carbon monoxide	70%	65%	5%*	0.107
4	Electricity generation in the US from burning oil, coal & wood	56%	33%	23%*	0.467
5	Surface water runoff (nonpoint source pollution) is most common water pollution	44%	28%	16%*	0.336
6	Trees are renewable resources	77%	65%	12%*	0.266
7	Ozone layer protects from cancer-causing sunlight	74%	54%	20%*	0.420
8	Most garbage in US ends up in landfills	80%	85%	–5%*	–0.132
9	EPA—primary federal environmental agency	83%	72%	11%*	0.266
10	Batteries are household hazardous waste	88%	67%	21%*	0.516
11	Human destruction of habitat is most common reason for animal extinction	87%	74%	13%*	0.333
12	US stores and monitors nuclear waste	65%	57%	8%*	0.164
	Mean	74%	58%		
	Maximum	88%	85%		
	Minimum	44%	28%		
	Std Deviation	14.17	17.86		
	Variance	200.7	319.02		

*Significant difference at the 1% level based on chi-square test.

highest non-response rate (1.6%), while the question with the lowest number of correct responses (item H5, surface water runoff) was least often left blank (1.1%).

Students compared to national population

A chi-square test was used to test the hypothesis that there is no difference in environmental knowledge levels of MSU students and that of the American public. Aggregating the data from the MSU survey as well as the 2001 NEETF and Roper survey into pass/fail categories, the null hypothesis tested whether the pass/fail rates for the two populations were equal. Table 4 illustrates the aggregate pass/fail percentages and frequencies for both the MSU survey and the NEETF/Roper 2001 survey. The results of this test reject the null hypothesis that the pass/fail rates are equal at the 0.01 significance level ($\chi^2 = 574.801$, df = 1, $P < 0.01$).

One can note from Table 4 that the majority of MSU students passed, while the majority of respondents from the national survey failed. To assess the relative size of the relationship between population and pass/fail performance, it is customary to take into consideration the total sample size, by taking the square root of chi square divided by the total sample size, *n*, where in this study *n* equals 7150 people. This

Table 4. MSU survey and national survey pass/fail percentages and counts (number of respondents passing/failing in parentheses). Source: National Environmental Education and Training Foundation and Roper Starch Worldwide (2001)

Result	MSU	National Survey	Difference in Percentage
Pass	66 (3963)	32 (482)	34*
Fail	34 (2041)	68 (1024)	–34*

*Chi-square value = 574.801; df = 1; and P value = 0.000

statistical index of association is called ϕ, which is the Pearson product correlation coefficient in the case of 2×2 contingency table. The value of ϕ was .28, only a moderate relationship between population and pass/fail performance.

With respect to the proportion of each group that had a passing score, it seems that 34% more MSU students received a passing score on the environmental knowledge items than the US adults. The results of performing a Z-test on differences in those proportions showed a significant difference between the two groups ($Z = 26.54$, $P < .01$). The 95% confidence interval around .34 had a lower bound equal to .31 and an upper bound equal to .37.

To test whether the aggregation of scores might mask equivalencies in the studies' letter grades, a chi-square test was used to test the significance of apparent differences in letter grades between the two sets of data. The chi-square test results in the rejection of the null hypothesis that the letter grades were equivalent for MSU students and American adults ($\chi^2 = 4490.787$, df = 4, $P < 0.01$).

To examine the equivalency of the two samples' responses to particular items, a chi-square test was again used. The results of this analysis of responses to individual knowledge questions are included in Table 3. All of the observed differences between the two populations' responses were significant—not surprising given the large sample size of the MSU study. It appears that on all items but one, MSU students were more often correct than the national sample. For example, 45% more students answered correctly on the item concerning biodiversity than the national sample. The item that MSU students appear to know less than the national sample is item H4 concerning garbage disposal in the United States. In that instance, 5% more of the US public sample than the MSU student sample seem to know that most garbage ends up in landfills. Overall, Table 3 also illustrates that MSU students have inadequate knowledge in three areas—electricity generation, nonpoint source pollution and nuclear waste. While the students' environmental knowledge deficiencies in three areas are better than those of the national sample (inadequate knowledge in 8 of the 11 areas), they demonstrate that more environmental education may be warranted also at the university level.

Given the size of the two samples, it might be easy to obtain statistically significant differences even when those differences might be quite small in absolute terms. One may go beyond performing tests of statistical significance by assessing the strength of the difference between groups, i.e. the effect size (ES). Lipsey (1990) and Lipsey and

Wilson (2001) suggest using an arcsine transformation to measure the size of the effect for proportions. The ES is equal to the difference between the two transformed proportions. This index is roughly comparable to the standardized d-statistic frequently used in meta-analysis studies. The effect sizes associated with the difference in the MSU and national samples' proportion of correct responses are shown in the last column of Table 3. The work of Cohen (1988) and Lipsey and Wilson (1993) (meta-analyses in the realm of psychological and educational treatments) provide a sense of what level of ES can be considered as small, medium or large effects. Using the Cohen and the Lipsey and Wilson approach, there are some large differences among the two populations' responses on the 11 environmental knowledge items, namely items 2 (biodiversity) and 10 (batteries). The ES analysis also reveals only two of the eleven items having small effect sizes, namely items 3 (motor vehicles) and 8 (garbage). The remaining seven environmental knowledge items may be considered as showing moderate differences between the MSU students and the general public. That is, not only are the item differences between the two samples statistically significant but the strength of these differences is moderate to high for 9 of the 11 items.

Differences among colleges

Table 5 illustrates the mean number of items 'passed' for each college unit of MSU. An analysis of variance (ANOVA) test was used to examine whether student knowledge levels varied between students enrolled in different colleges. The descriptive statistics shown in Table 5 indicate that there are differences in the environmental knowledge levels of students among colleges, suggesting a rejection of the null hypothesis. To test the null hypothesis that there is no difference in knowledge between the colleges, the analysis of variance (ANOVA) test is used. The ANOVA test results support rejection of the null hypothesis that MSU student environmental knowledge is equal among varying colleges of major study ($F = 37.114$, $df = 13, 5987$, $P < 0.00$). Consequently, the alternative hypothesis that student environmental knowledge differs depending on their college of study is supported.

To further evaluate the strength of the observed differences among the groups, the researchers computed Eta, a measure of effect size. Eta ranges from 0.0, no relationship, to 1.00, a perfect functional relationship. Eta is comparable to a correlation coefficient, r. It can, unlike r, measure the strength of non-linear relationships and is a function of the F ratio. The observed Eta was .270, which supports the conclusion that there are moderate-sized differences among groups in environmental knowledge. That is, the results evidence moderate difference of students' environmental knowledge based on their college and course of study.

Discussion

The data, in several ways, seem to demonstrate that students at MSU are statistically significantly more knowledgeable about environmental issues than the average American adult. For example, twice as many MSU students (66%) received acceptable

Table 5. Average number of items passed and college of major study

College Major	*n*	Mean	sd	Std Error	95% Confidence Interval Lower Bound	95% Confidence Interval Upper Bound	Min.	Max.
Ag. & Nat. Resources	624	8.84	2.03	0.08	8.68	9.00	1	11
Arts and Letters	714	8.08	2.28	0.09	7.91	8.25	0	11
Business	663	7.84	2.37	0.09	7.66	8.02	0	11
Education	578	7.99	2.43	0.10	7.79	8.19	0	11
Engineering	577	8.27	2.33	0.10	8.08	8.46	0	11
Human Ecology	226	7.25	2.35	0.16	6.94	7.56	0	11
Human Medicine	115	8.92	1.64	0.15	8.62	9.23	4	11
James Madison College*	110	8.20	2.49	0.24	7.73	8.67	2	11
Natural Science	813	8.48	2.24	0.08	8.33	8.63	0	11
Nursing	80	7.48	2.06	0.23	7.02	7.93	0	11
Osteopathic Medicine	118	9.25	1.90	0.17	8.90	9.59	0	11
Social Science	744	8.14	2.21	0.08	7.98	8.30	0	11
Veterinary Medicine	233	8.67	1.98	0.13	8.41	8.93	1	11
Don't Know	406	6.12	3.30	0.16	5.80	6.44	0	11

*James Madison College is an undergraduate honors college focusing on international relations.

letter grade scores (A, B or C) on the environmental knowledge items than did the national sample (32%) (See Table 4). Likewise, 24% more MSU students received an environmental knowledge score in the 'A' or highest percent range (91–100%) than the general population sample. Nevertheless, the MSU students' environmental knowledge levels were still relatively low, with the mean MSU student grade being a 'D.'

Self-evaluation of knowledge

As Table 6 shows, the self-evaluation of environmental knowledge item was answered by most students indicating that they have 'only a little' such knowledge (41.5%) followed by students reporting that they have 'a fair amount' of environmental knowledge (39.7%). A total of about 11% of respondents reported having practically no environmental knowledge (8.2%) or that they did not know (3.1%). The survey results appear to suggest that MSU students were fairly realistic about their level of environmental knowledge.

To test this and explore how well MSU students self-assessed their own level of environmental knowledge relative to adults in the national sample, letter grades were assigned to both populations' answer choices for item H1, respondents' perceived level of environmental knowledge. Specifically, responses were coded as follows: 'a lot' as A, 'a fair amount' as B, 'only a little' as C, and both 'practically

Table 6. MSU student self-evaluation of environmental knowledge

H1. How much do you think you know about environmental issues and problems?	*n*	%
A lot	448	7.5%
A fair amount	2385	39.7%
Only a little	2489	41.5%
Practically nothing	494	8.2%
Don't Know	199	3.1%
	Mean	20.0%
	sd	0.19

nothing' and 'don't know' as D/F. Then respondents' self-assessments were compared to their actual performance on the environmental knowledge items. Seventy percent of the adult respondents to the national study rated themselves as knowing either 'a lot' or 'a fair amount' (A or B). However, only 21% of respondents in the national survey scored grades of either A or B. In comparison, 53% of the MSU students indicated that they knew 'only a little' or 'practically nothing' about environmental issues and problems. This compares favorably with the 58.4% of the MSU students that scored grades of C or lower. These results do support the notion that the students have better ability to judge their environmental knowledge than a national sample.

To further examine how well the students were able to judge their own environmental knowledge, the data were recoded to allow for bivariate correlation analysis of students' number of correct answers and their self-evaluation measure. The result of this analysis is the finding that the number of students' correct answers is significantly correlated in the correct direction with their results on the 11 environmental knowledge items (0.411, n = 5321, P = .000).

Differences and similarities in knowledge

The one environmental knowledge item where the students failed to exceed the knowledge levels of the national sample concerned landfills, the primary method for disposal of garbage in the United States. Perhaps this difference may be explained by the relative youth and inexperience of the students, with most likely never to have owned a home or have paid for refuse service. It is easy to imagine most students living on campus, at their parents' home or in apartments where they put their trash in a dumpster or put it out for someone else to dispose of. The MSU and national samples alike scored lowest on the surface water pollution item (H5). Likewise, both sample populations failed to correctly identify motor vehicles as the major contributor of carbon monoxide; the burning of oil, coal and wood as the largest source of electricity generation in the United States; and storing and monitoring as the primary method of disposal for nuclear waste in the United States. In contrast, both the students and national samples scored at or above passing on the items concerning landfills, Environmental Protection Agency and human destruction of habitat items.

Role of students' college

The data suggest that there is a difference between the students' environmental knowledge and their college of major study ($F = 34.50$, $P < 0.00$). Based on the average number of items passed, the five highest scoring colleges were the Colleges of Osteopathic Medicine (mean = 9.25, sd = 1.90), Human Medicine (mean = 8.92, sd = 1.64), Agriculture and Natural Resources (mean = 8.84, sd = 2.03), Veterinary Medicine (mean = 8.67, sd = 1.98) and Natural Science (mean = 8.48, sd = 2.24). The students who indicated 'no preference/don't know' for their college of major scored the lowest (mean = 6.12, sd = 3.30) followed by the Colleges of Human Ecology (mean = 7.25, sd = 2.35), Nursing (mean = 7.48, sd = 2.06), Business (mean = 7.84, sd = 2.37), and Education (mean = 7.99, sd = 2.43). While it might be expected that the College of Agriculture and Natural Resources and the College of Natural Science scored within the top five, it is interesting to see the Colleges of Medicine (i.e. Osteopathic, Human and Veterinary) among the highest scoring schools. Perhaps the demographic characteristics of students in these colleges suggest some correlation between academic level and environmental knowledge. Students seeking either a professional or doctoral degree appear to dominate the Colleges of Osteopathic, Human and Veterinary Medicine. These students are upper-level graduate students who, at a minimum, have already finished their baccalaureate degrees. Similarly, the respondents from the Colleges of Natural Science and Agriculture and Natural Resources were heavily doctoral students who would have completed both a baccalaureate and a Master's or professional degree. The College of Human Ecology, which had the lowest score of defined colleges, was dominated by students in their junior or senior year of the baccalaureate study. Likewise, the 'no preference/don't know' category which had the lowest score overall was dominated by undergraduate freshman and sophomores.

Educational attainment

In a national study of adult Americans, respondents with a high school-level education were found to possess less environmental knowledge than college-educated respondents (National Environmental Education and Training Foundation & Roper Starch Worldwide, 2001). The results reported in this paper support that finding since freshmen were the least knowledgeable of the students. In that same national survey, it appeared that respondents with a college education received an environmental report card score equivalent to a C–/D+ (National Environmental Education and Training Foundation & Roper Starch Worldwide, 2001). The MSU students, in aggregate, have an environmental knowledge score of about 74% correct, equivalent to a letter grade of 'C.' Within the academic levels, 70% of the professional students achieved a passing score followed by doctoral students (46%), seniors

(39%), Master's (36%), juniors (34%), sophomores (24%) and freshman (22%). The report research tends to support the notion that environmental knowledge increases with educational attainment (e.g. Maloney & Ward, 1973; Miller, 1990; Arcury & Christianson, 1993; Hsu & Roth, 1996; Dunaway, 1999; Tikka *et al.*, 2000).

Conclusion

The findings of this research indicate that MSU students are more knowledgeable about environmental issues and problems than a national sample of adult Americans. However, the overall environmental knowledge level of the MSU student is only a 'C' when calculated using the NEETF and Roper grading scale. While most MSU undergraduates come from Michigan, Michigan State University does have a diverse student population with students from all over the world. The reported research was not able to investigate the impact of students' nationality on their responses. Also, the environmental knowledge and environmental education background of student respondents prior to entering the university are unknown.

In any event, it is fair to say that the majority of the student respondents to the Michigan State University survey were born between 1973 and 1982 and thus grew up after the rise of the environmental education movement. The results of this study do not present clear evidence of the success of environmental education efforts of the past three decades. It is fair to say that kindergarten through twelfth-grade educators may need more help increasing the environmental literacy of high-school graduates. Likewise, while general university education does seem to improve some students' environmental knowledge, overall environmental literacy is not uniform and widespread at Michigan State University. The reported research suggests that there is room in both K-12 and university-level education for increased environmental education efforts.

One interesting component of the reported results was the relatively low level of environmental knowledge among MSU students in the College of Education. The MSU College of Education is a nationally recognized program of excellence. However, its students were ranked 10th among the 14th MSU colleges, above the Colleges of Business, Nursing, Human Ecology and the 'no preference/don't know', in average level of environmental knowledge. These results suggest that increasing the level of environmental knowledge of tomorrow's teachers may be both possible and fruitful. Doing so may be one way to help improve environmental education efforts at the K-12 levels. More research is needed to determine the role that teachers and their education play in the environmental education of their students.

If MSU is at all representative of US colleges and universities, institutions of higher learning have much room to improve their environmental education efforts so that environmental knowledge is disseminated to all post-secondary students regardless of their college or major study. As a land-grant university, MSU may be better at disseminating environmental knowledge than many universities. In any event, institutions of higher learning should recognize the value of working towards producing graduates who have better understanding of their natural environment and how human actions affect it.

Acknowledgements

Funding for the reported research was provided, in part, by Michigan State University's Watershed Action through Education and Research (MSU-WATER) program and the Michigan Agricultural Experiment Station. The reported research was undertaken with the able assistance and hard work of Ms Kelly Kolakowski, Master's student, Department of Resource Development.

Notes on contributors

Michael D. Kaplowitz is an Associate Professor of Environmental Law & Policy in the Department of Community, Agriculture, Recreation, and Resource Studies, Michigan State University, USA.

Ralph L. Levine is a Professor Emeritus of Environmental and Behavioral Systems in the Department of Community, Agriculture, Recreation, and Resource Studies, Michigan State University, USA.

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Appendix. Environmental knowledge questions (correct answer in bold)

H) PLEASE ANSWER THE NEXT 12 QUESTIONS. IF YOU DON'T KNOW THE ANSWER, PLEASE MARK 'DON'T KNOW.'

(Mark ⊗ one response for each statement.)

H1) In general, how much do you feel you know about environmental issues and problems?

1 ☐ A lot
2 ☐ A fair amount
3 ☐ Only a little
4 ☐ Practically nothing
5 ☐ Don't Know

H2) There are many different kinds of animals and plants, and they live in many different types of environments. What is the word used to describe this idea?

1 ☐ Multiplicity
2 ☐ Biodiversity
3 ☐ Socio-economics
4 ☐ Evolution
5 ☐ Don't Know

H3) Carbon monoxide is a major contributor to air pollution in the U.S. Which of the following is the biggest source of carbon monoxide?

1 ☐ Factories and businesses
2 ☐ People breathing
3 ☐ Motor vehicles
4 ☐ Trees
5 ☐ Don't Know

H4) How is most electricity in the U.S. generated?

1 ☐ By burning oil, coal and wood
2 ☐ With nuclear power
3 ☐ Through solar energy
4 ☐ By hydro electric power plants
5 ☐ Don't Know

H5) What is the most common cause of pollution of streams, rivers and oceans?

1 ☐ Dumping of garbage by cities
2 ☐ Surface water running off yards, city streets, paved lots and farm fields
3 ☐ Trash washed into the ocean from beaches
4 ☐ Waste dumped by factories
5 ☐ Don't Know

H6) Which of the following is a renewable resource?

1 ☐ Oil
2 ☐ Iron Ore

3 ☐ Trees
4 ☐ Coal
5 ☐ Don't Know

H7) Ozone forms a protective layer in the earth's upper atmosphere. What does ozone protect us from?
1 ☐ Acid rain
2 ☐ Global warming
3 ☐ Sudden changes in temperature
4 ☐ Harmful, cancer-causing sunlight
5 ☐ Don't Know

H8) Where does most of the garbage in the U.S. end up?
1 ☐ Oceans
2 ☐ Incinerators
3 ☐ Recycling centers
4 ☐ Landfills
5 ☐ Don't Know

H9) What is the name of the primary federal agency that works to protect the environment?
1 ☐ Environmental Protection Agency (the EPA)
2 ☐ Department of Health, Environment, and Safety (the DHES)
3 ☐ National Environmental Agency (the NEA)
4 ☐ Federal Pollution Control Agency (the FPCA)
5 ☐ Don't Know

H10) Which of the following household wastes is considered a hazardous waste?
1 ☐ Plastic Packaging
2 ☐ Glass
3 ☐ Batteries
4 ☐ Spoiled Food
5 ☐ Don't Know

H11) What is the most common reason that an animal species becomes extinct?
1 ☐ Pesticides are killing them
2 ☐ Their habitats are being destroyed by humans
3 ☐ There is too much hunting
4 ☐ There are climate changes that affect them
5 ☐ Don't Know

H12) Scientists have not determined the best solution for disposing of nuclear-waste. In the U.S. what do we do with it now?
1 ☐ Use it as nuclear fuel
2 ☐ Sell it to other countries
3 ☐ Dump it in landfills
4 ☐ Store and monitor the waste
5 ☐ Don't Know