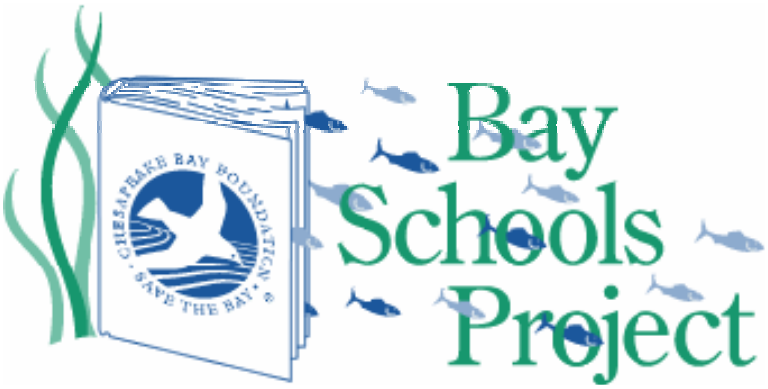


YEAR THREE SUMMATIVE EVALUATION

February 2004

Prepared for the Chesapeake Bay Foundation

By

Clare Von Secker, Ph.D.
Department of Measurement, Statistics and Evaluation
and
Maryland Assessment Research Center for Education Success
University of Maryland, College Park

TABLE OF CONTENTS

APPENDICES

EXECUTIVE SUMMARY

One of the common assumptions driving many environmental education initiatives is that K-12 education should include instructional experiences that create an authentic context for learning. One environmental education model—the Environment as an Integrating Context (EIC) for learning model—connects the classroom to the community by using thematic environmental issues as a focus for curriculum content and by providing instructional experiences that engage students in solving real-world problems.

In 2000, the Chesapeake Bay Foundation (CBF) initiated the Bay Schools Project to provide a vehicle for allowing CBF and Maryland schools to adopt EIC programs by using the Chesapeake Bay and its watershed environment as the theme for integrated instruction. Three goals of the Bay Schools Project were to—

1. encourage students to act responsibly toward the environment and the Chesapeake Bay;
2. foster greater student engagement in learning; and
3. demonstrate the successful integration of environmental themes into the curricula and instruction of a range of school levels, types, and populations.

The primary purpose of the summative evaluation conducted in 2003 was to determine whether these goals were met. Analysis of data collected from students and teachers at five Bay Schools suggests the following conclusions about the Bay Schools Project.

1. Students' environmental knowledge, attitudes, and stewardship behaviors were significantly more positive when they had teachers who placed greater emphasis on EIC.
2. Students' engagement in learning was significantly more positive when they had teachers who placed greater emphasis on EIC.
3. On average, program implementation was not significantly different at the three elementary or two middle schools. Teachers at all schools successfully used EIC.
4. Both students and teachers reported that, within each Bay School, some teachers placed greater emphasis on EIC than did others. Thus, the intensity of each student's EIC experiences depended on the combination of teachers he or she had.
5. Some differences in the levels of implementation of the Bay Schools Project were explained by the amount of knowledge teachers had about the Chesapeake Bay. Teachers who had a better understanding of the environmental issues that served as an integrating context for learning, perhaps as a result of more active participation in Bay School Project professional development activities, were more likely to implement an EIC program.
6. There were no differences in the levels of EIC emphasis that could be explained by teachers' gender, race/ethnicity, type of certification, years of teaching experience, or highest degree earned.

These findings have three important implications. First, they provide confirmatory evidence of the impact of EIC on three components of student environmental literacy: knowledge, attitudes, and stewardship behaviors. In all five Bay Schools, students whose

teachers placed greater emphasis on EIC instruction reported more frequently that they knew “a lot” about environmental issues affecting the Chesapeake Bay, cared “a lot” about the those problems, and were strongly committed to taking actions to solve them.

Second, these findings reinforce results published in the environmental education evaluation literature showing that student engagement in learning is greater in classes where teachers emphasize EIC. In all five Bay Schools, students whose teachers provided more opportunities for them to participate in project-based, interdisciplinary activities reported more frequently that what they learned in school was interesting and useful, and that they felt more empowered to make a difference in their communities.

Third, the consistency of the outcomes observed at five sites, each of which had a different combination of implementation strategies and challenges, provides evidence that inferences about program replication are valid and warranted. Although comparison data were not collected at schools that did not participate in the Bay Schools Project, each school provided its own comparison data because students were grouped according to the intensity of their EIC experiences. The stability of the relationship between EIC experience and student outcomes suggests an EIC model can be effective implemented with a wide range of students.

INTRODUCTION

Program Rationale

One of the common assumptions driving many environmental education initiatives is that K-12 education should include instructional experiences that create an authentic context for learning. One environmental education model—the Environment as an Integrating Context (EIC) for learning model—connects the classroom to the community by using thematic environmental issues as a focus for curriculum content and by providing instructional experiences that engage students in solving real-world problems. Studies of the impact of EIC programs suggest that, compared to students taught using a traditional educational model, students at EIC schools are more enthusiastic about learning and score higher on standardized tests[1].

One of the leaders in environmental education is the Chesapeake Bay Foundation (CBF). CBF believes that the local environment—combined with a school culture that values investigation, exploration, and authentic, project-based learning—provides a powerful context for student learning and achievement in today's schools. In 2000, CBF initiated the Bay Schools Project to provide a vehicle for allowing CBF and Maryland schools to adopt EIC programs by using the Chesapeake Bay and its watershed environment as the theme for integrated instruction. Three goals of the Bay Schools Project were to—

1. encourage students to act responsibly toward the environment and the Chesapeake Bay;
2. foster greater student engagement in learning; and
3. demonstrate the successful integration of environmental themes into the curricula and instruction of a range of school levels, types, and populations.

Program Implementation

During the spring and summer of 2000, teachers and principals from the Bay Schools Project schools worked with CBF facilitators to develop in-depth curricular projects that reflected an emphasis on the Chesapeake Bay and/or its watershed and were aligned with the Maryland State Department of Education (MSDE) Content Standards[2] in English, mathematics, science, and social studies. As partners in the Bay Schools Project, CBF, teachers, and administrators continued to collaborate over the next three academic years to create school cultures that valued investigation, exploration, and authentic, project-based learning.

---

[1] Lieberman, G. A., & Hoody, L. L. (1998). Closing the achievement gap: Using the environment as an integrating context for learning. http://www.seer.org

[2] The MSDE Content Standards define what students in Grades K-12 should know and be able to do in each subject area and the specific learning outcomes that are measured on state assessments.

One critical element of the Bay Schools Project was on-going professional development to support teachers' exploration of new subject matter and use of inquiry-based teaching methods. While the professional development associated with the Bay Schools Project was intended to be flexible so as to meet the needs of a variety of students, teachers, and schools, it included certain common elements that ensured a consistent level of preparation and support. The common elements of the professional development programs at all schools were—

- a 10-day professional development workshop for lead teachers and administrators from each Bay School Project school during the first summer of the school's participation that included (1) hands-on, field-based immersion into the Bay watershed environment; and (2) an intensive period of curriculum development and implementation planning to build a framework for the year ahead;
- weekly or biweekly curricular and instructional training and support from CBF mentors with expertise in environmental education as well in curriculum and instruction;
- common planning time for teachers to collaboratively develop and refine curriculum and project ideas;
- in-service or college credit and/or stipends for all professional development days; and
- instructional and curricular emphasis on environmental literacy (*i.e.*, environmental knowledge, attitudes, and stewardship behaviors).

The curricular and instructional programs at the five Bay Schools explored different aspects of environmental literacy, but all were alike in their emphasis on—

- the Chesapeake Bay and its watershed as a theme for instruction;
- engaging students in project-based, interdisciplinary learning;
- real-life investigation and problem solving focused on the local environment; and
- enabling teams of students to conduct service-learning projects.

Over three academic years beginning in September 2000, interdisciplinary, grade-level teams of teachers from each Bay Schools Project school worked with Project Coordinators and other trained facilitators provided by CBF to develop a Chesapeake Bay-focused learning sequence that was integrated into each school's year-long, state- or county-mandated curriculum. Each interdisciplinary, hands-on, project-based Bay curriculum was designed specifically to meet the interests, needs, and resources of a particular school and was aligned with the school's School Improvement Plan. In addition, the Bay Schools Project provided a network through which teachers could share their project ideas, questions, and advice with colleagues at other participating schools.

By 2003, the Bay Schools Project had been implemented at five Bay Schools in five Maryland counties, namely (1) Perry Hall ES, in Baltimore County; (2) North Bend ES, in Harford County; (3) Hollywood ES, in St. Mary's County; (4) Bohemia Manor MS, in Cecil County; and (5) Forest Oak MS, in Montgomery County. At each of the five schools, some teachers embraced professional development opportunities and the EIC

pedagogical model with greater enthusiasm than did others[3]. As a result, students' EIC experiences depended on which combination of teachers they had during the three years of the Bay Schools program.

Evaluation Purpose and Questions

The summative evaluation measured the impact of the Bay Schools Project at the end of the third year of implementation. The primary purpose of data collection and analysis in 2003 was to determine how well the program goals were met. Three key questions that the summative evaluation sought to answer were—

1. Were students' environmental knowledge, attitudes, and stewardship behaviors related to the amount of emphasis their teachers placed on EIC?
2. Was student engagement in learning related to the amount of emphasis teachers placed on EIC?
3. Was EIC implementation successful with a range of school levels, types, and populations?

[3] CBF Project Coordinators documented the process of program implementation throughout the three years of the Bay Schools Project. Field notes and Coordinators' reports are available from CBF.

METHODOLOGY

Sample Selection

This summative evaluation measured program impact at three elementary schools (Grades K-5) and two middle schools (Grades 6-8) where teachers and students participated continuously in the Bay Schools Project from 2000 to 2003. The sampling frame for the summative evaluation included all teachers from five schools, elementary school students in Grade 5, and middle school students in Grade 8. Most of the teachers and students who returned surveys in 2003 had participated in the Bay Schools Project for two years or more.

Instrumentation

Student Survey. The student survey administered by CBF in 2003 contained items that measured students' (1) knowledge about the environment, notably the Chesapeake Bay; (2) attitudes and beliefs about environmental problems; (3) environmental stewardship behaviors; (4) engagement in learning; and (5) beliefs about the amount of emphasis their teachers placed on EIC. An item analysis of students' responses to survey items in each of these five areas is provided in Appendix A.

Principal components analysis of the student surveys was used to create composite scores for constructs measured by subsets of items. Separate reliability analyses were conducted on each subset of items to evaluate the extent to which they were related to each other. For the student survey, principal components analysis produced composite scores that measured five constructs, namely students' (1) environmental knowledge[4]; (2) attitudes about the environment[5]; (3) environmental stewardship behaviors[6]; (4) engagement in learning[7]; and (5) EIC experiences[8]. Each composite was standardized to have a mean value of 50 and a SD of 10.

Preliminary analysis confirmed that, in every school, students' beliefs about the amount of emphasis their teachers placed on EIC varied considerably. To facilitate interpretation of the relationship between program implementation and student outcomes, the continuous composite score measuring students' EIC experiences was rescaled to represent three groups. The three EIC groups—low, average, and high—correspond respectively to composite scores that are .5 SD or more below, within .5 SD of, and .5 SD or more above, the average amount of emphasis that students reported their teachers placed on EIC instruction.

Teacher Survey. The teacher survey administered by CBF in 2003 contained items that asked teachers about their (1) background, professional training, and certification; (2)

[4] The knowledge composite is composed of 11 items and has a reliability (Cronbach's alpha) of .86.
[5] The attitudes composite is composed of 6 items and has a reliability of .83.
[6] The stewardship composite is composed of 8 items and has a reliability of .81.
[7] The engagement composite is composed of 4 items and has a reliability of .77.
[8] The EIC learning experience composite is composed of 7 items and has a reliability of .84.

knowledge of environmental issues; and (3) emphasis on EIC instruction. A total of 101 teachers returned surveys in 2003. Responses could not be matched with surveys obtained from formative evaluations or with students' responses in 2003. Not all of the teachers who participated in the program for three years returned surveys in 2003. Some of the teachers who did return surveys in 2003 were new to the school and had only participated in the program for one or two years.

Descriptive statistics were used to compare the background characteristics of teachers at each Bay School. These included gender, race/ethnicity, type of certification, years of teaching experience, and highest degree earned.

For the teacher survey, principal components analysis produced composite scores that measured two constructs, namely teachers' (1) knowledge about environmental issues that effect the Chesapeake Bay (content knowledge)[9]; and (2) emphasis on EIC (teacher practices)[10]. Each composite was standardized to have a mean value of 50 and a SD of 10. An item analysis of teachers' responses to the survey items that were used to create the two teacher composites is provided in Appendix B.

To facilitate interpretation of the relationship between teachers' content knowledge and instructional practices, the continuous composite score measuring teachers' knowledge about environmental issues was rescaled to represent three groups—low, average, and high—that correspond respectively to composite scores that are .5 SD or more below, within .5 SD of, and .5 SD or more above, the average amount of knowledge teachers had about environmental issues that effect the Chesapeake Bay

Interpretive Analysis

For each comparison, separate one-way analysis of variance (ANOVA) was used to evaluate the extent to which mean scores of groups of students or teachers were significantly different from one another. Results were considered statistically significant if the *p*-values were .05 or smaller.

One of the limitations of interpreting program effects in terms of statistical significance only is that the calculation of the value of *p* for a test statistic (*e.g.*, the *F*-statistic used in ANOVA) depends in part on sample size and variability. Analysis of a large sample may produce a statistically significant result ($p < .05$) that has limited practical value. Conversely, statistical tests conducted on small, highly variable samples can produce *p*-values that are not statistically significant even when the practical effects of a program are large. For this reason, the program outcomes are described in terms of the practical, as well as statistical, significance of the magnitudes of group differences.

Generally, evaluation of the practical significance is described in terms of effect size (ES) estimates. ES estimates are standardized measures of the significance of statistical tests that allow comparisons of outcomes with different metrics and yield results that are less

[9] The knowledge composite is composed of 11 items and has a reliability (Cronbach's alpha) of .86.
[10] The teachers EIC emphasis composite is composed of 15 items and has a Cronbach's alpha of .90.

sensitive to sample size and variability. In educational research, ES values of ±.10, ±.30, and ±.50 SD are interpreted as small, medium, or large, respectively[11]. ES values less than ±.10 are trivial and of no practical significance even when the *p*-values associated with them are statistically significant.

To simplify interpretation of the many comparisons described in this evaluation report, the practical effects are described in terms of standardized mean differences that correspond directly to ES values of ±.10, ±.30, and ±.50. The transformation is simple because each of the composite scores described in this evaluation report has a mean value of 50 and SD of 10. Therefore, the ES value comparing the difference between any two group means is calculated by dividing the difference of the two means by 10. Standardized mean differences of ±1, ±3, or ±5 correspond to ES values of ±.10, ±.30, and ±.50, and should be interpreted as small, medium, or large, respectively. Standardized mean differences greater than ±5 indicate effects that are very large relative to what typically is observed in other educational program interventions.

[11] Cohen, J. (1988). Statistical power analysis for the behavioral sciences. Hillsdale, NJ: Lawrence Erlbaum Associates.

KEY FINDINGS

1. Were students' environmental knowledge, attitudes, and stewardship behaviors related to the amount of emphasis their teachers laced on EIC?

In all five schools, students' environmental knowledge, attitudes, and stewardship behaviors were significantly more positive when their teachers placed greater emphasis on using the Chesapeake Bay environment as an integrating context for learning.

Table 1. Impact of EIC Emphasis on Environmental Literacy[a] at Five Bay Schools

School		Knowledge about the Chesapeake Bay for Students whose Experience with EIC Was			Attitudes about the Chesapeake Bay for Students whose Experience with EIC Was			Stewardship Behaviors of Students whose Experience with EIC Was		
	Grade	Low	Average	High	Low	Average	High	Low	Average	High
Perry Hall	5th	39.4	50.7	57.4	41.6	49.7	56.8	42.9	50.3	56.7
North Bend	5th	46.2	51.9	58.3	46.4	55.0	58.1	46.6	52.7	57.2
Hollywood	5th	51.1	52.8	57.4	51.7	53.7	58.9	53.8	53.7	59.0
Bohemia Manor	8th	38.1	48.9	52.4	40.2	47.4	52.2	39.8	47.2	49.4
Forest Oak	8th	44.5	48.7	54.4	45.4	48.2	51.6	46.1	47.9	52.1

[a] Each composite score was standardized to have a mean value of 50 and a standard deviation (SD) of 10. Higher values indicate more positive outcomes.

Data presented in Table 1 and in Figures 1, 2, and 3 represent statistically significant differences (p-value < .05) in the environmental knowledge, attitudes, and stewardship behaviors of students whose EIC experience was low, average, or high. In addition to being statistically significant, the effects were of large practical significance. Within each school, environmental literacy in three areas—knowledge, attitudes, and stewardship behaviors—was significantly more positive for students whose EIC experiences were higher.

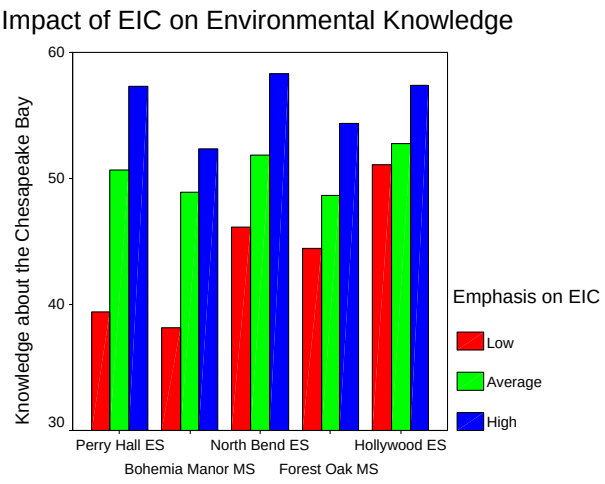
As described earlier, program effects can be considered large from a practical standpoint if the difference in the mean score for any two groups of students is ±5 or more. On average, the environmental knowledge, attitudes, and stewardship behaviors of students whose teachers placed high emphasis on EIC were 12.1, 10.1, and 9.0 points higher, respectively, than those of students whose EIC experiences were low. Medium to very large program effects occurred also among groups of students whose EIC experiences were low versus average, or average versus high. For example, at Perry Hall ES, the environmental knowledge of the group of students whose EIC experience was average was more than 11 points higher than that of the group of students whose EIC experience was low. The associations of higher amounts of EIC instruction with more positive environmental literacy were similar in elementary and middle schools.

Environmental literacy differences were smallest at Hollywood ES. However, this observation can if misleading if the high levels of the mean values of each group are not taken into account. Formative evaluation conducted during 2000-2001indicated that the environmental knowledge, attitudes, and stewardship behaviors of students at Hollywood

ES were very high at the onset of the program[12]. After three years, environmental literacy at Hollywood ES in each of these areas continued to be among the most positive of any of the Bay Schools, with all EIC groups scoring above the composite means of 50.

Data supports a conclusion that differences in environmental knowledge, attitudes, and stewardship behaviors among students who attend the same school are strongly influenced by their teachers' curricular and instructional choices.

Figure 1



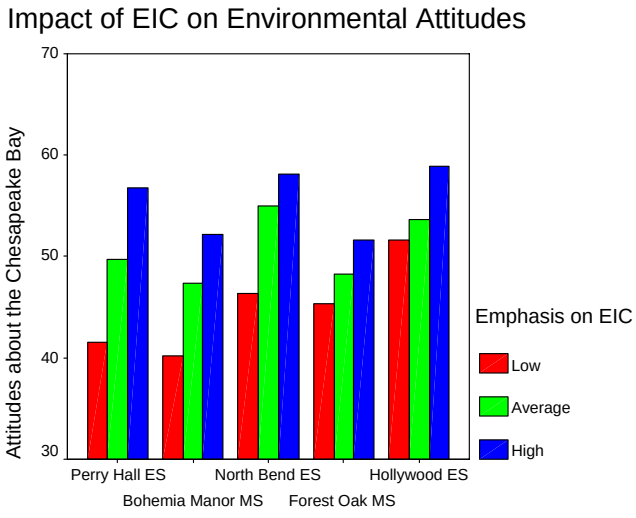
The bar graph in Figure 1 compares the environmental knowledge of students whose teachers' emphases on EIC curriculum and instruction were low, average, or high.

The relationship between greater experience with EIC and increases in students' environmental knowledge was evident regardless of grade level, school type, school demographics, or geographic region.

The bar graph in Figure 2 compares the environmental attitudes of students whose teachers' emphases on EIC curriculum and instruction were low, average, or high.

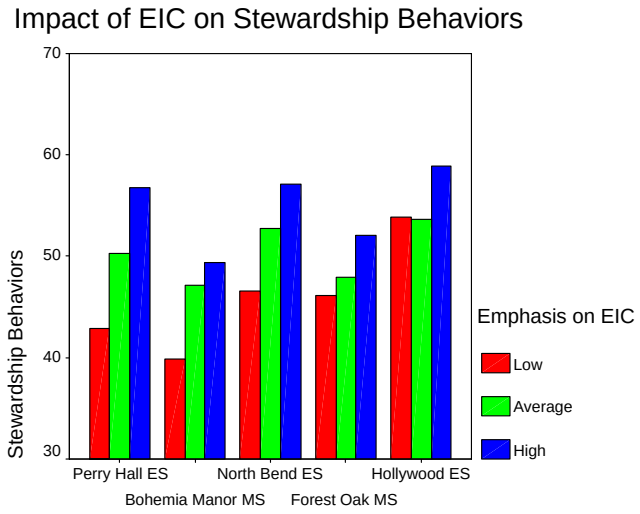
Students' attitudes about the environment were more positive when teachers chose curricula and instruction that emphasized EIC. These differences were evident for students in all five Bay Schools, regardless of grade level, school type, school demographics, or geographic region.

Figure 2



[12] A description of each Bay School was presented in the Bay Schools Project 2000-2001 Technical Report. available from CBF.

Figure 3



The bar graph in Figure 3 compares the environmental stewardship behaviors of students whose teachers' emphases on EIC curriculum and instruction were low, average, or high.

In all schools, students' stewardship behaviors were more positive when teachers emphasized EIC. Even at Hollywood ES, where students' stewardship behaviors were relatively high compared to other schools, greater teacher emphasis on EIC was associated with more positive stewardship behavior.

2. Did the Bay Schools Project foster student engagement in learning?

The results shown in Table 2 and in Figure 4 suggest that student engagement in learning was higher for students whose teacher placed greater emphasis on EIC. Students who applied what they learned to solve environmental problems and complete issue-based projects reported that they enjoyed learning more and felt that what they learned was more meaningful.

Table 2. Impact of EIC Emphasis on Student Engagement at Five Bay Schools

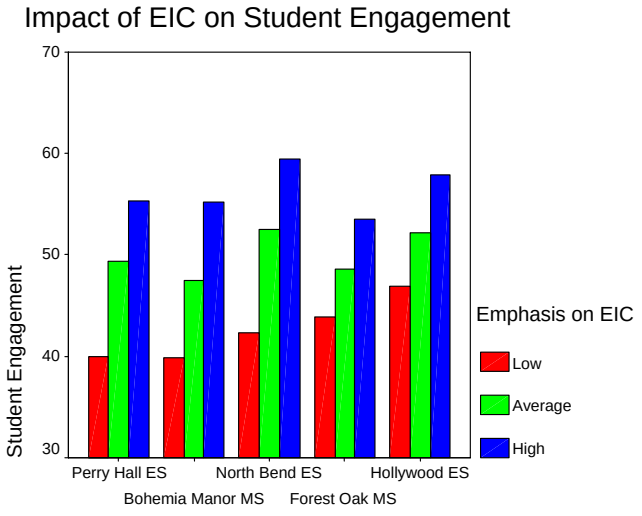
School		Student Engagement in Learning for Students whose Experience with EIC Was		
	Grade	Low	Average	High
Perry Hall	5th	39.4	50.7	57.4
North Bend	5th	46.2	51.9	58.3
Hollywood	5th	51.1	52.8	57.4
Bohemia Manor	8th	38.1	48.9	52.4
Forest Oak	8th	44.5	48.7	54.4

The results have both statistical (*p*-value < .05) and practical (standardized mean differences of 5 points or more) significance. Within each school, student engagement was statistically significantly higher for students whose EIC experiences were more intense. The large ES differences suggest that the statistically significant differences have important practical implications as well. Across the five schools, the average mean difference in the engagement of students whose EIC experience was average was 5.6 points above that of students whose EIC experience was low, and 5.1 points less than that of students whose EIC experience was high. Across the five schools, the average standardized mean difference in the engagement of students whose EIC experience was high compared to that of students whose EIC experience was low was 10.6.

The bar graph in Figure 4 compares the engagement in learning of students whose teachers' emphases on EIC curriculum and instruction were low, average, or high.

At all five Bay Schools, students' reports of their engagement with learning were significantly more positive when they had teachers who placed greater emphasis on EIC curriculum and instruction.

Figure 4



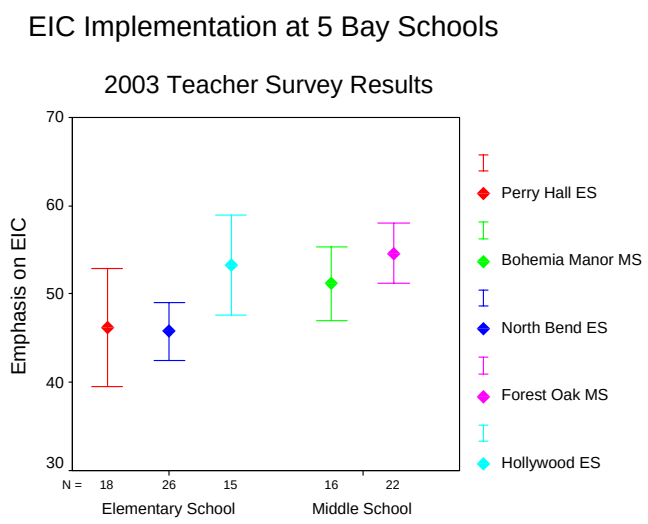
3. Was EIC successfully integrated into the curricula of a range of school levels, types, and populations?

One measure of program implementation was the amount of EIC emphasis teachers reported including in their teaching. The composite score measuring teachers' EIC emphasis has a mean value of 50 and a standard deviation (SD) of 10. As described earlier, mean differences of 1, 3, or 5 points should be considered small, medium, or large, and have significant practical implications even if the differences are not statistically significant.

Program Implementation at 5 Bay Schools.

Figure 5 uses error bars to illustrate whether differences in the amount of emphasis that elementary and middle schools placed on EIC instruction were statistically significant[13]. The ♦ at the center of each error bar shows the average of all teachers who returned surveys for that school. The vertical error band is a 95 percent confidence interval that shows the variability in responses of teachers in the same school. On average, EIC instruction was implemented more in some schools than in others. However most of the differences were not statistically significant.

Figure 5



EIC emphasis was comparable at the three elementary schools and at the two middle schools. However, EIC emphasis was significantly higher at Forest Oak MS than at North Bend ES.

This finding is consistent with data obtained from surveys of students about their EIC experiences. The program was implemented in a variety of schools. However, the wide error bars indicate that, within each school, some teachers were more likely to emphasize EIC than others.

Program Implementation and Teacher' Content Knowledge.

Further analysis was conducted to attempt to explain the variability in EIC emphasis among teachers who worked at the same school. Table 3 and Figure 6 compare the EIC emphasis of teachers whose personal knowledge about Chesapeake Bay environmental

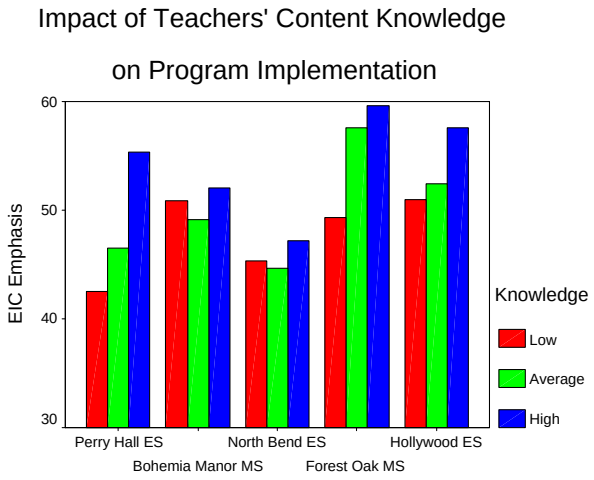
[13] Differences are statistically significant if confidence intervals do not overlap.

issues was low, average, or high. Except for Forest Oak MS, there were no statistically significant differences in the amount of EIC emphasis among teachers whose knowledge of environmental issues was low, average, or high[14]. However, there were significant practical differences.

Table 3. Impact of Teachers' Knowledge on EIC Emphasis at Five Bay Schools			
School	EIC Emphasis of Teachers Whose Knowledge about Chesapeake Bay Environmental Issues Was		
	Low	Average	High
Perry Hall	42.5	46.5	55.3
North Bend	45.3	44.6	47.1
Hollywood	51.0	52.5	57.6
Bohemia Manor	50.9	49.1	52.0
Forest Oak	49.4	57.6	59.6

Within each school, teacher emphasis on EIC was higher among teachers with deeper understanding of the environmental issues that were the themes for integrated instruction. While the magnitudes of the effects ranged from trivial to very large, the results at each school were indicative of a positive relationship.

Figure 6



The bar graph in Figure 6 compares the EIC emphasis of teachers whose knowledge about environmental issues was low, average, or high.

In all schools, there was a positive relationship between teachers' content knowledge and their pedagogical practices. The upward trends suggest that both elementary and middle school teachers may be more likely to emphasize EIC if they have a better understanding of the environmental issues that serve as the integrating themes for EIC instruction.

[14] At each school, the number of teachers who returned surveys ranged 16 to 26, and the number of teachers assigned to each category was small. When used to measure program effects, relatively small sample sizes such as these frequently yield outcomes that are not statistically significant even if the results have practical significance. Thus, statistical results may underestimate the impact of teacher knowledge on EIC emphasis.

For example, at Perry Hall ES and Forest Oak MS the EIC emphases of teachers whose knowledge about Chesapeake Bay environmental issues was high were 12.8 (ES = 1.28) and 10.3 (ES = 1.03) points greater, respectively, than those of teachers in the same school whose knowledge was low. The large ES for these schools strong suggests a connection between teacher knowledge and practice.

On the other hand, at North Bend ES and Bohemia Manor MS, differences in the EIC emphases of teachers whose knowledge about Chesapeake Bay environmental issues was high were only 1.8 (ES = .18) and 1.1 (ES = .11) points greater, respectively, than that of teachers in the same school whose knowledge was low. These very small effects suggest that other factor besides teachers' content knowledge influence their decisions to use the EIC model.

Program Implementation and Other Teacher Characteristics. Data presented in Table 4 revealed no systematic differences in program implementation at the five Bay Schools that could be explained by teachers' gender, race/ethnicity, type of certification, years of teaching experience, or highest degree earned. However, teachers surveyed in year three were relatively homogeneous with regard to their demographic profiles. Thus, generalizations about the successful integration with a broad population of teachers are limited to those represented by this sample.

Table 4. Other Teacher Characteristics

School	Gender		Racial/ethnic group			Type of Certification			
	Female	Male	Asian	Black	White	Other	None	Regular	Temp.
Hollywood ES	15	1	1	1	13	1	0	16	0
North Bend ES	24	2	0	0	26	0	1	25	0
Perry Hall ES	20	1	0	0	21	0	2	19	0
Bohemia Manor MS	13	3	0	1	15	0	0	15	1
Forest Oak MS	15	7	0	2	20	0	0	22	0
School	Years of Teaching Experience					Highest Degree Earned			
	1-5	6-10	11- 15	16 - 20	21 or more	AA	BA or BS	MA, MS, or M.Ed.	Ph.D.
Hollywood ES	2	2	1	2	9	0	6	10	0
North Bend ES	4	7	0	2	13	1	4	21	0
Perry Hall ES	3	5	4	2	7	0	5	16	0
Bohemia Manor MS	3	1	1	2	9	0	8	8	0
Forest Oak MS	3	3	4	6	6	0	4	18	0

Approximately 86 percent of the teachers in this sample were female. Seventy-one percent of the male teachers in the sample worked at one of the two middle schools. Ninety-four percent of the teachers were white. Three of the four teachers who identified their race/ethnicity as black taught at the middle schools.

Forty-three percent of teachers in the Bay Schools had taught 15 years or fewer and 57 percent had taught more than 15 years. Virtually all of the teachers (96 percent) were certified. Ninety-nine percent of the teachers had earned a Bachelors degree or higher; 72 percent had earned a Masters Degree or equivalent.

CONCLUSION

Analysis of data collected from students and teachers at five Bay Schools suggests the following conclusions about the Bay Schools Project.

1. Students' environmental knowledge, attitudes, and stewardship behaviors were significantly more positive when they had teachers who placed greater emphasis on EIC.
2. Students' engagement in learning was significantly more positive when they had teachers who placed greater emphasis on EIC.
3. On average, program implementation was not significantly different at the three elementary or two middle schools. Teachers at all schools successfully used EIC.
4. Both students and teachers reported that, within each Bay School, some teachers placed greater emphasis on EIC than did others. Thus, the intensity of each student's EIC experiences depended on the combination of teachers he or she had.
5. Some differences in the levels of implementation of the Bay Schools Project were explained by the amount of knowledge teachers had about the Chesapeake Bay. Teachers who had a better understanding of the environmental issues that served as an integrating context for learning, perhaps as a result of more active participation in Bay School Project professional development activities, were more likely to implement an EIC program.
6. There were no differences in the levels of EIC emphasis that could be explained by teachers' gender, race/ethnicity, type of certification, years of teaching experience, or highest degree earned.

These findings have three important implications. First, they provide confirmatory evidence of the impact of EIC on three components of student environmental literacy: knowledge, attitudes, and stewardship behaviors. In all five Bay Schools, students whose teachers placed greater emphasis on EIC instruction reported more frequently that they knew "a lot" about environmental issues affecting the Chesapeake Bay, cared "a lot" about the those problems, and were strongly committed to taking actions to solve them.

Second, these findings reinforce results published in the environmental education evaluation literature showing that student engagement in learning is greater in classes where teachers emphasize EIC. In all five Bay Schools, students whose teachers provided more opportunities for them to participate in project-based, interdisciplinary activities reported more frequently that what they learned in school was interesting and useful, and that they felt more empowered to make a difference in their communities.

Third, the consistency of the outcomes observed at five sites, each of which had a different combination of implementation strategies and challenges, provides evidence that inferences about program replication are valid and warranted. Although comparison data were not collected at schools that did not participate in the Bay Schools Project, each school provided its own comparison data because students were grouped according to the intensity of their EIC experiences. The stability of the relationship between EIC experience and student outcomes suggests an EIC model can be effective implemented with a wide range of students.

APPENDIX A

Table A1. Item Analysis of Students' Environmental Knowledge

		Perry Hall ES	North Bend ES	Hollywood ES	Bohemia Manor MS	Forest Oak MS
		N responses to each item	N responses to each item	N responses to each item	N responses to each item	N responses to each item
The Bay is a shallow body of water that is easily affected by pollution from the land.	Incorrect	54	57	70	102	113
	Correct	28	19	19	26	109
Underwater Bay grasses provide a habitat for young crabs and fish.	Incorrect	27	12	17	54	66
	Correct	55	64	72	74	156
When rain runs off the land and into streams or rivers, it carries pollutants with it.	Incorrect	28	16	29	54	88
	Correct	54	60	60	74	134
How much do you know about the loss of important habitats, such as wetlands and submerged aquatic vegetation, and how this affects people and the Bay?	Nothing	12	1	2	22	15
	Very little	12	10	13	32	48
	Some	41	38	38	42	115
	A lot	16	27	33	31	41
	Invalid Response	1	0	3	1	1
How much do you know about high levels of nutrients and their sources and how they affect people and the Bay?	Nothing	16	10	11	37	31
	Very little	22	25	23	45	74
	Some	24	26	39	32	89
	A lot	20	15	16	14	24
	Invalid Response	0	0	0	0	3
How much do you know about over fishing and over harvesting of fish, oysters, and crabs and how they affect people and the Bay?	Nothing	10	4	3	26	31
	Very little	16	13	8	21	42
	Some	22	22	23	43	82
	A lot	32	33	50	35	63
	Invalid Response	2	4	5	3	2
I know how to clean up or care for a local stream.	Strongly disagree	6	4	4	19	23
	Disagree	9	8	7	13	16
	Neither agree nor disagree	15	12	20	45	68
	Agree	28	37	28	36	89
	Strongly agree	23	15	30	15	24
I know how to protect the Bay by conserving water at home.	Strongly disagree	5	2	4	24	10
	Disagree	10	4	3	15	24
	Neither agree nor disagree	5	8	16	19	60
	Agree	34	21	31	50	99
	Strongly agree	27	41	35	20	29
I know how to restore Bay habitats by growing and planting underwater grasses or oysters.	Strongly disagree	5	5	6	26	22
	Disagree	9	8	3	14	46
	Neither agree nor disagree	23	18	21	42	63
	Agree	29	30	36	35	73
	Strongly agree	16	15	23	11	18

(Table A1 continued)		Perry Hall ES	North Bend ES	Hollywood ES	Bohemia Manor MS	Forest Oak MS
		N responses to each item	N responses to each item	N responses to each item	N responses to each item	N responses to each item
While studying about the Chesapeake Bay, I developed new skills.	Strongly disagree	4	7	5	26	17
	Disagree	16	3	3	16	27
	Neither agree nor disagree	18	12	15	30	65
	Agree	28	29	38	43	93
	Strongly agree	15	25	28	13	20
I learned to how help solve some of the problems that the Bay faces.	Strongly disagree	5	7	3	21	17
	Disagree	5	5	3	12	24
	Neither agree nor disagree	16	3	15	37	46
	Agree	38	41	42	46	111
	Strongly agree	18	20	26	12	24

Table A2. Item Analysis of Students' Environmental Attitudes

		Perry Hall ES	North Bend ES	Hollywood ES	Bohemia Manor MS	Forest Oak MS
		N responses to each item	N responses to each item	N responses to each item	N responses to each item	N responses to each item
By working on my own, I can make a difference in solving Chesapeake Bay problems.	Strongly disagree	23	13	9	29	40
	Disagree	22	7	18	28	48
	Neither agree nor disagree	12	24	27	36	75
	Agree	15	17	24	27	52
	Strongly agree	10	15	11	7	6
By working with others, I can make a difference in solving Chesapeake Bay problems.	Strongly disagree	2	1	2	18	11
	Disagree	11	1	1	7	8
	Neither agree nor disagree	10	6	7	25	32
	Agree	25	23	23	54	91
	Strongly agree	34	45	56	24	79
How much do you care about the Chesapeake Bay?	Not at all	3	7	1	21	16
	A little	17	6	10	26	64
	Quite a bit	17	13	16	35	75
	Very much	18	17	26	29	41
	Very, very much	26	33	36	17	24
How much do you care about aquatic animals such as fish, oysters, and crabs?	Not at all	5	4	0	13	9
	A little	10	7	7	27	49
	Quite a bit	22	14	16	30	58
	Very much	16	24	30	29	71
	Very, very much	29	27	36	29	35
How much do you care about natural areas such as streams, rivers, wetlands, and marshes?	Not at all	5	4	3	26	19
	A little	21	11	13	30	56
	Quite a bit	19	17	16	33	64
	Very much	19	19	26	23	59
	Very, very much	18	25	31	16	23
While studying about the Chesapeake Bay, I felt like I really helped to protect the Bay.	Strongly disagree	6	7	5	23	19
	Disagree	10	6	4	19	26
	Neither agree nor disagree	29	10	22	44	93
	Agree	22	36	31	33	73
	Strongly agree	15	17	27	9	11

Table A3. Item Analysis of Students' Environmental Stewardship Behaviors						
		Perry Hall ES	North Bend ES	Hollywood ES	Bohemia Manor MS	Forest Oak MS
		N responses to each item	N responses to each item	N responses to each item	N responses to each item	N responses to each item
In the next 6 months, I intend to protect the Bay by conserving water at home.	Very unlikely	5	7	4	29	20
	Unlikely	15	4	14	35	59
	Likely	38	27	42	51	107
	Very likely	16	23	19	10	17
	Definitely	8	15	10	3	18
In the next 6 months, I intend to clean up or care for a local stream.	Very unlikely	13	10	8	39	46
	Unlikely	28	24	20	50	63
	Likely	23	25	32	24	67
	Very likely	9	11	16	11	31
	Definitely	9	5	13	4	13
In the next 6 months, I intend to restore Bay habitat by growing and planting underwater grasses.	Very unlikely	20	25	10	55	58
	Unlikely	22	25	7	45	96
	Likely	14	16	7	17	50
	Very likely	9	5	4	5	15
	Definitely	17	5	61	6	3
It is my personal responsibility to help protect the Chesapeake Bay.	Strongly disagree	4	3	2	21	21
	Disagree	15	6	7	11	33
	Neither agree/disagree	31	21	22	45	85
	Agree	20	23	31	43	64
	Strongly agree	12	23	27	8	19
It is my personal responsibility to help protect aquatic animals such as fish, oysters, and crabs.	Strongly disagree	7	4	4	15	18
	Disagree	14	7	11	18	32
	Neither agree/disagree	20	22	20	48	87
	Agree	26	21	34	34	67
	Strongly agree	15	22	20	13	18
In the last year, how many times have you protected the Bay by conserving water at home?	Never	12	9	14	38	40
	Once	13	3	6	18	31
	Twice	8	6	12	26	37
	Three times	14	4	15	10	32
	Four or more times	35	53	42	36	81
In the last year, how many times have you cleaned up or cared for a local stream?	Never	31	13	29	81	67
	Once	23	19	17	21	84
	Twice	9	21	14	14	36
	Three times	7	9	14	4	17
	Four or more times	12	14	15	8	18
In the last year, how many times have you cleaned up or cared for a local stream?	Never	31	13	29	81	67
	Once	23	19	17	21	84
	Twice	9	21	14	14	36
	Three times	7	9	14	4	17
	Four or more times	12	14	15	8	18

s

Table A4. Item Analysis of Students' EIC Experiences						
		Perry Hall ES	North Bend ES	Hollywood ES	Bohemia Manor MS	Forest Oak MS
		N responses to each item	N responses to each item	N responses to each item	N responses to each item	N responses to each item
How much time did you spend learning about the Chesapeake Bay?	None	6	3	12	20	26
	Very little	12	7	7	21	26
	Some	19	20	25	38	68
	A lot	44	42	39	48	89
	A lot	1	4	5	1	8
How much time did you spend learning about streams, wetlands, or marshes?	None	3	3	4	18	20
	Very little	15	11	15	22	35
	Some	27	18	32	45	88
	A lot	35	42	33	39	70
	A lot	1	2	4	3	6
How much time did you spend learning about aquatic animals such as fish, oysters, and crabs?	None	5	4	7	24	15
	Very little	13	14	9	18	51
	Some	34	24	28	46	91
	A lot	28	30	43	36	56
	A lot	2	4	1	4	6
How much time did you spend learning about the environment around your school?	None	6	2	6	21	15
	Very little	11	11	6	14	24
	Some	21	27	32	45	62
	A lot	41	34	42	46	109
	A lot	3	2	3	2	9
How many outdoor environmental field trips or Chesapeake Bay field trips did you take with your class?	None	5	5	8	32	67
	One	12	12	12	20	45
	Two	10	16	30	35	53
	Three	20	15	16	27	30
	More than three	35	28	23	14	22
How often did you do experiments or projects?	Never	3	3	3	20	21
	Very little	22	14	16	33	51
	Some	40	32	41	51	88
	A lot	16	25	27	20	54
	A lot	1	1	2	4	5
How often did you do work with others in small groups?	Never	4	2	4	17	22
	Very little	18	5	8	24	35
	Some	28	29	31	54	85
	A lot	28	39	45	29	71
	A lot	3	1	1	3	6

Table A5. Item Analysis of Students' Engagement in Learning						
		Perry Hall ES	North Bend ES	Hollywood ES	Bohemia Manor MS	Forest Oak MS
		N responses to each item	N responses to each item	N responses to each item	N responses to each item	N responses to each item
Most of what I learned in school last year was useful to me in my own life.	Strongly disagree	9	8	6	30	23
	Disagree	16	12	11	25	64
	Agree	38	29	36	52	101
	Strongly agree	17	25	33	14	26
	Strongly Agree	0	2	3	6	5
Most of what I learned in school was interesting to me.	Strongly disagree	15	9	7	29	25
	Disagree	21	9	11	25	54
	Agree	22	28	29	47	96
	Strongly agree	18	30	39	19	27
	Strongly Agree	1	0	3	4	8
I had opportunities to work with my friends.	Strongly disagree	6	7	8	18	17
	Disagree	11	1	1	14	19
	Neither agree nor disagree	9	9	12	20	43
	Agree	31	21	36	53	95
	Strongly agree	24	38	32	23	48
While studying about the Chesapeake Bay, I saw how my work helped protect the Bay.	Strongly disagree	8	7	7	26	19
	Disagree	9	5	8	19	37
	Neither agree nor disagree	20	8	24	34	74
	Agree	32	28	26	37	80
	Strongly agree	13	27	24	10	11

Table B1. Item Analysis of Teachers' Emphasis on EIC Instruction

Scientific literacy -- 15 items (Standardized; mean 0; SD 1)		Hollywood ES	North Bend ES	Perry Hall ES	Bohemia Manor MS	Forest Oak MS
		N responses to each item	N responses to each item	N responses to each item	N responses to each item	N responses to each item
How much emphasis do you place on						
increasing students' interest and engagement in the subject you teach?	None	0	0	1	0	0
	A little	0	1	1	0	0
	Moderate	3	9	8	4	9
	Heavy	12	16	10	12	13
students' abilities to design and execute real-life projects in their communities?	None	1	4	2	4	3
	A little	6	11	6	5	12
	Moderate	4	8	9	7	4
	Heavy	5	3	3	0	3
students' abilities to write thoroughly developed, extended constructed response essays?	None	1	7	7	1	1
	A little	6	6	2	3	2
	Moderate	5	8	5	7	12
	Heavy	4	5	6	5	7
students' abilities to synthesize information to provide a correct answer to a question or problem?	None	0	0	2	1	0
	A little	5	9	5	0	2
	Moderate	4	12	8	9	11
	Heavy	7	5	4	6	9
frequent assessment of students' abilities to apply information to a practical problem in a related area?	None	0	1	2	2	0
	A little	1	6	4	3	4
	Moderate	9	17	10	8	7
	Heavy	6	2	4	3	11
students' abilities to compare and contrast different perspectives about a question or problem?	None	0	2	4	0	0
	A little	5	10	2	6	2
	Moderate	5	11	10	9	10
	Heavy	6	3	4	1	10
students' abilities to use accurate terminology when writing to enhance reader understanding of a question or problem?	None	0	2	3	0	0
	A little	3	8	4	1	4
	Moderate	6	12	9	6	7
	Heavy	7	4	4	9	11
students' abilities to think critically and solve problems?	None	0	0	2	1	0
	A little	2	6	4	0	2
	Moderate	7	17	6	9	6
	Heavy	7	3	8	6	14
students' abilities to use supporting evidence to justify their answers?	None	0	0	1	2	0
	A little	2	7	2	0	1
	Moderate	8	14	8	5	4
	Heavy	6	5	9	9	17

Table B1. Item Analysis of Teachers' Emphasis on EIC Instruction

Scientific literacy -- 15 items (Standardized; mean 0; SD 1)		Hollywood ES	North Bend ES	Perry Hall ES	Bohemia Manor MS	Forest Oak MS
students' abilities to use analysis to demonstrate a full and complete understanding of a question or problem?	None	0	4	2	1	0
	A little	4	9	4	1	3
	Moderate	6	11	11	10	8
	Heavy	6	2	3	4	11
problem-solving and inquiry skills?	None	0	0	1	0	0
	A little	3	9	8	3	3
	Moderate	6	13	6	8	8
	Heavy	7	4	4	5	11
increasing student awareness of the importance of environmental literacy and stewardship in daily life?	None	1	0	2	0	2
	A little	1	7	6	7	10
	Moderate	8	11	7	6	4
	Heavy	6	7	4	3	5
	N/A	0	1	0	0	1
learning about the application of your subject area to environmental issues?	None	0	0	2	0	3
	A little	4	13	7	10	10
	Moderate	9	10	8	4	5
	Heavy	3	3	2	2	4
developing writing skills?	None	0	3	2	0	0
	A little	2	4	1	3	4
	Moderate	4	10	8	7	4
	Heavy	10	9	8	6	13
	5	0	0	0	0	1
data collection and analysis?	None	0	7	3	2	1
	A little	4	13	4	5	11
	Moderate	6	6	11	5	8
	Heavy	5	0	1	4	2

Table B2. Item Analysis of Teachers' Environmental Literacy

Environmental Knowledge—Self Report[1]		Hollywood ES	North Bend ES	Perry Hall ES	Bohemia Manor MS	Forest Oak MS
How Much Do You Know About Environmental Issues Affecting the Chesapeake Bay?[1]		N responses to each item	N responses to each item	N responses to each item	N responses to each item	N responses to each item
How much do you know about how over-fishing and over-harvesting affect the Bay?	Nothing	1	0	0	0	1
	Very little	0	1	3	0	4
	Some	8	15	14	6	12
	A lot	7	10	4	10	5
How much do you know about the sources of high levels of nutrients in the Bay and how this affects the Bay?	Nothing	1	0	1	0	0
	Very little	1	1	2	2	5
	Some	8	14	15	4	9
	A lot	6	11	3	10	8
How much do you know about the loss of important Bay habitats such as wetlands and underwater grasses (SAV)?	Nothing	1	0	1	0	0
	Very little	1	1	2	0	3
	Some	8	14	10	6	11
	A lot	6	11	8	10	8
How much do you know about how too much sediment from the land causes cloudy water and affects underwater grasses, also known as submerged aquatic vegetation (SAV)?	Nothing	1	0	0	0	0
	Very little	2	0	2	0	4
	Some	6	15	9	7	8
	A lot	7	11	10	9	10
How much do you know about how increasing human populations also increases the demand for resources and increases pollution?	Nothing	0	0	0	0	0
	Very little	1	0	0	0	1
	Some	7	14	7	2	11
	A lot	8	12	14	14	9