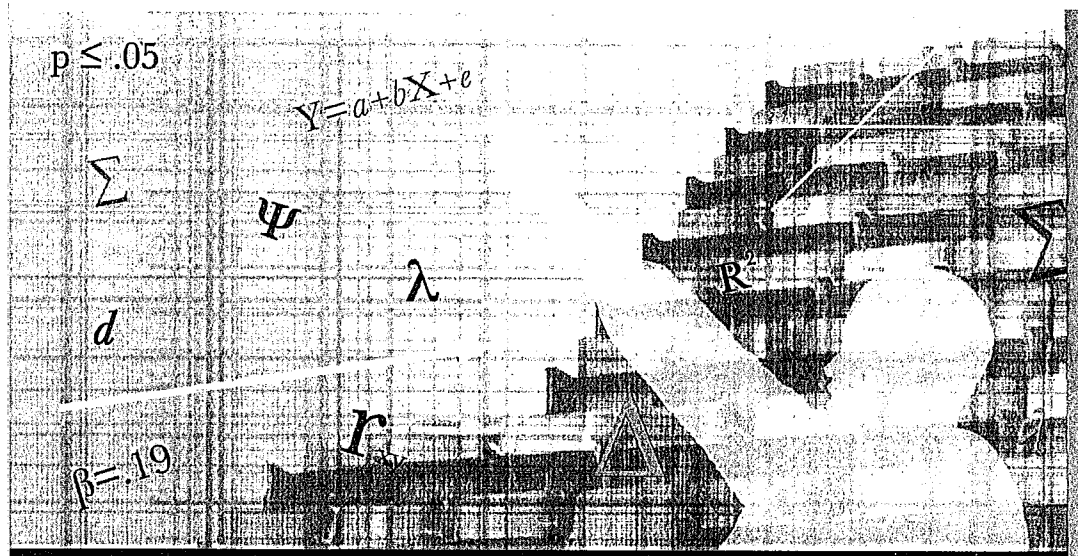

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Missouri State University™

1 Impact of Environment-Based Teaching on Student Achievement: A Study of Washington State Middle Schools

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ABSTRACT

This paper reports on a project which investigates the impact of systemic environmental education (EE) programs on student achievement on EE-based integrated tests and standardized tests in math, language arts, and listening. Systemic environmental education programs are defined by curriculum designed to align and integrate subjects around real world environmental contexts. To assess environmental literacy knowledge and skills, integrated EE-based tests for Grade 8 were administered to students in participating schools, and the results were compared to students' scores on standardized tests. Quantitative analysis shows correlatiosn between EE scores and standardized scores in math, reading and writing, with students from EE schools performing higher on EE and state tests than students from schools with traditional curriculum. The project findings suggest that by providing a universal context for learning, environmental education could support schools' accountability efforts to integrate discipline standards and improve student performance.

INTRODUCTION & RESEARCH OBJECTIVES

"I have to serve my masters. I have to cover all the curriculum. I have to make sure my students do well on the state tests. And all this doesn't leave much time for environmental education or other extra activities." "As an administrator I need to see evidence that these types of programs can help my school perform well on the WASL." The Pacific Education Institute (PEI) research group regularly encounters comments like these during research meetings, professional development workshops and informal conversations with teachers and administrators from Washington State public schools. While those involved in environmental education strongly believe in its benefits for students and schools, teachers and administrators often need more than just words and emotions. They need evidence that proves EE's beneficial impact on students; evidence that would help them defend their choices of the curriculum activities and programs.

In Washington State, like in many other states and countries across the globe, environmental education is required to be taught in all grades and subjects. However, while most teachers and parents would like to see EE become a part of the school programs, environmental education designed to align subjects around real world environmental contexts is still marginalized or absent from everyday school activities (Hart, 2003; Volk, Hungerford, & Tomera, 1984; U.S. Environmental Protection Agency, National Environmental Education Advisory Council, Environmental Education Division (EPA), 1996). As a result of the current accountability climate, schools in North America (and especially in the USA) continue to focus on the content that is measured on discipline-based standardized tests, marginalizing rich interdisciplinary activities and environments. While teachers and researchers in the field of environmental education call for more evidence that EE can be effective in improving student learning (see Angell, Ferguson, & Tudor, 2001), this research is still limited. The study presented here begins to address this need.

Our research project investigated the impact of high quality EE programs on student performance on the EE-based assessments and the state standardized tests. Specifically, we asked whether students involved in rigorous environmental education programs achieve at higher levels on standardized tests and/or on environmental literacy measures. This paper presents a summary of our findings.

THEORETICAL BACKGROUND

While EE practitioners have been observing the beneficial influence of EE on their students for years, there are a limited number of empirical research studies corroborating this fact.

One of the first groups that attempted to investigate the efficacy of environmental education in increasing student learning was the State Education and Environment Roundtable (Lieberman & Hoody, 1998). Their study, *Closing the Achievement Gap: Using the Environment as an Integrating Context for Learning*, analyzed student achievement at 40 schools with environment-based programs across the United States. The report suggests that students in classrooms with EE programs tend to have higher scores on standardized tests in math, reading, writing, science, and social sciences.

California Student Assessment Project, another study conducted by the SEER group, evaluated student achievement in 11 environmental schools in California and found that when compared to students from traditional (non-EE classes), EE students showed higher results in 101 (72%) out of 140 academic assessments in language arts, math, science, and social science (Lieberman, Hoody, & Lieberman, 2000).

In their study of the impact of EE on students' critical thinking, achievement and motivation, Athman and Monroe (2004) also found a strong positive correlation between participation in environmental education programs and higher achievement on state tests. The study compared students' scores on three tests that measure critical thinking and motivation (the Cornell Critical Thinking Test, the California Measure of Mental Motivation, the Achievement Motivation Inventory), and found that students in programs designed around an environmental context tended to score higher than students in the traditional classes.

Cheak, Hungerford, and Volk (2002), Billings, Plato, Anderson, and Wiley (1996), Monroe, Randall, and Crisp (2001), National Environmental Education and Training Foundation, 2000; National Environmental Education and Training Foundation and North American Association for Environmental Education, 2001) also suggest that environmental education may improve student learning. According to these authors, achievement, student motivation and engagement tend to improve when students participate in environment-based programs. Unfortunately, some of the reports published to date on this issue present promising anecdotal "success stories" (e.g. NEETF & NAAEE, 2001) rather than rigorous empirical studies corroborating these findings.

The literature reviews conducted by Norman, Jennings and Wahl (2006) and Wheeler, Thumlert, Glaser, Schoellhamer, and Bartosh (2007) support the claim of the lack of rigorous studies. Norman, Jennings and Wahl (2006) who aimed to "to determine whether meaningful evidence exists that shows a connection between environmentally-based education programs and improvements in academic achievement" (p. i) reviewed 100 studies and identified only 8 that were regarded as providing strong or supportive evidence of the positive impact of EE programs on student achievement, whereas 35

studies provided incomplete or unclear data and descriptions. Similarly, the review of the research conducted by Wheeler et. al. (2007) which included 20 studies that address student achievement found that while 18 papers and reports indicated a correlation between participation in environmental education and improved academic achievement, many of them did not provide sufficient description of the research methods, and/or participants. Very few studies controlled for other factors such as gender, socioeconomic status, age, and level of achievement prior to participation in environmental education; some relied on small sample sizes and did not test for statistical and/or practical significance of the results. The existing research points to the complexity of understanding the impact of environmental education programs and illustrates a pressing need for more in-depth qualitative and quantitative studies of this issue.

In response both to these calls for more rigorous research and to the urgency of education reform, the Pacific Education Institute, a consortium of stakeholders interested in advancing student learning through curriculum designed around an environmental context, started a long-term research project which investigated the impact of EE on student achievement in Washington State. This consortium was initially called the Environmental Education Assessment Project and, in 2003, came under the umbrella of the Pacific Education Institute (PEI). Initially, the effort was co-sponsored by Project Learning Tree (PLT) and the Washington Forest Protection Association (WFPA), Project WILD and the Washington Department of Fish and Wildlife (WDFW), Project WET of the Washington State Department of Ecology (DOE), and the Washington State Office of the Superintendent of Public Instruction (OSPI). Today the participants in PEI now include additional representatives from the business community, non-profit education and environmental organizations, state agencies, national environmental education programs, residential environmental learning centers, school districts, and individual schools.

Since 2003, the Pacific Education Institute has conducted studies that explored the relationships between student achievement on the state tests and EE programs. The first study (Phase 1) compared the results of state standardized tests for 77 pairs of schools in Washington State: schools that have environmental programs and schools with traditional curriculum (Bartosh, Tudor, Taylor, & Ferguson, 2006). The Environmental Education Rubrics were used to select schools with well-developed environmental education programs for this study. Environmental Education Rubrics has been developed by representatives of several state agencies, business and educational organizations including the Washington Department of Fish and Wildlife, the Washington Forest Protection Association, the University of Washington, and the Evergreen State College. Using these EE Rubrics, it was possible to evaluate a school's activities in six areas:

- School commitment to integrate environmental education into the curriculum (measures number of years in EE, number of students and teachers participating in EE programs; frequency of EE programs or units);
- Curriculum development (evaluates how teachers design their curricula, whether they work alone or in a team, the type of curriculum and the links to natural environment);
- Instruction used in the classrooms (determines whether teachers work in teams integrating different subjects together);
- Student learning (evaluates the way students learn and whether they are encouraged to construct their own knowledge);
- Assessment (determines whether students have an opportunity to make presentations and assess their own learning or if they are assessed through more traditional assessments); and
- Community commitment (studies the ties between school curriculum and community).

Schools involved in the programs with environmental education were targeted initially and ranked on EE Rubrics in terms of level of involvement. The rankings were conducted by external EE providers and other EE and educational experts who work with the schools in Washington State and know how programs are implemented by the schools. For the study only the schools that have at least 3 years of practicing EE strategies and have 20% of teachers/classrooms and at least 33% of students involved have been selected as "environmental" schools. Table 1 presents characteristics of EE and comparison schools on the Rubric (Ferguson, Tudor, & Bartosh, 2005).

For each EE school a comparison school was identified using the US census and other economic, demographic, and geographic criteria. Pairs were selected in the same location and where possible in the same school district and had similar ethnic composition, size and the percentage of students receiving free/subsidized lunch. The study used Non-Equivalent Groups Design and instead of random assignment to control and treatment groups used economic, demographic, and geographic data to ensure comparability of the groups.

Table 1
Characteristics of EE & Comparison Schools On The EE Rubrics

	EE	Comparison
Extent of EE Implementation • # of years in EE • % of students involved • % of teachers /classrooms involved	• At least 3 years • 20% or more • 33% or more	• less than 3 years • less than 20% (or none at all) • less than 33% (or none at all)
Curriculum	• Integration around EE • Links to natural areas	• No integration around EE • Stand-alone EE activities or none at all
Instruction	• Team teaching	• Individual teaching OR no teaming OR teams are only forming
Assessment	• Best practices	• Traditional assessment practices
Student Learning	• Focus on activities allowing students to construct their own learning	• Traditional approach
Community	• Participation of community members in learning process	• Few community partners OR no participation of community members in learning process

Bartosh et. al.'s (2006) study showed that schools that undertake systemic environmental education programs consistently outperform "traditional" schools on state standardized tests in math, reading, writing, and listening. In 73 pairs (out of 77), environmental schools had higher scores in *at least* one subject. Furthermore, analysis of longitudinal data for the period of 1997-2002 showed that EE schools had higher mean percentages of students who met standards on the WASL every year. However, although the percentage of students who meet or are above standards on the state tests is higher for EE schools, the question remains what does it mean for individual students? Will we observe the same trend if we look at individual student scores? The second stage of the project presented in this paper explores that issue.

RESEARCH METHODOLOGY

Study Groups

Out of 77 pairs of schools participating in the first stage of the project, 10 schools were invited to participate in the second stage. Five of the selected schools had a long history of environmental education. The PEI staff have been working with the administrators and teachers of these schools for at least 5 years helping with development of programs and materials and providing professional development workshops. This close partnership allowed us to identify schools with exemplary environment based programs and collect information about school wide initiatives and individual classroom activities.

In the first phase of the research, administrators and teachers at participating schools and external experts familiar with school programs, activities and environment evaluated the schools' level of EE implementation using Environmental Education Rubric developed by PEI. Table 2 presents the comparison of scores on the EE Rubric for 5 pairs of schools selected for this second phase of the project and compares it to the scores of the 77 pairs of schools from the initial phase of the research. As seen from the table, the scores for the individual categories (implementation of EE programs, curriculum, instruction and assessment strategies, student learning and community involvement) are similar for the pairs of schools that participated in Phase 1 and Phase 2 of the study. The EE Rubric scores indicated that EE schools had higher level of EE implementation with more students and teachers being involved in environmental education for at least three years. Furthermore, curriculum of EE schools was integrated around environmental themes, had multiple links to outdoors and nature areas and was designed and delivered by teams of teachers. The Rubric also showed that the groups of schools were similar with regard to their assessment strategies and student learning approaches.

Table 2
Comparison of EE Rubric Scores for EE & Comparison Schools (Averages)

	Study of 77 Pairs of Schools (1 Phase)		Present Study of 10 Pairs of Schools (2 Phase)	
	EE	Comparison	EE	Comparison
Implementation	4	1	4	1
Curriculum	4	1	4	1
Instruction	4	2	4	2
Assessment	4	3	4	3
Student learning	4	3	4	3
Community Involvement	4	2	4	1
Total Rubric Score	24	12	24	11

Since for the second phase of the project, we have selected schools from the list of 77 pairs that participated in the first part of study, the selected EE and non-EE schools were similar in their demographic and economic criteria. Table 3 presents the comparison of the demographic and economic data for EE and non-EE schools.

Table 3
Demographic & Economic Comparison of EE & Non-EE Schools (Averages)

	Study of 77 Pairs of Schools (1 Phase)		Present Study of 10 Pairs of Schools (2 Phase)	
	EE	Comparison	EE	Comparison
School Size	550	547	656	610
Free /Reduced Lunch %	27	27	24	23
Ethnicity				
White %	84	80	81	79
Black %	4	4	5	8
Native Americans %	3	3	3	2
Asian %	7	7	7	8
Hispanic %	6	6	4	4

All participants of this study were students in the K-12 public school system in Grade 8 during the 2002-2003 school year. Between 30 and 50 students from each school participated. Students represented rural, suburban and urban populations as well as geographically diverse regions in Washington State. Grade 8 was selected for the testing because students at this level are tested in math, reading, writing, listening[1], and science.

Research Instruments

To explore if there is a difference in academic achievement of students in EE and non-EE schools, we used two measures: integrated EE-based assessments developed by the Pacific Education Institute and scores on the state standardized tests in math, reading, writing and listening.

[1] *Listening has not been tested on the WASL since 2004. Science was not tested the year this study was conducted.*

Integrated EE-Based Tests

To assess environmental literacy knowledge and skills, students from participating schools were given 3 integrated EE-based tasks, one in each of the three areas: inquiry, systems and civic participation. The Inquiry task assesses inquiry skills of students and their ability to design and describe steps of an inquiry process. Systems assessment focuses on students' understanding of environmental systems and the interplay between natural and social systems. Finally, the Civics assessment task evaluates students' civic participation skills that would allow them to play an effective citizenship role. The tests were developed by the Pacific Education Institute and refined from 1998 to 2003 (Taylor, Kurtz-Smith, Tudor, Ferguson, & Bartosh, 2005). These criterion referenced assessments are modeled on the Washington Assessment of Student Learning (WASL) test (standardized test in Washington State) in format and correlate with the state standards (Essential Academic Learning Requirements) which are consistent with and reflect National Standards. The WASL-like assessments integrate subject areas and allow assessment of student performance not only in environmental education but also in the process skills of language arts and mathematics and content knowledge of science and the social sciences (geography, civics, and economics). Each assessment has been pilot tested, and student work has been gathered to help ensure the validity of the tasks and the rubrics. The Office of Superintendent of Public Instruction (OSPI)'s personnel have worked with the assessments to ensure that the EE-based assessments remain close to the WASL tests in format.

Short-answer and extended (open-ended) response items of the EE WASL-like assessments were scored using rubrics similar to those used for the operational WASL assessments. They were scored by teachers trained to score standardized tests developed by NCS-Pearson, Washington State's scoring contractor. Three trained teachers (raters) scored each student's work, and the final student score was the average of the 3 raters' scores. If raters' item-level scores were discrepant by more than one point, a fourth rater scored student work to ensure accurate scores. Table 4 presents the number of students from both groups completed the tests.

Table 4
Number of Students in EE & Non-EE Programs Completing WASL-Like Tests

Task	Number of Students	
	EE program	Non-EE program
Inquiry	204	166
Systems	215	210
Civics	208	194

Information about Standardized Tests

The second measure of achievement used in this study was student achievement data for the Washington Assessment of Student Learning test. This criterion-referenced achievement test is designed to measure whether students are achieving the Washington State standards in reading, writing, listening, mathematics, and science. This data was obtained from the WA OSPI database.

FINDINGS

Reliability & Validity of WASL-like Tasks

To obtain evidence of the reliability of the EE WASL-like assessment scores, two types of data have been analyzed: inter-judge agreement data (to look at reliability of raters using rubrics) and internal consistency data. In most cases, exact agreements and exact plus adjacent rater agreements (which looked at the percent of times a pair of raters give the same score to the same students' responses) for all Grade 8 items were high (70% and 90% respectively) suggesting that rater agreement was acceptable. Table 5 presents the inter-judge agreement data for the WASL-like items.

Table 5

Agreement by Rater (R) Pairs for Grade 8 WASL-Like Tests

Test	Item	Points Possible	R1 & R2 Exact Agreement	R1 & R2 Exact + Adjacent Agreement	R1 & R3 Exact Agreement	R1 & R3 Exact + Adjacent Agreement	R2 & R3 Exact Agreement	R2 & R3 Exact + Adjacent Agreement
Inquiry	1	4	78.9%	98%	79.6%	99%	84.8%	~100%
Systems	1	4	72.5%	99%	70%	98%	75.3%	100%
	2	4	75.8%	98%	83.8%	97%	78.2%	97%
	3	4	68.5%	99%	78.1%	99%	69.2%	96%
	4	4	60.7%	89%	78.9%	97%	70.8%	90%
	5	4	61.7%	95%	77.4%	98%	64.7%	95%
Civics	1	4	75.7%	99%	76.3%	~100%	70.1%	~100%
	2	3	70.2%	~100%	74.7%	99%	74.4%	~100%
	3	4	66.7%	95%	66.9%	97%	63.5%	96%
	4	4	66.2%	97%	68.5%	95.8%	70.3%	98%
	5	4	77.4%	97%	65.2%	94%	69.2%	98%

Similarly, the correlation between the total scores (sum of the item scores) given by a pair of raters (which illustrates the degree to which students would earn the same total score if scored by different raters) was high (~0.9). Table 6 presents the correlations between raters' final scores for one of the WASL-like tests. The complete reliability and validity data is published in the Technical Report #7 by Taylor et. al. (2005), available for download through the PEI's website (www.pacificeducationinstitute.org).

Table 6

Rater Score Agreement for A WASL-Like Task: Pearson Correlation

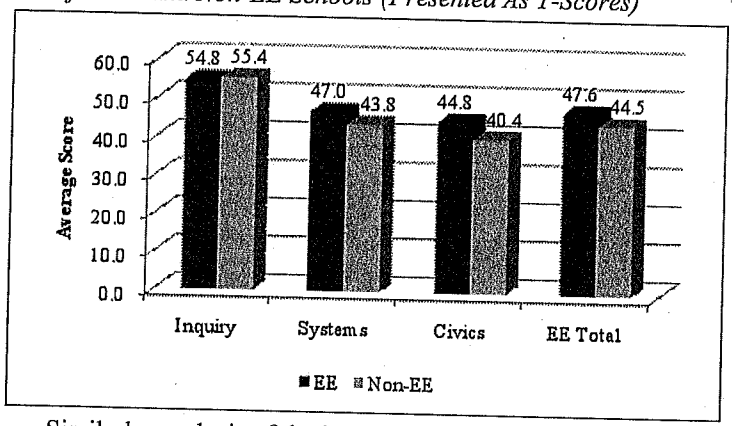
	Rater 1	Rater 2	Rater 3
Rater 1	1.000	.928	.883
Rater 2		1.000	.933
Rater 3			1.000

Comparison of State Test Scores & WASL-Like Scores For EE And Non-EE Students

To investigate the differences in achievement for students in integrated EE programs and non-EE classes, two sets of scores were analyzed: scores on the WASL standardized tests and scores on the PEI's WASL-like EE-based assessments. Figure 1 presents the comparison of average scores for students from EE and non-EE schools on the WASL-like tests. According to Individual Sample T-tests, students in EE schools tend to have higher scores on the Inquiry, System, and Civics WASL-like tests, and this difference was statically significant (p[inquiry] = 0.036; p[systems] = 0.001; and p[civics] = 0.000). This demonstrates that students in EE programs develop stronger environmental literacy skills and deeper understanding on environmental systems.

Figure 1

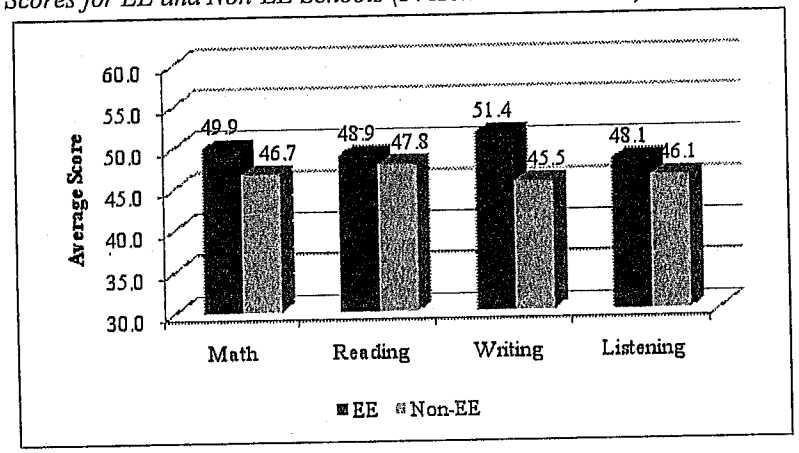
Middle School Comparison of Student Achievement on WASL-Like Tests for EE And Non-EE Schools (Presented As T-Scores)



Similarly, analysis of the individual students' WASL test scores in math, reading, writing, and listening indicated that on average students from EE schools have higher scores on the WASL tests. Figure 2 presents the comparison of average test scores on the WASL tests. However, statistically this difference is significant for two tests (out of four) – for math and writing. Although students from EE schools tend to outperform students from non-EE schools on reading and listening

tests on the WASL, there is no significant difference in these areas with p values higher than 0.05 (0.24 for reading and 0.11 for listening).

Figure 2
Middle School Comparison of Student Achievement on WASL Test Scores for EE and Non-EE Schools (Presented as T-scores)



Although statistical significance testing (the results of which are presented above) allows us to speculate about the possible effects of EE programs, it does not allow us to assess the magnitude of the observed effect. To explore the practical significance of our results and measure the magnitude of the treatment effect, the effect sizes were calculated as standardized difference between two means (Cohen's *d*) (Cohen, 1988; Hartung, Knapp & Sinha, 2008). Cohen considered *d* which is equal or smaller than .2 as small, *d* around .5 as medium, and *d* equal or larger than .8 as large effect size. Table 7 presents effect sizes for both EE tasks and WASL tests.

Table 7
Effect Sizes for Both EE Tasks & WASL tests

Subject Area	Effect Size (*d*)
WASL	
Math	0.3
Writing	0.8
Reading	0.2
Listening	0.2
EE-Based Tasks	
Inquiry	-0.1
Systems	0.4
Civics	0.5
Total EE Score	0.3

As seen from the table, the largest effect is observed in WASL writing and civics whereas inquiry, WASL reading and listening have small effect sizes that cannot be considered as practically significant. At the same time while the differences between EE and non-EE schools are not large, this finding has educational significance. Our study illustrates that students in EE programs can perform at least at the same level as students in non-EE classes and do well on the state tests, while learning things that go beyond the "three R" basics. EE students gain an understanding of environmental issues and concepts and develop skills that are crucial for our survival as a species in the age of current environmental crisis and degradation. They learn about natural systems and interactions of the environment and society, gain inquiry, problem solving and decision-making skills and develop an understanding of how they can participate in society as citizens. In other words, by doing environmental education teachers can help their students become better readers, writers and thinkers as well as develop awareness about environmental issues, sense of responsibility and care for the world and the environment.

DISCUSSION & CONCLUSIONS

This study illustrates what many EE practitioners and supporters have anecdotally known for a long time: students benefit from environmental education programs. Experiences outside the classroom with the opportunity to observe, explore, wonder, and engage students motivate students and improve their attitude to school and learning and, as a result, their achievement and grades. Programs that use the environment as a context for learning provide space and time for students to make connections between school learning and real life.

In this study, we compared two groups of students: students participating in school-based environmental programs and students from traditional classrooms. The schools differed by the level and extent of environmental education programs and were assessed by internal and external experts. While we did not randomly assign students to control and treatment groups, we used demographic, economic and geographic data to ensure the comparability of the groups. Furthermore, the 5 pairs of schools selected for the second phase of the project, were similar in demographic parameters and level of EE implementation (according to the EE Rubric scores) to the 77 pairs of schools that participated in the first study. Using these procedures we tried to control for some of the factors that may affect student achievement, such as school size and socio-economic status. Because of the design of this study and our extensive knowledge of schools and teachers who participated in this project, we believe that our study indicates a correlation between student achievement and environmental education programs. However, we acknowledge that

other factors (e.g. gender, parent educational background, internal and external motivations) may and often do influence student academic performance; and this study does not investigate the impact of those factors on student scores. Furthermore, as the purpose of this study was to explore if there was a difference in student scores on state and EE-based tests, the study does not analyze the specific reasons of why that difference occurs. To identify specific characteristics of EE programs that may lead to improved student test scores, there is a need for more in-depth research using qualitative and quantitative methods.

Overall, this study adds to the body of evidence that environmental education not only provides an opportunity to help students learn how to live sustainably but also helps schools to meet state standards and requirements. With the current focus on accountability and testing, studies like this support teachers who want to teach EE in their classrooms. Some educators critique these efforts of the EE community to find evidence of EE efficacy. Gruenewald (2004, p. 82) believes that they shift the priorities from transformation of the society, culture, and educational system to being able to "satisfy problematic state learning goals". At the same time, these so-called "legitimatization" efforts can be seen as first steps to transformation of the educational system. Elements of the educational culture (as well as system of schooling) are closely interconnected, and a serious change in one of them might lead to changes in the others (Hargreaves, 1994; Sarason, 1990). As such, changing teaching requirements and guidelines, adopting more EE-friendly administrative and educational policies, and providing teachers with more empirical evidence could be the first steps in this process of systemic change. Changes in cultural values and practices take years to happen. Teachers and administrators need research to support their instructional choices. The research presented here supports anecdotal evidence known by those who believe in the benefits of EE for their students and provides statistical evidence of the impact of environmental education on students. Through environmental education programs we can provide learners with a richer, more comprehensive experience that ties learning to the real world, advances thinking abilities and helps students to perform at high levels. Moreover, it allows us to educate citizens of the future who would have knowledge and skills to address the environmental problems the world is facing- the very skills and knowledge that we do want our children to know.

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