THE IMPACT OF ENVIRONMENTALLY-RELATED EDUCATION ON ACADEMIC ACHIEVEMENT

A Literature Survey

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Executive Summary

Introduction

Environmental education program providers are eager to help teachers incorporate environmental principles and experiences into their teaching. However teachers are faced with extremely crowded schedules, strict curriculum requirements, and intense pressure to improve academic achievement. K-12 environmental education will be valued more if it is perceived by teachers, administrators, parents, and community members as contributing to academic achievement for students. The purpose of this survey was to determine whether meaningful evidence exists that shows a connection between environmentally-based education programs and improvements in academic achievement. The project was undertaken in winter and spring of 2006, and was funded by StopWaste.Org.

The survey looked for English-language documents published between 1990 and 2006 that addressed the academic outcomes of environmentally-based, K-12 education programs. Sources included websites, online databases, university libraries, peer-reviewed dissertations, and references from persons and organizations concerned with environment, horticulture, science, and education.

Results of Literature Search

There is a large body of research, meta-analysis literature, and related articles and reports about a wide variety of environmentally-based programs studying specific learning outcomes. Approximately 200 documents were discovered that fulfilled one or more of the search terms. Further review identified 100 original research papers, literature compilations, and related articles to be analyzed. Upon closer analysis, some of these documents were determined to be non-relevant materials focused on non-academic outcomes or programs that took place outside of a K-12 educational context. Some documents provided interesting meta-analyses of combined research or were descriptive articles.

A total of 24 documents contained comparable, original research data that could be used for analysis. The research documents selected for analysis focused on:

- Studies with comparable quantitative data measuring change in traditional curriculum subjects
- Or quantitative data for related outcomes that might contribute to academic achievement

Analysis of Original Research

The collective research studied a range of environmentally-related programs in schools across the U.S. and in widely different student populations (urban to rural, affluent to underserved, diverse to homogeneous). Studies were found investigating specific curriculum initiatives as well as more immersive or integrated approaches, in grades ranging from elementary to high school. Studies looked at variety of quantitative and qualitative data.

The analysis of original research documents used seven criteria: two relevance criteria to determine alignment with survey goals and five research quality criteria to determine the strength of the research. The quality criteria were informed by the Education Science Reform Act of 2002 (see Appendix G) and the work of the Department of Education and other groups to improve the quality of educational research. Applying the quality criteria to the existing body of research revealed widespread methodological flaws. Since the federal guidelines are relatively new, and the range of studies provides interesting insights into different aspects of EE programs and research approaches, this survey includes studies that cover a range of relevance and conclusiveness.

Collective Evidence of Academic Outcomes

The eight strongest studies addressed all of the criteria used for analysis. Four studies actually did statistical significance tests, meeting the more rigorous requirements for possible evidence by eliminating chance results. The other four strongest studies provided suggestive evidence because their results were still likely to be significant due to the size of the populations and outcomes reported.

These studies focused on programs that were generally longer, integrated curriculum approaches that studied natural environmental areas regularly and used a range of best educational practices. The research showed a variety of results across the targeted subject areas, with significantly positive outcomes in general:

Summary of Strongest Research

Curriculum Subject Area	Possible Evidence	Suggestive Evidence
Writing/Language Arts	**2 of 2 studies positive**	2 of 2 studies positive
Reading	**2 of 3 studies positive,** **1 of 3 studies slight negative**	1 of 1 studies positive
Math	**3 of 3 studies positive**	3 of 4 studies positive 1 of 4 studies negative
Science	**1 of 1 studies no impact**	3 of 3 studies positive
Social Studies		2 of 2 studies positive

These results show meaningful evidence of positive impacts on academic achievement across many curriculum subjects as a result of environmentally-related programs using best educational practices. Results of the less definitive studies also showed positive outcomes, although the methodological shortcomings of these ten studies in terms of the guidelines for evidence indicate that their conclusions may be erroneous. Nonetheless, the continuing positive trend in these documents lends support to the overall picture.

Research showing possible evidence of academic achievement tends to study results in terms of standardized tests, the most widely established measure of academic outcomes. However, some educators and researchers question whether these tests are reliable indicators of either achievement or ability to achieve. The results of the remaining research pieces showed positive impacts on a broader set of outcomes that might contribute to academic gains, including attendance, behavior, and a range of skills from critical thinking to collaboration. While not analyzed in terms of their research quality, these studies are included in the report to illustrate the interest in and need for a deeper understanding of how to measure impacts on academic achievement and contributing behaviors and skills.

Association with Particular Characteristics and Practices

This cumulative positive trend does not necessarily mean that all environmentally-related teaching experiences will have a positive impact on academic achievement. The results show strong correlation with many different educational best practices, revealing the complexity of proving a causal relationship for any overall approach involving multiple factors.

The one exceptionally strong study that looked at a broader set of data to isolate causal relationships did find that the environmental nature of the experience was a significant factor in the positive academic outcomes measured. Additionally, all of the programs showing strong results used natural environments regularly. Some other teaching practices that were more frequently associated with

suggestive results in this analysis include: project-based, interdisciplinary teaching that uses learner-centered, constructivist methods in both cooperative and independent experiences. Some teacher support practices, including training, curriculum, collaborative planning and teaching, and facilitating community involvement, were also commonly mentioned in strong research descriptions.

Findings and Implications

Based on the literature surveyed here, there are four main findings:

- There is meaningful evidence that environmentally-related education, using best educational practices, can increase academic achievement across curriculum subjects.
- Study of natural environments can be a significant factor in academic achievement gains
- Certain teaching practices and teaching support in EE programs appear to strengthen academic outcomes
- More and better research is needed to reach conclusive results and verify the most important practices and support.

The results of this literature analysis can be used to build the capacity of the environmental education community both to reach K-12 students and provide stronger support for academic achievement. The survey indicates that the study of natural areas combined with best teaching practices and teaching support can improve academic performance. The challenge to us all – community, businesses, school districts, EE providers and classroom educators – is to make use of that potential for our students by: 1) using best teaching practices and support, 2) reaching more students, and 3) building our understanding of the important factors that produce academic achievement. The literature analysis suggests a variety of actions that could be taken in these three areas. These actions are summarized briefly below and explained more fully in "Findings", Section IV of the report.

Strengthening EE's Contribution to Academic Achievement

The EE community can strengthen the academic contributions of their programs in several ways:

- Follow current educational research and incorporate best practices where possible:
  - use of natural environments for longer, interdisciplinary teaching
  - cooperative, project-based learning
  - inquiry-based, learner-centered teaching

- Extend the contribution of shorter programs with teacher-based extensions that use best practices, links to other EE programs, and involving the community

Reaching More Students

More students need access to this potential for academic improvement. A key proposition of this study is that research-based results can help influence school decision-makers about incorporating EE programs and curriculum. Suggestions for reaching more students include:

- Build community awareness and confidence in connections between EE, best practices, and achievement by sharing credible research and evaluation that meets federal guidelines
- Develop program descriptions that focus on academic outcomes that are important to educators and show credible relationships between program practices and these outcomes.

- Make it easier for schools and educators to use EE programs with research-based teacher support, flexibility in program design, and response to previously identified barriers to EE (confidence, funding, administrative support, materials)

Using Research and Evaluation to Expand EE's Potential

In addition to programmatic implications, this study also points to the need for additional research that investigates further questions in depth, while improving the quality of research and evaluation methods in response to guidelines from the Department of Education and other agencies. It will be important for the field to improve both the relevance (what is studied) and the significance (methodologies applied) of EE studies. In addition, the community in general, and educators in particular, must improve their ability to use research results effectively.

- Deepen understanding of links between EE, specific practices and academic achievement
  - Do more evaluation and research causal relationships
  - Programs and administrators must work together to evaluate academic as well as other outcomes of environmentally-based education.
  - Develop broader range of accepted tools to measure academic achievement and skills.

- Contributions to relevance include studies that:
  - Select outcomes to study based on information needs
  - Address factors that might affect outcomes to reduce error and identify strong practices
  - Choose appropriate data collection tools, using accepted, standardized instruments where possible.
  - Study impacts of shorter-term interventions and sustainability of results

- The significance of studies may be improved by consulting education research guidelines (Appendix G), and incorporating:
  - Carefully matched test and control groups, studied over time
  - Extended length and/or breadth of studies to allow for statistical analysis
  - Isolation of specific variables (program experiences or characteristics) for targeted testing, including baseline conditions of study population
  - Complete descriptions of research methods and conditions, including characteristics of test and control groups, differences between test and control teaching experiences

In order to develop a basis for specific, targeted research, it would appear to be most beneficial for EE programs to consider developing partnerships with specific programs or schools in order to test longer interactions over time and in the context of a range of environmental and/or academic goals.

LITERATURE SURVEY ON THE IMPACT OF ENVIRONMENTAL EDUCATION ON ACADEMIC ACHIEVEMENT

SECTION I: PURPOSE AND PROCESS

Purpose and Critical Definitions

In the face of continuing efforts to reach basic curriculum goals for public school students, the ability to support academic achievement, as well as accomplishing the goals of environmental education, is an important part of gaining access to public schools. Many individual studies have been undertaken by individual programs, environmental education organizations, school reform initiatives, and educational institutions to look at the outcomes of different programs related to the environment in some way. In addition to documenting support for main curriculum goals, looking at the outcomes, best practices, and research approaches in these research projects can improve the practice of environmental education.

Community Resources for Science (CRS) was asked by StopWaste.Org to complete a literature survey of research that attempted to measure the impact of environmental education on academic achievement. The purpose of this survey was to determine whether there was sound evidence that environmental education could support academic curriculum goals and to identify program trends that could inform the environmental education programs in Alameda County. CRS undertook this work in a three step process:

1) Collecting a broad group of research results that study the connections between environmental experiences and academic achievement;
2) Reviewing the research for both relevance and quality; and
3) Analyzing the outcomes in order to provide recommendations for ongoing programs and to support opportunities for further research or analysis.

The search was conducted on literature published in the English language from 1990 to the present. Search parameters were defined quite strongly in terms of the academic experience: studies were selected about environmental education experiences offered to K-12 students during the school day. Academic achievement was also defined strictly in terms of measurable change in test scores in curriculum subject areas (i.e. math, language arts, social studies, science).

By contrast, environmental education (EE) was defined quite broadly to include: environmental education, place-based education, environment as an integrating context for overall education, garden-based education, and other outdoor experiential or hands-on education. Because these terms are often used interchangeably, but have distinct meanings for people in the field, it is worth taking the time to describe their unique characteristics.

Environmental Education: During the 1970's two different United Nations conferences held in Belgrade, Serbia, and Tbilisi, Republic of Georgia, defined EE as a learning process that:

- Increases people's knowledge and awareness of the environment and associated challenges.
- Develops the necessary skills and expertise to address the challenges.
- Fosters attitudes, motivations, and commitments to make informed decisions and take responsible action.

The National Project for Excellence in Environmental Education, an initiative of the North American Association for Environmental Education (*www.naaee.org*), defined the overall educational goal of environmental literacy in terms of four facets:

- Personal and civic responsibility.
- Knowledge of environmental processes and systems.
- Skills for understanding and addressing environmental issues.
- Questioning and analysis skills.

By these definitions, EE is focused on building knowledge, skills and attitudes that will lead to responsible action. EE is delivered in a variety of formats and specific focuses by both informal education programs and classroom teachers. Writing about best practices in environmental education brings in ideas of different teaching approaches or pedagogies such as using outdoor settings, focusing on issues relevant to the learner, inquiry-based experiences, interdisciplinary skills, and supporting standards-based curriculum. (Archie, 2001) (The National Environmental Education Advisory Council, 2005)

Environment as an Integrating Context (EIC): Attention to pedagogy and an increased focus on academic outcomes possible through study of the environment has come to the forefront for some researchers and practitioners. Using the Environment as an Integrating Context for learning (EIC) is a term coined by the State Education and Environment Roundtable. As defined in SEER publications, EIC-based learning is "not primarily focused on learning about the environment, nor is it limited to developing environmental awareness." (Lieberman and Hoody, 1998) EIC uses natural and community settings to engage students while applying some fundamental educational strategies: interdisciplinary instruction, hands-on experiences combined with problem solving and project-based activities, a team teaching approach, student-centered, constructivist methods that adapt to individual student skills and abilities, and a combination of independent and cooperative learning experiences.

School Gardening/Schoolyard Habitat Projects: The School Gardening movement is an outgrowth of EE, encouraging teachers in urban schools to develop an outdoor classroom within school grounds as a setting for learning across the curriculum while building student awareness and stewardship of the natural world. More than 1,000 schools nationwide have joined the Garden in Every School Registry maintained by the National Gardening Association. Another 1,100 schools have launched Schoolyard Habitat projects, organized by the National Wildlife Federation. (Boss, 2001)

Place-Based Education: Place-Based Education is a newer term that encompasses EE in a similar fashion to EIC. It includes investigation of surrounding bioregions, concern for the local human and natural environment, and may consider the geography, ecology, sociology, politics and other dynamics of a region. Place-Based Education is experiential and multidisciplinary. (Woodhouse & Clifford, 2000)

Experiential/Project-Based Learning: These terms describe teaching strategies that range from individual hands-on activities to long-term, cross-curriculum projects addressing specific questions or issues. Project-based learning often uses the environment or local issues to engage students, but is not restricted to outdoor settings or environmental topics. It is a strong teaching technique with an issue-based, inquiry-based, and interdisciplinary approach similar to the pedagogies used in place-based education and EIC programs.

Search Methods

The literature search looked first for any abstracts, articles, dissertations, reports, and other documents reporting original research on the relationship of school day environmentally-based education practices to academic achievement in curriculum subject areas. This research also incidentally produced a second group of studies focused on outcomes that might contribute to academic achievement, such as building a willingness to learn or critical thinking skills.

References were obtained from websites, online databases, university libraries resources, and from persons and organizations concerned with environment, horticulture, science, and education. Databases included:

- Dissertation Abstracts (Index to Theses, WorldCat, and ProQuest Digital Dissertations)
- Education Full Text (Wilson Web)
- Educational Resource Abstracts/ Taylor & Francis Online Journals
- ERIC- Education Resources Information Center
- HighBeam Research

Search words used included "environmental education", "outdoor education", "place-based education", "school gardening", and "project-based learning", combined with "achievement" and/or "evaluation". Published journal articles that are not currently available in electronic form were researched through the Biological Sciences Library at the University of California, Berkeley. Personal requests for references were made to people and organizations involved in environmental education both locally and nationally.

Analysis Process

Selecting Documents for Review

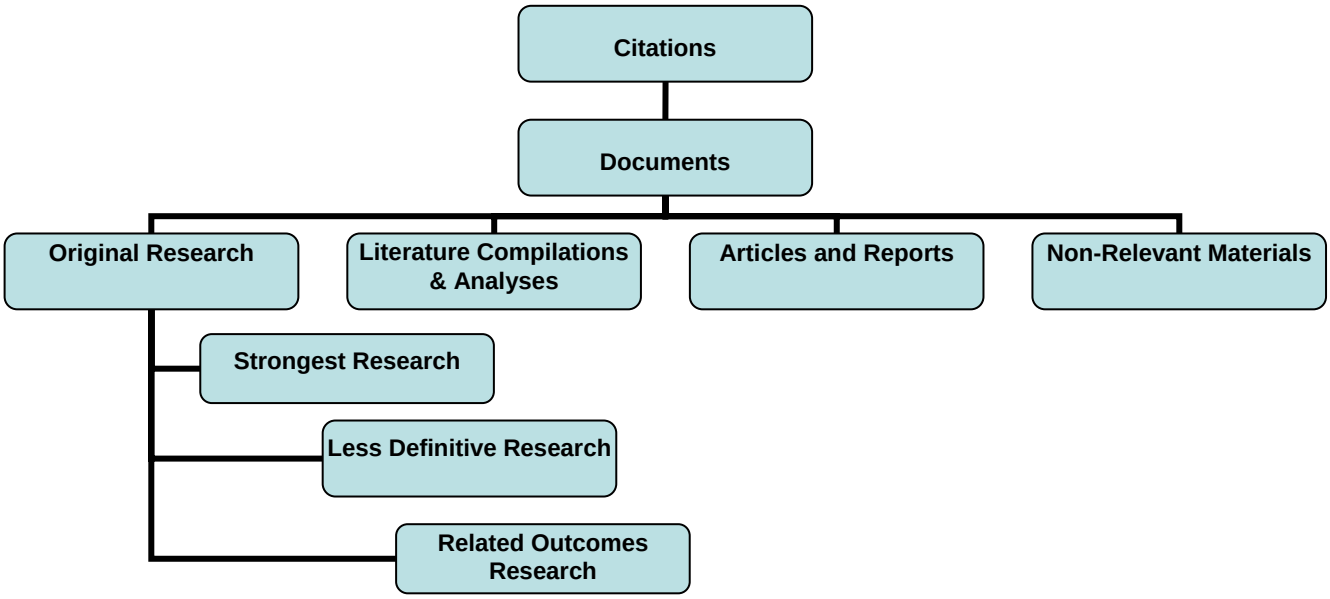
Approximately 200 citations were collected in an initial search, and 100 documents were selected as potentially relevant for review. These documents were initially sorted into four groups: 1) original research, 2) literature compilations and analyses, 3) related articles, and 4) unrelated materials. All of the documents reviewed are listed in the complete bibliography to provide context for the results.

Original research consists of analytical studies that connect environmental experiences and academic achievement. These studies are the primary focus of this survey, and are further divided into categories of "strongest research", "less definitive research", and "related academic outcomes research", based on review criteria for both relevance and quality.

Literature compilations and analyses were used primarily as resources for references to original research documents, since methods and focus in these overview documents varied widely from our search parameters and research guidelines. Meta-analyses and overviews were also used for insight into trends and practices in environmental education.

Articles and reports provide additional context for the results of the survey, but do not provide specific results or analysis.

Non-relevant materials were focused on non-academic outcomes, after-school or summer programs, or were otherwise unrelated to the search parameters.



Review Criteria for Original Research

The original research documents discovered by the survey were reviewed to sort the studies into the three research categories shown in the diagram above. Review criteria were developed to look at both the *relevance* of the study to the search directives and the *quality* or strength of the research results.

In order to look at the evidence related to support for academic achievement through the same lens as educators and administrators making decisions about environmental education, the review focused on *two relevance criteria:*

1. Studies of changes in academic achievement as measured by widely-used standardized tests in core curriculum areas: writing, reading, math, science, or social studies.
2. Studies of programs that were delivered as part of a K-12 school program.

Any documents, including research, which did not meet the relevance criteria were added to non-relevant materials.

The *quality criteria* were guided on the standards for evidence-based research listed in H.R. 3801, the Education Sciences Reform Act of 2002 (Appendix G). The U.S. Department of Education, the Institute of Education Sciences, The National Center for Education Evaluation and Regional Assistance, and the National Science Foundation have all been involved in efforts to clarify how to use scientifically-based research methods to improve education research and practice. The key idea is to be able to identify clear causal relationships using methods of data collection and analysis that can be understood by peers and outside experts. The *five quality criteria* used in this literature review were developed from a combination of the original legal language in H.R. 3801 and the work of these agencies:

1. Research used randomized control or other technique to avoid group bias
2. Peer-reviewed report contains description of intervention and participants
3. Study included at least 300 students or 50 classrooms/schools
4. Study used valid outcome measures related to conclusions (standardized tests)
5. Study performed statistical tests on significance of impact measured (size/chance of impact)

There are two practices in these criteria, randomized control studies and statistical analysis, which are often missing in educational research and had to be more carefully considered in this survey.

Randomized control studies are studies that randomly assign individuals to an intervention group or control group in order to measure effects of an intervention. In the studies reviewed in the literature search, two principal techniques were used to address the requirement for randomized control trials: large scale studies of relative performance change over time within test and control populations with acknowledged differences (achievement gap analysis), or direct comparisons of performance between EE student test groups and closely matched non-EE student groups. The best research of this latter type made strenuous efforts to ensure comparability of test and control groups through correlation with demographics, past test scores, location, and socio-economics factors. However, it is important to note that results from matched comparison studies can differ widely (and even contradict) results with randomized controls. Because of the strong effect of self-selection in education programs, outcomes are often less convincing from a scientific perspective.

Statistical analysis is used to determine whether results are "significant" rather than the result of chance or random variation. The best studies reviewed in this survey applied statistical tests and/or regression analysis to look at the size of the impact in context, eliminating chance and sometimes identifying other statistical correlations that indicated stronger explanations. It is important to point out that some researchers noted that their efforts to secure funding to do the additional statistical analyses on initial results were not successful.

Applying the quality criteria to the existing body of research revealed that there are few studies in environmentally-related education that use either randomized control trials or statistical analysis to evaluate the significance of the impact of EE experiences. Rather than eliminate interesting studies that did not completely meet the standard, we used our relevance and quality factors as guidelines to help us create three groups for analysis: 1) strongest research, 2) less definitive research , and 3) related outcomes research. Relevant research documents that contained missing, non-quantitative, or non-comparable data were considered non-comparable research and were included in the report as related articles and reports.

The strongest research includes the studies that came closest to the seven listed review criteria, with at least partially positive answers to all of the seven review criteria.

Most of the less definitive research had one or more of the following flaws:

- Measured only a subsection of academic curriculum or particular skill
- Focused on a small study populations (fewer than 300 test subjects)
- Had limited description of intervention or participants, and/or
- Used a unique or non-standardized test to gather data

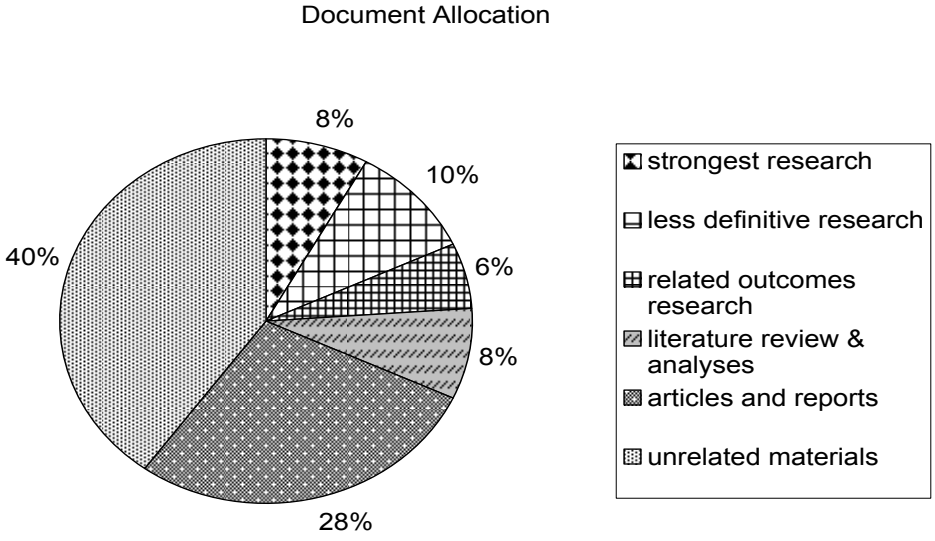
The related outcome research is comprised of studies that were discovered while searching for studies on environmentally-based programs' impacts on academic outcomes in specific curriculum areas. These studies focus on outcomes in related areas that might be contributing factors to academic success such as willingness to learn or attendance. It is important to note that since these contributing factors were not the main focus of this survey, the included list is not comprehensive in this category. This research was summarized, but not used in the findings, since the actual academic outcomes are not measured.

SECTION II: RESULTS OF LITERATURE SEARCH

Literature Search Results

Document Allocation

Using the criteria described above, a total of 86 of the 100 documents were analyzed to inform our conclusions. The remaining 14 were found to be unrelated materials. The 24 pieces of original research were reviewed using the criteria described in the previous section. Of the 24, eight studies fell into the strongest research category, providing meaningful results about the academic outcomes of environmentally related education. These studies are described briefly in this section and in more detail in Appendix A. A total of ten studies were determined to be less definitive when compared to the review criteria and six concentrated primarily on other outcomes that might have an impact on academic achievement (such as motivation to learn, or critical thinking skills, or attitudes toward science). An overview of the less definitive research and related outcomes research is included below and the studies are summarized in Appendices B and C respectively. The 35 remaining research documents did not provide comparable data, lacking the descriptions and/or data necessary for analysis. These documents are included in the bibliography as background.



The rest of the documents reviewed in the literature search are described in Appendix D: Literature Compilations and Analyses, and Appendix E: Articles and Reports. These documents summarized and interpreted original research documents for a variety of different outcomes and with varying levels of research rigor. While for the purposes of this survey these studies were used primarily as references to find existing research, they are included here for background and different insights into research needs and best practices. Some organizations and people who provided useful reference points in the environmental education field are listed in Appendix F: Organizations and People.

Survey Summary

The strong message from the breadth of studies discovered by the search is that there are widespread efforts at making strong connections between environmental education and academic achievement. From the smallest evaluation study to the most comprehensive and longitudinal research, investigators are working to establish causal relationships and to understand factors for "successful" in-school environmental education. Studies were found from states across the U.S., investigating specific curriculum initiatives as well as more immersive or integrated approaches, in grades ranging from elementary to high school, and in students of diverse populations from a range of socio-economic backgrounds. Moreover, the focus of this literature survey on K-12 in-school programs and academic outcomes related to standardized tests limits the results within a much larger field. Almost all the studies collected for this survey show positive connections, leading readers to conclude that EE may provide a powerful vehicle for improving academic achievement.

However, despite the substantial number of studies making positive connections between EE and academic achievement, this survey also points to methodological shortcomings in many of the studies that make the conclusions less substantive. As noted in a report to Congress on the Status of Environmental Education in the United States, "a significant body of research exists on various aspects of environmental education, including: the effectiveness of environmental education in improving student achievement and meeting education reform goals. The scope of this research, however, tends to be limited (particularly in terms of focus, methodology, geography, and populations), leaving gaps in what is truly known about the field." (NAAEE, 2005)

Overview of Strongest Research

The survey found eight research documents that at least partially met all seven of the relevance and quality criteria. These studies ranged from a curriculum-based program lasting less than a year for one grade level to long-term studies of K-12 schools using the environment as a vehicle for integrated, project-based teaching. These projects encompassed a wide variety of teaching practices and teacher support techniques and used different methodologies to measure their results. An overview of the strongest research projects is provided in Table 1: Overview of Strongest Research. The table lists the research author and title and describes the participants, program being studied, and research quality in relation to the quality criteria.

Of these eight, four studies performed the statistical analysis necessary to show "possible evidence" that their results are significant: Bartosh 2003, Clavijo 2002, Danforth 2005, and Lieberman et. al 2005. Statistical analysis is a key part of the scientific research guidelines outlined by the U.S. Department of Education based on the Education Science Reform Act of 2002. The other four (Emekauwa 2004-AK, Emekauwa 2004-LA, Lieberman et. al. 2000, and Sterbinsky 2002) contain methods that could lead to erroneous conclusions, but are still strong enough to provide "suggestive" results.

The studies showed meaningful, predominantly positive academic outcomes related to the environmentally-based programs that they studied as shown in Table 2: Academic Outcomes Measured in Strongest Research. The particular curriculum areas measured varied in terms of the goals of the program and the particular test instrument used.

Table 1: Overview of Strongest Research

[Research producing possible evidence that meets survey criteria or suggestive evidence]

Research Author	Participants/ Age Tested	Program Experience	Research Methodology and Strength
Bartosh 2003 *Environmental Education: Improving Student Achievement*	K-12, Washington 77 paired EE and non-EE schools, 700 students/school 47 elementary schools 21 middle schools 9 high school 5 years multiple curriculum test data over multiple grades	▪ Environment-based 5 yr programs, with > 20% of teachers ▪ Receive EE more than 33% of year, and regular use of natural areas ▪ Variable integration ▪ Project-based, constructivist, inquiry, cooperative/indep ▪ EE training, collaborative planning Community support	**Possible Evidence** 5 years quantitative test data from two statewide annual tests over very large group of carefully matched pairs. Statistical and longitudinal tests showed significant results. Extended analysis of extensive qualitative data showed clearer causal relationships with broad range of factors.
Clavijo 2002 *The Impact of Environmental Education of 6th Grade Science Achievement*	K-6, Kentucky 4 elementary, 3 middle schools Testing 5th & 6th grade science performance of students in EE and non-EE schools;	▪ Environment as a context for science learning ▪ At least 2 years experience, regular use natural areas ▪ Project-based, inquiry, and problem solving ▪ Focus on local issues ▪ Broad support in school	**Possible Evidence** Analyzed change in science scores compared with previous performance of same students in 4th grade. While test did not eliminate all factors with randomization, some contributing factors were addressed in analysis and matching, including earlier science knowledge and socio-economic status. Applied statistical tests for significance.
Danforth 2005 *An Evaluation of NWL's Schoolyard Habitat Program-Houston*	4th grade, Houston. 3 paired elementary schools; matched by demographics 306 students in Schoolyard Habitat Program 108 students traditional Testing 4th grade reading and math performance on statewide tests.	▪ EE elementary class program ▪ Less than one year, based on outdoor study ▪ Variable integration, stronger math connection ▪ Project-based, problem solving ▪ Local habitat improvement ▪ Curriculum and training	**Possible Evidence** Measured relative changes between students' 3rd and 4th grade data in matched school pairs. Study used data from pretest, posttest, statewide achievement tests, and attendance records. While pair matching may introduce some error, statistical analysis demonstrated that results were significant.
Emekauwa 2004. *The Star with My Name - Alaska*	K-12, Alaska 18,982 students in 176 schools, 90% of state's native Alaskan students Testing math performance at 8th, 10th, 11th grade compared to 28 other non-AKSRI rural schools and total Native Alaskan student population	▪ Place-based, systemic initiative, 10 years ▪ regularly studied environment ▪ Integration with emphasis on cultural and scientific subjects ▪ Inquiry-based, project-based, career & role models ▪ Culturally relevant, strong community involvement, collaborative teaching ▪ Curriculum development and training	**Suggestive Evidence** Comparing relative change in math performance between targeted test group and other rural schools and total Native Alaskan student population (gap analysis). Although no statistical analysis and some possibility of method error, the large population in the study, the focus on changes within populations, and size of the increases sustained over time suggest that results are significant.

Research Author	Participants/ Age Tested	Program Experience	Research Methodology and Strength
Emekauwa 2004 *They Remember What They Touch - LA*	K-8, Louisiana 2000 students, in 5 middle or elementary schools Testing 4th grade math, science, social studies performance	▪ Place-based, 3 year, systemic program ▪ Study of local natural areas ▪ Variable integration across subject, starting in math and science ▪ Hands-on, small projects ▪ Local place connection ▪ Training, modeling, mentoring for teachers	**Suggestive Evidence** Study compared changes in % of students with unsatisfactory performance over 3 years with state-wide changes (gap analysis). Although no statistical analysis and some possibility of method error, the large population in the study, the focus on changes within populations, and size of the increases sustained over time give strong indications that the results are significant.
Lieberman, Hoody & Lieberman, 2000 *CA Student Assessment Project*	K-12, California 8 paired programs or schools classes Tested at 3 successive years in different grades depending on school; multiple curriculums with variety of tests	▪ EIC school or class programs, at least 3 year ▪ Regularly study local environment ▪ Varying curriculum and integration ▪ Project- and issue-based, constructivist, cooperative/independent ▪ Collaborative teaching	**Suggestive Evidence** Compared performance of matched pairs on variety of standardized and non-standardized tests over a three-year period, totaling times EIC outperformed traditional programs. Analytical approach and lack of statistical analysis make significance of results less certain, but still suggestive.
Lieberman, Hoody & Lieberman, 2005 EE student achievement	K-5, California 3500+ students in 4 paired k-5 schools Tested a total of 20 times for multiple curriculum areas over 5 years at grades 2, 3, 4	▪ EIC school programs, at least 5 years ▪ Regularly study local environment ▪ Varying integrated curriculum ▪ Project- and issue-based, constructivist, cooperative/independent Collaborative teaching, authentic assessment	**Possible Evidence** Compared performance of API matched pairs on standardized tests over a five-year period, totaling # of times EIC students scored significantly higher based on statistical analysis. Collected qualitative data to compare instructional practices.
Sterbinsky 2002 Rocky Mtn Expeditionary School	3-12, Colorado 300+ students self-selected for EE compared with adjusted test scores in feeder schools. 54 test results for 3rd through 10th grade with state standardized tests for multiple curriculum areas over 5 year period	▪ Outdoor Learning program, long term, multiple years ▪ Routinely study natural environment ▪ Integrated curriculum ▪ Project-based	**Suggestive Evidence** Compared scores on state achievement tests of RMSEL students with scores of weighted control group to adjust for differences in RMSEL and feeder group student populations in terms of previous achievement. Although analytical approach and lack of statistical analysis make significance uncertain, results are suggestive due to size of group and sustained results.

Table 2: Academic Outcomes in Strongest Research

Possible Evidence from Strongest Research						
Research Author	**Writing**	**Reading**	**Math**	**Science**	**Social Studies**	**Summary Results**
Bartosh 2003	Positive EE schools *significantly* better than paired school in 56 of 77 pairs	Positive EE schools *significantly* better than paired school in 51 of 77 pairs	Positive EE schools *significantly* better than paired school in 50 of 77 pairs			EE outperformed non-EE in math, reading, writing, listening in one test; and math and reading on 2nd test.
Clavijo 2002				No Impact No correlation with any difference in science achievement		No correlation with EE. Earlier science knowledge and socio-economic status were significant predictors in later performance in science.
Danforth 2005		Negative Overall drop in test and control groups, but slight added negative correlation for tested environ program.	Positive Significant gain when compared to students in traditional program			Negative results in reading for all with slight negative impact correlation demonstrated for total test group* Significant, positive improvement in math scores. **some indication of slight positive impact for African American students, but significance unclear.*
Lieberman Hoody & Lieberman2 005	Positive EIC groups significantly higher in 40% of tests, while control only scored significantly higher in 5% of tests.	Positive EIC groups significantly higher in 46% of reading tests, while control only scored significantly higher in 0% of tests.	Positive EIC groups significantly higher in 48% of math tests, while control only scored significantly higher in 8% of tests.			EIC students scored significantly higher on more state tests in math, reading and writing.
Suggestive Evidence from Strongest Research						
Emekauwa 2004. *The Star with My Name - Alaska*			Positive significantly closed gap in top math performance vs. other rural schools and whole native population *(11.7% to .8%*			Over 7 years AKRSI schools had large net gain over non-AKRSI rural schools in the percentage of 8th graders scoring in the upper quartile on math Also outperformed state's Alaska Native population as a whole.

Suggestive Evidence continued						
Research Author	**Writing**	**Reading**	**Math**	**Science**	**Social Studies**	**Summary Results**
Emekauwa 2004 *They Remember What They Touch - LA*			Positive High relative decrease in unsatisfactory performance in math vs. state-wide scores. *14.1 pt decrease vs. 3.6 pt drop state-wide*	Positive High relative decrease in unsatisfactory performance in science vs. state-wide scores. *8.1 pt decrease vs. 3.7 drop state-wide*	Positive High relative decrease in unsatisfactory performance in science vs. state-wide scores. *11.3 pt decrease vs. 3.2 pt drop state-wide*	Over 3 year program, test schools in parish had at least double the statewide decrease in percentage of 4th grade students scoring unsatisfactory on state tests in math, science and social studies.
LiebermanHoody & Lieberman2000 *CA Student Assessment Project*	Positive EIC schools outperformed traditional paired group in 69 of 71 language arts assessments (76%) (Mix of standardized and non-standardized)	See writing.	Positive EIC schools outperformed traditional paired group in 17 of 27 math assessments (63%) (Mix of standardized and non-standardized)	Positive EIC schools outperformed traditional paired group in 7 of 11 science assessments (64%) (Mix of standardized and non-standardized)	Positive EIC schools outperformed traditional paired group in 8 of 11 social studies assessments (73%) (Mix of standardized and non-standardized)	Positive results in language arts, math, science and social studies.
Sterbinsky 2002 Rocky Mtn Expeditionary School	Positive	Positive	Negative RMSEL test group did less well than traditional schools in math.	Positive		RMSEL students do slightly better than the comparison group in reading, writing, and science, RMSEL test group did less well than traditional schools in math.

Only two of the strongest research studies, Bartosh 2003 and Clavijo 2002, extended their analysis beyond the statistical significance of the environmental experience to look at other factors that might have influenced the outcomes. Clavijo, 2002, found that previous scientific knowledge as measured by previous test scores of the same students and socio-economic factors had a more significant impact on academic gains than the program experience.

Bartosh did a full statistical analysis on an extensive set of quantitative and qualitative data for 77 carefully matched pairs of schools in Washington State, including five years of standardized test data. Bartosh went on to analyze the similarities and differences between the school pairs in order to identify critical differences that might be related to the positive outcomes measured. In summary, the strongest causal factors for the better performance of the EE schools appeared to be the environmental aspect of the experience, the specific EE training for teachers, and a belief that the chosen teaching approach was valuable by the teachers, administrators, and community.

Bartosh's longitudinal analysis also indicated that the scores for both EE and control schools were rising over time, showing the positive impact of some shared factors. The analysis of qualitative data showed that the test and control school were similar in terms of their: student and teacher characteristics, teaching and planning practices, and policies and needs that affected the practice of EE in the classroom. The similarities in some key teaching practices such as amounts of integrated teaching, collaborative planning and teaching, and project-based and constructivist approaches, may account for the parallel increases in academic outcomes for both the test and control groups.

Overview of Less Definitive Research

The ten studies that fell into the category of less convincing research on academic achievement are summarized in Appendix B. The significance of these studies is limited by research methodology, insufficient background information on the experiences or groups tested, or size of the study sample. As shown in Table 3 below, all of these studies assert that different kinds of environmentally-related experiences can have a positive impact on academic achievement in core curriculum areas. Six of the ten studies are longer-term programs and four are shorter units lasting three months or less. There are a variety of program descriptions, but the uneven program information in these reports makes comparison of pedagogical practices difficult. However, nine of the ten studies mention hands-on or project-based experiences and four refer to EIC or integrated curriculum approaches. Seven of the ten studies involve learning in natural settings.

Table 3: Overview of Less Definitive Research

Author, year	Type program	Size of test group/age	Impact on Academic Achievement
Abrams, 1999	3 yr variable hands-on experiences & integration, EE curriculum, training and resources, regular use of natural environment.	4 schools of 11 completed data 4th grade	Saw different increases in percent of 4th grade students meeting/exceeding standards at four schools, principal impact in writing, slight impacts in math, reading. Behavior/attendance.
Basile, C.G., 2000	7 week unit with walk, looking at ability to transfer knowledge.	45 students Primary	Positive impact on ability to transfer procedural knowledge (process skills) Non-standardized test

Beard, L. J., 1998	3 yr outdoor classroom experience, hands-on, interdisciplinary	104 students	EE group mean score in ITBS (std state test) significantly higher
Blake, A. (2004)	Unit linking rock cycle with recycling program, studying limited content and use of analogy method	60 students Upper Primary age	Students showed gains in specific earth science content targeted. Non-standardized test.
Falco, E., 2004	EIC program, One year study of impact on GPA for groups of students	1400 students 5th through 8th grade	Suggestive results of large GPA increases within same group of students. More information needed.
Hitz, W. H Jr., 2000	Study of three month project-based instruction in math looking at immediate testing scores and later testing	95 students 10th grade	Traditionally taught students showed higher math scores on immediate tests, but project-based student had greater level of retention after three weeks. Non-standardized tests.
Klemmer, C. D., Waliczek, T. M., & Zajicek, J. M., 2005	Study of impact of school garden program on science achievement looking at comparative performance on state test between test and control groups. Integrated curric, project-based	647 students 3rd, 4th, 5th grades	Measured statistically higher science test results for students participating in hands-on gardening. Results limited by unmatched test and control groups, lack of information about demographics and other factors, and comparison of only post-experience tests across these different groups.
Parish, D. & Phillips, G., 2005	Used Science Knowledge Scale to test for educational impact of one yr hands-on EE programs on at risk ELL students	255 students 6th grade	Results suggest positive impacts on science knowledge. Lack of control group and study methodology reduce impact.
Randall, J.M., 2001	5 lesson unit combining biodiversity and writing skills. Used rubric from state test to score pre- and post- writing samples.	132 students 9th and 10th grade	Pre and post tests show positive impact on writing skills. Limited significance due to sample size, lack of information, and methodology to exclude other factors
Zwick, T.T. & Miller, K.W., 1996	Compares one yr outdoor, hands-on science teaching approach vs classroom, textbook-based science on American Indian students	49 students total, 22 test 4th grade	American Indian and non-native students in outdoor classes showed better performance on state test scores. Limited by size and information.

Along with academic outcomes, a few of these studies also note improvements in other outcomes that are related to achievement. Two studies noted improvements in attendance and less behavior management. Two studies noted better retention of what was learned. One study reported increased enthusiasm for learning, greater pride of ownership, increased interest in reading, and "greater volumes of higher quality writing."

Overview of Related Outcomes Research

The six studies listed in Appendix C are those documents discovered during the literature search that focused on quantitative measures of outcomes related to academic achievement, rather than specific achievement measures for core curriculum areas. Although not a focus of the literature search, these research results touch on a growing interest in the educational community to expand the way we measure both academic achievement directly, and the skills or attitudes that are indicators or prerequisites for future academic achievement. Outcomes related to academic achievement that have been discussed in educational research include: willingness or motivation to learn, interest in particular subjects, critical thinking skills, problem-solving skills, ability to transfer knowledge, process or procedural skills, reflection skills, and collaboration skills.

While the documents presented here are only the tip of the iceberg, they provide some interesting ideas for expanding research discussions. As shown in Table 4, all of these studies assert that different kinds of environmentally-related experiences can have a positive impact on outcomes related to academic achievement. They all studied programs using natural environments and were oriented towards hands-on or project-based experiences. These particular studies looked at increases in motivation to learn, critical thinking, analytical skills, interest in science careers and knowledge of science methodology.

Several existing test instruments for these related outcomes were mentioned in the research, including:

- Critical Thinking Test of Environmental Ed
- Cornell Critical Thinking Test
- CA Measure of Mental Motivation
- School Attitude Measurement test.

Table 4: Overview of Related Outcomes Research

Author, year	Type program	Size of test group/age	Related Outcome Impacts
Athman, J. & Monroe, M., 2004	EIC program, long-term. Env themes, project- and issue-based, student voice, connection to community, learner-centered	400 students 9th and 12th grade	Raised achievement motivation and critical thinking scores on surveys. Results controlled for GPA, gender and ethnicity.
Barnett, et al, 2005	Urban youth, unknown age, project-based, scientific field investigations	Pretest: 418 randomly selected test, 228 control Post-test: 335 randomly selected test, 184 control	Starting from comparable levels with control group, test group showed significant increase in interest in being a scientist and increased knowledge of investigative methodologies. Control group lost interest in science careers. Significance limited by lack of information.
Cheak, M., Hungerford, H., & Volk, T., 2002	Unclear, EE program. Assessments with Environmental Literacy Inventory and Critical Thinking Test of Env Ed (CTEE)	38 students in test group 5th & 6th grade	Compared to control group, test group using a wider, more challenging group of reading materials, were skilled analysts of complex issues, had improved writing skills, and were more motivated learners.
Ernst, J., & Monroe, M., 2004	Environment-based program. Tested with Cornell Critical Thinking Test & CA Measure of Mental Motivation	404 students from 11 schools 9th and 12th grade	Student in environment-based programs more skilled in critical thinking than peers, even those in traditional env science classes. Suggest critical thinking connection to outdoor, project-based program, but need more information on experience.
Nava-Whitehead, S., 2002	Nature's Classroom EE program, 5-day residential program. Gains measured using School Attitude Measurement test.	110 students 6th graders	Indicates that even short EE program positively affects a student's disposition to learn.
Von Secker, C., 2004	3-year EE program, problem-solving projects related to watershed	Unknown # 3 elementary schools 2 middle schools	Found that test students had increased engagement in learning compared to students at same school with less intense EE experiences.

SECTION III: ANALYSIS

This section combines the results of the research documents described in Section II to look at the collective evidence related to academic achievement outcomes of environmentally-related learning experiences. Because some of the research also quantitatively measures some outcomes that might be related to academic achievement, the section is divided into two parts, Impacts on Academic Achievement and Impacts on Related Outcomes.

Impacts on Academic Achievement

The survey analyzed impacts of environmentally-based education on academic achievement that were measured in terms of performance on well-established standardized tests applied in a similar fashion in both test and control groups. The research studies were focused on outcomes in different curriculum areas depending on their goals and the tests used.

In addition to this direct result, the research literature also contained other information worth analyzing. Each report contained varying descriptions of different experiences, teaching practices, and teaching support, being studied by the research, and some researchers tried to determine which factors were most important. This information was used to identify particular practices or factors that were commonly associated with positive academic outcomes in the strongest research.

The impacts on academic achievement are discussed below in terms of 1) impacts by curriculum subject area, 2) the significance of the environmental factor, and 3) practices that support academic achievement.

Impacts by Curriculum Subject

The eight strongest studies showed a variety of results across the particular subject areas targeted by the specific research, with significantly positive outcomes in general:

Summary of Strongest Research

Curriculum Subject Area	Possible Evidence	Suggestive Evidence
Writing/Language Arts	**2 of 2 studies positive**	2 of 2 studies positive
Reading	**2 of 3 studies positive,** **1 of 3 studies slight negative**	1 of 1 studies positive
Math	**3 of 3 studies positive**	3 of 4 studies positive 1 of 4 studies negative
Science	**1 of 1 studies no impact**	3 of 3 studies positive
Social Studies		2 of 2 studies positive

Results of the less definitive studies also showed positive outcomes, although the methodological shortcomings of these studies in terms of the guidelines for evidence indicate that their conclusions are possibly erroneous. Nonetheless, the strong positive trend lends support to the overall picture. The ten less definitive studies are summarized here:

Summary of Less Definitive Research

Curriculum Subject Area	*Less Definitive Results*
Writing/Language Arts	*3 of 3 studies positive*
Reading	*1 of 2 studies positive* *1of 2 slight positive*
Math	*1 of 3 studies positive* *1 of 3 slight positive* *1 of 3 short-term negative but long-term positive*
Science	*3 of 3 studies positive*
Standardized Tests Mean/GPA	*3 of 3 studies positive*

In addition to these positive results using well-established standardized test instruments, several researchers noted the need for expanding our ability to measure academic ability and, by connection, a program's impacts on academic achievement beyond standardized subject tests. Critics pointed at the limited capacity of multiple choice tests for measuring more complex thinking and analytical skills. Researchers are working on a range of other measures and test instruments that could be used in future EE research and evaluation projects as the education community comes to value and accept this deeper look into achievement.

To summarize, the research reviewed in this survey suggests that there is meaningful evidence supporting positive impacts on academic achievement across many curriculum subjects as a result of environmentally-based education. It is important to note, however, that this is not the same as asserting that all EE teaching has had or will have a positive impact on academic achievement. Because the results also show strong correlation with many educational best practices, the research also reveals the difficulty of proving a causal relationship between an overall approach like environmental education and positive academic outcomes.

However, it is possible to look for causal relationships between academic gains and particular factors that might influence academic outcomes – including factors that are unique to environmentally-based experiences. There are many factors that might influence academic outcomes. In a model developed by A.W. Austin, and reported by Bartosh, these factors can be divided into "Inputs," including initial characteristics of the students, teachers and schools, and the teaching and learning "Environments" in the program or school, including confidence, pedagogies, assessment practices, teacher support and training, planning time and approach, district policies, and funding. (Austin 1991; Bartosh 2003) These interacting factors are shown in Figure 1. Addressing and understanding these factors will make it possible to address them in research and draw clearer relationships between causes and effects.

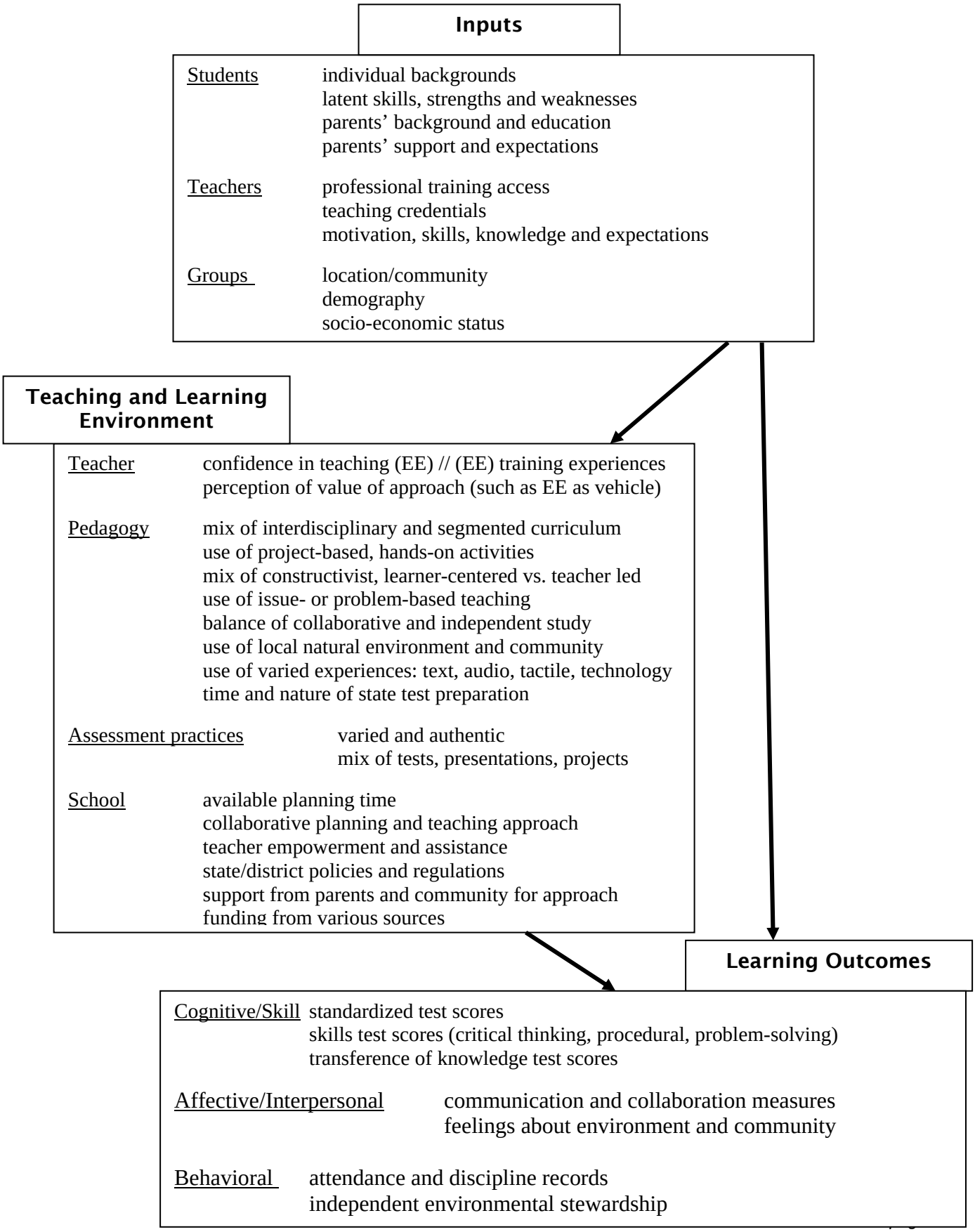
In addition to creating a stronger case for environmentally-based education, studying the variety of factors that might be influencing academic outcomes may help educators to identify and replicate practices that have helped EE programs make positive impacts on academic achievement. The following findings look at what the literature survey revealed about the impacts of specific factors.

Significance of the Environmental Factor

Only two studies looked at the statistical significance of the environmentally-related results they were asserting and also began to separate the relative impacts of different factors within the overall experience. (Bartosh, 2003, Clavijo, 2002.) Clavijo found that while there was no correlation between

Figure 1: Input-Environment-Outcome Model for Educational Research

[adapted by Community Resources for Science from Austin (1991) and Bartosh (2002)]



a two-year science-based EE program and scores on a standardized science test, previous science knowledge and socio-economic indicators were significant predictors of performance. This suggests that participation in learning experiences that differed in terms of an EE-based experience may not have been as important in improving performance as other factors. (Clavijo, 2002)

Bartosh, however, did find that the environmental nature of the experience was a significant factor in the positive academic outcomes measured using a much broader set of experiences, schools, and statistical analyses to eliminate competing explanations. The research was a more extensive study over 77 carefully matched pairs of schools, looking at five years of test data and a large set of factors related to performance. The strongest causal factors for the better performance of the EE schools were the environmental aspect of the experience and a belief among the teachers, administrators, and community, that the environmental teaching approach would improve academic performance.

Practices that Support Academic Achievement

The programs described in the original research documents include everything from short-term environmental education programs focused on a single core curriculum area to long-term EIC programs focused on overall learning outcomes, including changes in behavior and attitude. They all describe their participants, length, and goals, but vary in their attention to the practices they used or the actual differences between the teaching and learning environment in the test and control groups. Consequently, this analysis can only provide indications of best practices by identifying those most commonly associated with positive academic outcomes.

Seven of the eight strongest studies document programs that are at least two years in length. However, one program showing possible evidence for positive impacts in math was less than a year long. In general, longer experiences that involve the classroom teacher as the primary educator were more frequently associated with gains in academic achievement.

The programs studied reported a range of teaching techniques and teaching support practices that are being researched and applied in both EE and non-EE schools to improve academic outcomes.

Pedagogies and teaching practices mentioned in the research include:

- **Regular study of natural environments**
- Challenging, engaging subject matter
- **In-depth, longer-term investigation of topics**
- **Integrated, interdisciplinary curriculum**
- **Active learning** (from hands-on activities to more intensive project-based learning experiences)
- **Problem-solving and inquiry experiences**
- Connection to relevant issues leading to problem-based teaching
- **Constructivist, student-centered and student-led teaching**
- **Mix of cooperative and independent study**
- Varied student experiences: text, audio, tactile, technology
- Authentic, on-going assessment

Teaching support practices mentioned in the research include:

- **Professional training and support for new practices**
- Curriculum support and/or development
- **Collaborative planning and teaching**
- **Administrative and community support and involvement**
- Expectations of student performance from teacher and parents
- Safe school and home climate

The practices shown in bold were more frequently mentioned in association with the positive outcomes measured in the strongest research. All of the programs described in the strongest research used local natural environments regularly and were active-learning, project-based experiences. Most of the less definitive research was also either hands-on or project-based and used natural environments. Although seven of the eight strongest studies mention using EE to integrate teaching across subject as a teaching practice, the actual level of integration being practiced is not well described and quite variable. The one study that actually compared the amount of subject integration between the control and test schools found that they used similar proportions of integrated teaching and traditional single discipline teaching, associating this factor with a parallel positive rise in both control and test schools. (Bartosh, 2003) Some other factors that are commonly associated with positive academic results in this analysis include: the use of learner-centered, constructivist methods to help students build their own knowledge, inquiry and problem solving experiences, cooperative and independent learning experiences, and collaborative planning and teaching. Most of the strongest research outcomes were for programs that included training and/or curriculum support for the classroom teacher and involved the community and administration.

All of these practices for teaching and teaching support have been and continue to be the subject of educational research nationally and internationally in all kinds of schools and learning settings. As research improves, there will be more and better evidence about the effectiveness of different techniques. Both EE and non-EE educators need to build their capacity to access and weigh different educational research results in order to choose a set of "best practices" that can maximize their ability to support academic achievement.

The overall results of this literature survey analysis indicate that the academic achievement impacts of EE can be strengthened by drawing on the best educational practices while preserving strong connections to natural environmental experiences. It is important for the EE community to stay abreast of current research on educational practices and put these practices into their own programs whenever possible.

Impacts on Related Outcomes

As described in the search methods in Section 1, some of the research also studied other outcomes that might contribute to academic achievement, such as motivation to learn, problem-solving skills or critical thinking skills. Although this was not a primary focus of this literature search, these results are interesting in terms of broadening the ability to measure other skills and behaviors that may contribute to academic achievement.

All of the research included in this report that looked at attendance, behavior, motivation to learn, critical thinking skills, analysis of complex issues, or other outcomes reported positive results from student involvement in environmentally related experiences. Although the results are all limited by gaps in information on experiences, testing instruments, and methodology, the uniformity of the response is suggestive. The gaps also make it difficult to determine what parts of the experiences – unique environmental aspects, different teaching approaches, or other factors - affect these outcomes. It is interesting to note that positive results were found for everything from five-day programs to multi-year EIC programs underscoring the need for improved research methods in general.

Future research on how environmental education affects these contributing factors could help to clarify these relationships. The few studies collected incidentally in this survey reveal that many different test instruments exist to measure these types of behaviors and skills. The possible contributions of different behaviors and skills to academic achievement have been a topic of research in the academic community for years. Since improving academic achievement is the primary goal, future research on the impact of environmental education on particular contributing factors should be guided by evidence of established connections with academic improvement, using the same kind of research standards applied in this report.

SECTION IV: FINDINGS

Summary

Using U.S guidelines for scientifically-based education research, there is meaningful evidence that:

- Environmentally-based education using best educational practices can improve academic performance across curriculum subjects
- The use and study of natural environments is a significant factor in academic achievement gains

This literature survey also reveals that:

- Certain teaching practices and teaching support in EE programs appear to strengthen academic outcomes
- More and better research is needed to reach conclusive results and verify the most important practices and support.

The results of this literature analysis can be used to build the capacity of the environmental education community both to reach K-12 students and provide stronger support for academic achievement. The survey indicates that the study of natural areas combined with best teaching practices and teaching support can improve academic performance. The challenge to us all – community, businesses, school districts, EE providers and classroom educators – is to make use of that potential for our students by: 1) designing EE programs that respond to changing knowledge of best teaching practices and support, 2) reaching more students, and 3) continuing to build our understanding of the important factors that produce academic achievement through better evaluation and research. The literature analysis suggests a variety of actions that could be taken in these three areas.

Strengthening EE's Contribution to Academic Achievement

The contribution of environmental education to academic achievement can be strengthened by the use of teaching practices and teacher support practices that have been associated with the positive outcomes documented by valid research. While our understanding of the impact of specific practices continues to change and grow, current research studied in this survey indicates several directions for educators to pursue in their own environmental teaching or EE program design.

- **Maintain strong connection with studying the natural environment**
- **Follow current educational research and incorporate best practices where possible**
    - Focus on active, project-based learning
    - Promote longer, integrated curriculum approaches to environmental study
    - Maintain relevance to local environmental issues and culture of target audience
    - Use constructivist, learner-centered methods that respond to knowledge of students
    - Use inquiry and problem-solving experiences to promote critical thinking
    - Include cooperative and independent learning experiences

- **Extend the contribution of shorter programs**
    - Promote effective teacher extensions of programs with training, curriculum, and materials that incorporate best teaching practices
    - Link with other environmental education and professional development providers using best practices to provide longer, richer environmental experiences
    - Promote administrative, community and parent involvement in experiences and outcomes

Reaching More Students

Academic performance is the primary measure of success for school-based education programs. Therefore, the key issue in gaining access to public school students is making it clear the specific ways in which EE programs will support improved academic performance. This can be accomplished through a combination of education, program outreach, and program design. The general public and educational decision-makers need more information about the possible connection between EE and academic achievement. Program outreach materials must both refer to valid research results and show how the specific program uses this research. Program design must make it easier for different schools and communities to use EE programs in a meaningful way.

- **Build community awareness and confidence in connections between EE, best practices, and achievement**
    - Educate program providers, parents and school decision-makers in conferences, District meetings, articles, and on websites
    - Be scrupulous in selecting the research used and quoted – using quality as a guide rather than favorable conclusions.
    - Share results of valid evaluations linking effective practices and outcomes

- **Develop outreach that connects the program with outcomes important to educators**
    - Explain the link between current research results and specific program design
    - Include academic results from program evaluation , as well as other outcomes in environmental knowledge and behaviors
    - Focus on characteristics important to educators in program descriptions:

      Academic achievement: *"We support the following specific curriculum goals and academic skills…."*

      Best education practices: *"We use teaching practices that support academic achievement, including …."*

      Teaching support practices: *"We help you make the most of our program by providing…"*

      Flexibility: *"We can be an engaging enrichment for existing units or part of collaborative teaching approach with our extended program offerings."*

- **Make it easier for schools and educators to use EE programs**
    - Provide support based on research results, including: professional training with opportunities for collaborative planning and facilitation of community involvement.
    - Respond to the needs and time constraints of different teachers and schools by considering different ways to offer your program: short-term enrichments with more limited outcomes and as longer experiences with more impact on academic achievement.
    - Continue to address barriers such as background knowledge, confidence, limited funds, and classroom support that have been previously identified in teacher research by CRS and other organizations.

Using Research and Evaluation to Expand EE's Potential

Information from scientifically-based research and evaluation is critical to both creating more access to students and improving EE's contribution to academic achievement. In order to develop a basis for specific, targeted research, it would appear to be most beneficial for EE programs to consider developing partnerships with specific programs or schools in order to test longer interactions over time and in the context of a range of environmental and/or academic goals.

Additional research could provide conclusive evidence that environmentally-based approaches improve academic performance and improve the likelihood of this positive outcome in practice by illuminating other important teaching and learning factors. Carefully-designed program evaluations can also help education decision-makers see the connection between specific programs and academic outcomes. Research and evaluation studies could increase their effectiveness by improving in relevance (what is studied) and significance (what methodology is used). Finally, and perhaps most importantly, the community in general, and educators in particular, must improve their ability to use research results effectively.

- **Expand and deepen knowledge of the links between EE and academic achievement**
    - Do more evaluation and research to look for strong causal relationships between environmental study and achievement, and across the range of other factors
    - Programs and administrators must work together to evaluate academic as well as other outcomes of environmentally-based education.
    - Develop broader range of standardized and accepted tools to measure academic achievement and skills.

- **Improve relevance of studies**
    - Carefully choose outcomes to measure in program evaluations or research, considering the audience for results. Funders should encourage positive overall results that are supported by sound research approaches. Educators should look for evidence that a specific EE approach will have a positive outcome on achievement in core curriculum areas, attendance, discipline, or key academic skills.

- Understand different factors that might affect results. Appendix I lists different factors that may affect the outcomes of research or evaluation. Understanding these factors can help the design of effective studies
- Select and design appropriate tools for collecting needed data. Determine quantitative and qualitative data needed to measure targeted outcomes and address as many possible contributing factors as possible. Use accepted standardized instruments to measure targeted outcomes whenever possible.
- Do more studies related to shorter-term interventions and the sustainability of the results

- **Improve significance of studies**
  - Follow U.S. guidelines for scientific educational research and evaluation when undertaking any studies of these kinds. (Appendix G)
  - Carefully match control and test groups in terms of as many baseline input factors (teacher experience, previous test performance, socio-economic factors) and learning environment factors as possible, whether the groups were selected randomly or not. Even randomly selected test and control groups should be compared to avoid bias introduced by chance.
  - Look at relative scoring over time between paired test and control groups, since an increase or decrease in test group performance may be due to factors other than the studied program.
  - Do statistical analysis of results to eliminate effects of chance and increase significance of results. If needed, combine data sets to extend length and breadth of data.
  - Address all factors that could have influenced results with either careful matching of groups initially or analysis of qualitative and quantitative data. This will help isolate particular program experiences or characteristics to study. (See Bartosh, 2003 for an interesting model for using a combination of data to address multiple factors affecting outcomes.)
  - Provide complete descriptions of the characteristics of the test and control groups, the specific differences between a test experience and the traditionally-taught experience, any other differences learning environments, and methodology for data collection.

- **Use research results effectively**
  - Develop ability to weigh and compare research results to determine strength of assertions. The Institute of Education Sciences, National Science Foundation, and other teacher support organizations provide resources and support.
  - Stay abreast of current research and use applicable results to inform teaching practices, EE program design for students and teachers, and general community education.

THE IMPACT OF ENVIRONMENTALLY-RELATED EDUCATION ON ACADEMIC ACHIEVEMENT

A Literature Survey

APPENDICES

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Appendix A: Strongest Research

Descriptions of Most Relevant Research

There were eight reports of research that met most of the relevance and quality criteria used in this literature search. The results of these studies are summarized here.

Bartosh, O. (2003) ***Environmental Education: Improving Student Achievement,*** Unpublished Masters Thesis, The Evergreen State College, Olympia, WA.

In this outstanding M.A. thesis, 77 sets of paired schools in Washington were studied to look at the impacts of ongoing EE programs on academic achievement as indicated over five years of state test scores. Schools included had been using an EE program to integrate curriculum for at least 33% of the school year for at least three years, involving at least 20% of the teachers and students. Practices in these programs included collaborative teaching teams to design and facilitate lessons, regular use of natural environments, project-based and constructivist teaching techniques, community involvement, and varied assessment techniques. "Comparison" schools were described as using a more "traditional" curriculum, with isolated or no EE activities, varying degrees of integration between traditional subjects (math, science, history, language arts), little or no teaching teams, and mostly teacher-led learning. A comparison or matched school was chosen on the basis of similar geographic, socio-economic, ethnicity and demographic criteria to each EE school. The author used descriptive statistical tests to ensure that there were no significant differences in these factors between the test and comparison groups overall or within the pairs.

The analysis of educational outcomes used well-described statistical methods to look at student scores on two standardized state tests: WASL tests (math, reading, writing, and listening) and the ITBS tests (math and reading). Results showed that there was a significant difference in math, reading, writing, and listening on the WASL and in math and reading on the ITBS, with EE schools outperforming non-EE schools on all tests (50 EE schools did better in math, 51 in reading, 56 in writing, and 46 in listening). According to the results, schools that undertake systemic environmental education programs consistently have higher test scores on the state standardized tests over comparable "non-EE" schools.

The research includes an interesting overview of factors that may influence educational outcomes and then attempts to address and isolate different factors within a research model that looks at input factors, teaching and learning environment factors, and educational outputs. (Figure 1 of report). Using a voluntary survey of participating teachers and principals, Bartosh looked at several of the factors that might influence learning outcomes and identified some suggestive differences and similarities between EE and comparison schools. Although the information is only partially complete, teachers reported that:

In addition to extensive statistical significance testing, the author also did longitudinal analysis that revealed a similar pattern of change for both groups over time. Although the test group remained higher, this test reveals that other factors than the EE programs are affecting both groups. Test and control schools were similar in terms of:

- student and teacher characteristics (demography, location, socio-economic status, professional experience, training and credentials)
- teaching practices (similar planning approaches; amounts of teacher collaboration; project-based teaching; amounts of interdisciplinary teaching, traditional curriculum, and gifted curriculum; independent and cooperative learning, time spent in WASL test preparation, assessment techniques)
- State and District policies, regulations, and needs and barriers for EE.

The key differences between the EE and control schools in Bartosh's study that were associated with the significantly higher performance of the EE schools across time and curriculum area were:

- degree of use of natural areas
- integration around EE in particular
- specific EE training
- strong teacher beliefs that the EE-based teaching approach was valuable
- support from administrators, parents and community for the approach being used.

In summary, the strongest causal factors for the better performance of the EE schools appeared to be the environmental aspect of the experience, the specific EE training for teachers, and a belief that the chosen teaching approach was valuable by the teachers, administrators, and community.

Summary for Bartosh

Focus	Relative academic achievement of EE versus non-EE schools
Target	77 matched pairs of k-12 schools- average school size was about 700 students
Program Type	EE integrated across subject in schools; using classroom and outdoor instruction continuously or at least seasonally for several years. At least 33% of student are involved in EE studies in the EE schools.
Support/Other Factors	
Methods	Comparison of EE vs. non-EE school scores on two different state's tests, and survey of teachers; Looked at 5 years of data.
Impact	EE schools significantly outperformed non EE schools on math, reading, writing, and listening tests given to students in 3^{rd}-10^{th} grade.

Relevance	
Measured academic achievement	Yes
Instruction as part of a k-12 school day	Yes
Quality:	
Randomized control study	No- excellent paired groups however
Description of intervention and participants	Yes
300 plus students or 50 classrooms/schools	Yes
Valid outcome measures, multiple years	Yes, 5 years
Statistical tests on size/chance of impact	Yes

Clavijo, K. G. (2002) ***The Impact of Environmental Education on Sixth-Grade Students' Science Achievement,*** Unpublished Doctoral Dissertation, University of Louisville, KY

In this dissertation, data showed that environmental education did not correlate with any difference in science achievement for 5th and 6th graders, as measured on the CTBS science test scores, when controlling for prior science knowledge and socioeconomic status. By contrast, prior knowledge and socioeconomic status were significant predictors of CTBS scores.

A total population of 5,671 6th graders in Jefferson County Public schools took the CTBS science subtest in the spring of 2000. The CTBS was analyzed to see if it was an effective test for measuring gains from EE and found that 14 items were identified as EE related and 11 were not related. County-wide scores on the CTBS science subtest were compared to the scores of seven EE schools in the county, (4 elementary/ 3 middle) that were selected by of a panel of 4 experts using the following criteria:

1. Environment used as a context for learning science
2. Students actively involved in projects and problem solving related to local environmental issues
3. Program in place for at least 2 years
4. Program have a broad base of support in the school

Earlier scores of these students on the 1999 KIRIS (Kentucky Instructional Results Information System) tests in 4th grade were used as a control variable to isolate the impact of previous knowledge on test scores. The scores of students eligible for free and reduced lunch were analyzed to look at the affect of socio-economic factors on test scores. The earlier score on the 4th grade KIRIS test explained 27.6% of the variance on CTBS scores. Participation in free and reduced lunch explained 7.1% of the variance. Analysis showed that participation in an EE classroom for either one or two years in 5th or 6th grades was not a significant predictor of the 6th grade CTBS science scores. The author posits that this study may vary from others that showed a positive correlation because EE was only integrated into science instruction; not cross-curricular. The author also noted that studies that have shown positive outcomes such as Lieberman & Hoody (1998 & 2000) do not provide statistical controls for background characteristics that are established predictors of achievement, which may affect their results. This type of analysis provideds similar controls against bias as matched groups, but is still less reliable than randomly assigned groups. This research meets the requirements for possible evidence of academic impacts of environmentally-related education on academic achievement.

Summary for Clavijo

Focus	Whether EE is predictive (related to) of achievement changes on state science tests
Target	7 schools offering project-based EE experience as context for science, testing at 5th or 6th grade
Program Type	EE as a context for science in EE schools; project-based; relevant issues; using classroom and outdoor instruction;
Support/Other Factors	Broad support across school
Methods	Comparison of changes in students' science scores between 4th grade and 6th grade compared with control population (4655 students) across county.
Impact	No correlation of EE with science achievement changes. Previous science test performance and participation in free-lunch program were both significant indicators of performance.

Relevance	
Measured academic achievement	Y in science
Instruction as part of a K-12 school day	Y
Quality:	
Randomized control study	N - but used analysis to address differences in socio-economic status and previous knowledge in test groups.
Description of intervention and participants	Y
300 plus students or 50 classrooms/schools	Y - 299 students who had EE in 5th grade, 561 who had EE in 6th grade, & 62 who had EE in both, compared with 4655 6th graders in the district.
Valid outcome measures, multiple years	Y
Statistical tests on size/chance of impact	Y, used a hierarchical regression design to look for any correlation between performance and EE; also looked at significance of socioeconomic and previous knowledge factors

Danforth, P. (2005). ***An evaluation of National Wildlife Federation's Schoolyard Habitat Program in the Houston Independent School District.*** Unpublished Master's Thesis, Texas State University, San Marcos, TX.

This study compared 3 pairs of Houston schools, matched by demographics. The treatment group included at total of 306 4th grade students whose teachers were implementing NWF's Schoolyard Habitat Program. The Schoolyard Habitat program helps teachers and students create wildlife habitat on school grounds. English, science, mathematics, history, geography, social studies and art may be involved in the process of planning, creating and using a habitat while providing students with hands-on experiences. The control group consisted of a total of 108 4th grade students whose teachers used a more traditional curriculum. Measures included standardized test scores (Texas Assessment of Knowledge and Skills), as well as attendance and demographic data. Changes were measured between students' 3rd grade data and their 4th grade data from the subsequent year. Results showed that SYH students increased math scores significantly more than peers with a traditional curriculum. Although there was a general decrease in reading scores for both groups, the SYH students' scores decreased more, showing a slight negative correlation with SYH participation overall. The author noted that the SYH curriculum was more directly connected to math than reading. Interestingly, the reading scores of African-American students involved in the SYH program showed a slight beneficial impact, in contradiction to the general trend. This research meets the requirements for possible evidence of academic impacts of environmentally-related education on academic achievement.

Summary of Danforth, P. (2005):

Focus	Impact of shorter (<1year) EE program for 4th grade on academic achievement
Target	306 4th grade students participating in Schoolyard Habitat program;
Program Type	EE program with integration opportunities; outdoor and indoor learning experiences, local habitat project,
Support/Other Factors	Curriculum provided

Methods	Comparison of changes in state test scores between 3rd and 4th grade for students at 3 pairs of schools matched by demographics. One SYH experience school and one control school in each pair. Also collected attendance and demographic data.
Impact	SYH students increased math scores significantly more than their peers. Reading scores decreased in general with slight negative impact correlation with SYH overall but slight increase correlation for African American students.

Relevance	
Measured academic achievement	Yes
Instruction as part of a K-12 school day	Yes
Quality:	
Randomized control study	Nonrandomized: Matched pairs with demographics
Description of intervention and participants	Yes
300 plus students or 50 classrooms/schools	Yes, 462 students tested in Math and 444 in Reading.
Valid outcome measures	Yes, Pretest, posttest; TAKS statewide achievement tests; attendance records
Statistical tests on size/chance of impact	Yes

Emekauwa, E. (2004). The Star with My Name: The Alaska Rural Systemic Initiative and the Impact of Place-Based Education on Native Student Achievement, Rural Trust White Paper on Place-Based Education, Retrieved from http://files.ruraledu.org/publications.html

The research summarized in this document looked at a 10-year rural school improvement effort, the Alaska Rural Systemic Initiative (AKRSI), that aimed at improving student performance in the lowest achieving districts in the state by developing the "untapped potential of indigenous knowledge systems as a foundation for rural/Native education in general, and science education in particular." The initiative involved 18,982 students at 176 schools, nearly 60% of the rural student population and 90% of the rural Alaska Native students. Schools served had a 50% or more Native Alaskan population.

Over the course of the program students were involved helping to document the cultural and ecological knowledge of the Native people in each of the state's five major cultural regions, inquiry-based projects in outdoor and in-door settings, and looking at the application of science in everyday native life. The project had a particular emphasis on science and fostering interest in science careers through exposure to science careers, role models, and observation of real field scientists, among other things. The project built strong community collaboration, new curriculum resources and provided training.

The research looked at changes in performance on CAT-5, and after 2000, on CAT-6 tests within the student populations of AKRSI rural schools, 28 non-AKRSI rural schools, the overall state, and the native Alaskan community as a whole. The source document reports scores for math performance of 8th, 10th , 11th grade, over several years. Initially in 1995, only 17.4% of 8th graders in the AKRSI schools scored in the top quartile on the CAT-5, compared to 29.1% of students in non-AKRSI rural schools. By 1998, AKRSI schools showed a 6.9 percentage point increase while non-AKRSI rural schools showed a one-point increase. The gap between AKRSI and non-AKRSI rural schools narrowed from 11.7 percentage points to 5.8. Between 2000 and 2002, AKRSI schools posted a 3.9% point gain in 8th graders scoring proficient or advanced in math on the new state benchmark exam, compared to a

.97% point loss for non-AKRSI rural schools and a 1.2 point gain statewide. On the 2002 exam, the gap between AKRSI and non-AKRSI rural schools had decreased by 4.85 points, and between AKRSI and schools statewide by 2.68 points. Even more noteworthy, given the differences in the test and control populations, AKRSI 8th grade students also outperformed Alaska Native students as a whole. While the source document does not state whether statistical tests were applied, the large population in the study, the focus on changes within populations, and size of the increases over time give strong indications that the results are significant.

With 2 years of data, AKRSI 10th graders scoring proficient or advanced on the State High School Qualifying Exam increased by 8.36 percentage points, from 19.95% to 28.31%. This was less than the 12.65 gain in non-AKRSI rural schools and the 10.7 point gain statewide but is significant within these schools' populations who have historically been the lowest performing in the state. Dropout rates declined .8% compared to a .03% decrease in non-AKRSI rural schools from 1995-2000, however it's not clear whether this change is a significant result. The study also collected data on first time freshman enrollment at the University of Alaska. The number of first time students from AKRSI districts increased significantly, surpassing enrollment from non-AKRSI schools

Summary for Emekauwa (2004) *The Star with My Name*

Focus	Impact of 7 years of 10-year place-based education initiative on academic achievement
Target	18,982 k-12 students in 176 rural schools (90% of AKs' rural Native students.)
Program Type	Place-based, systemic program focus on developing culturally relevant curriculum linking modern learning with Native Alaskan knowledge and practices, emphasis on inquiry-based science experiences, science and cultural projects, indoor and outdoor learning, integrated curriculum , career and role models
Support/Other Factors	Developed new curriculum; strong community collaboration, teacher professional development, scientist role models and science career examples and experiences
Methods	Comparison of relative changes in state math test scores within the student populations of AKRSI rural schools, 28 non-AKRSI rural schools, the overall state, and the native Alaskan community. Also collected data on dropout rate and first-time freshman enrollment in University of Alaska.
Impact	AKRSI schools had net gain over non-AKRSI rural schools in the percentage of 8th graders scoring in the upper quartile on math . Indication of positive change in scoring on High School Qualifying Exam. First-time University enrollment increased significantly compared to Non-ASKRI enrollment.

Relevance	
Measured academic achievement	Yes
Instruction as part of a K-12 school day	Yes
Quality:	
Randomized control study	No- gap analysis; compared relative changes with state scores overall and for Native Alaskan students
Description of intervention and participants	Yes
300 plus students or 50 classrooms/schools	Yes- state-wide study
Valid outcome measures	Yes
Statistical tests on size/chance of impact	Unknown- but significant results

Emekauwa, E. (2004). They Remember What They Touch: The Impact of Place-Based Learning in East Feliciana Parish. Rural School and Community Trust. Washington, D.C. Retrieved from http://www.seer.org/pages/research/Emekauwa2004.pdf

In 1999-2000, the East Feliciana parish began Project Connect, a district-wide place-based math and science initiative, in an attempt to reform their poor academic performance. The initiative began by using the environmental as a place-based theme for teaching science, and expanded over time to include local history and geography as a vehicle for teaching science, math, social studies, and language arts. The program started at 5 elementary/middle schools, reaching approximately 1800 k-8 students, 80% of whom are African American and approximately 85% qualify for free or reduced-price lunch. Fifty-two different teachers participated in one or more of three consecutive summer trainings on place-based learning, received ongoing support from teacher leaders, and saw modeling of place-based units developed for their district. Application of the units and techniques varied across schools and classes but students were generally involved in more outdoor, experiential, place-relevant learning, including nature trails, gardens, and studies of weather and soil.

This study investigated 4th grade ELA, Math, Science, Social Studies scores on Louisiana Educational Assessment Program (LEAP 21) from 1998-2002, comparing the district's 4^{th} grade population to the state's for percentage of students at "unsatisfactory" level. The performance gap between the district and state decreased for all subject areas. Further, the greatest individual school success occurred at Slaughter Elementary where three of the district's place-based leadership team teach.

Between the 3 years from 1999-2000 and 2001-2002, the % of 4^{th} graders performing at an unsatisfactory level dropped 13.2 percentage points compared to a statewide decrease of 6.5 points. The gap between district and state in ELA narrowed from 12.9 to just 4.2 percentage points difference. Math scores saw a 14.1 percentage point decline in district students with unsatisfactory performance over this period compared with a 3.6 point decline statewide, closing the gap between district and state from 9.3 to 4.9. In science, East Feliciana's 4th graders posted an 8.1-point decrease in the number of students scoring unsatisfactory between 1999-00 and 2001-02 while there was a 3.7-point decrease in the state overall during the same period. In 2000-01, East Feliciana's 4th graders tied the overall state performance in science. In social studies, there was an 11.3-point decrease in the number of students scoring unsatisfactory compared to a 3.2-point decrease for the state overall. While the source document does not state whether statistical tests were applied, the large population in the study, the focus on changes within populations, and size of the increases sustained over time give strong indications that the results are significant.

It is interesting to note that some individual schools varied from these rates of progress, showing more or less progress. Several factors were cited by principals including number of teachers involved, depth of involvement, and changing school staff. However the relative effect of these factors vs.other predictors was not studied. The study also noted changes in level of community involvement in the schools.

Summary of Emekauwa, E., (2004) *They Remember What They Touch*:

Focus	Impact of 3-year district-wide place-based program on overall academic performance
Target	Elementary students in 5 schools; Approximately 1800 K-8 students, 80% African American, 85% free lunch

Program Type	Place-based, project-based learning across curriculum, initially using environment to teach science and extending out into local history and geography
Support/Other Factors	Systemic support; Professional training in place-based, integrated teaching over 3 consecutive summers with modeling and ongoing support during year.
Methods	Comparison of relative changes in % of students with unsatisfactory performance on state tests within statewide and district 4th graders over 3 years
Impact	Performance gap between state and district decreased for all subject areas.

Relevance	
Measured academic achievement	Yes
Instruction as part of a k-12 school day	Yes
Quality:	
Randomized control study	No- gap analysis; compared relative changes with state scores
Description of intervention and participants	Yes
300 plus students or 50 classrooms/schools	Yes ?? (250? 1800/8 grades)
Valid outcome measures	Yes, scores on state LEAP tests over 3 years
Statistical tests on size/chance of impact	No but likely significance

Lieberman, G.A., Hoody, L.L., & Lieberman, G.M. (2000). California Student Assessment Project - The Effects of Environment-Based Education on Student Achievement. **San Diego, CA: State Education and Environment Roundtable,**

The researchers examined the results of Using the Environment as an Integrating Context for learning (EIC), a term coined by the State Education and Environment Roundtable (to which 12 states belong). EIC encompasses several important teaching practice goals: using natural and community settings as a context for learning, interdisciplinary instruction, issue- and project-based learning, collaborative team teaching, learner-centered/constructivist methods, and a combination of independent and cooperative learning experiences. Data was collected for eight EIC schools, or student groups within schools, that had been using EIC programs with an emphasis on three characteristics: consistent use of the local environment as a learning context, principally interdisciplinary study, and problem/issue-based instruction. The EIC programs included one on-site environmental center along with community destinations, one off-site environmental center with nearby stream and community settings, and six classroom programs using visits to ranches, tree farm, forest, creeks, with three programs having access to school gardens. The control schools varied in resources and approach, using some or all of the instructional practices, but less routinely than the EIC schools.

The research looked at academic achievement over a three year period, comparing standardized test scores of 8 pairs of matched student groups in EIC and traditional settings in each year. Of the eight paired groups, there were 3 high school pairs, 1 intermediate school pair, and 4 elementary school pairs (using data from 2nd grade up). Two of the high school treatment and control pairs were selected from student groups receiving different instruction within the same school and the remaining six pairs were made by matching the treatment EIC school students with students in the same grade at a school with nearby attendance areas and similar school size, class size, % of students with limited English proficiency, % of students receiving free or reduced-price lunch, and ethnic populations. The study

also attempted to match teachers in control and treatment groups in terms of years teaching experience and subject area.

The results are reported for each pair of EIC and control student groups after a brief description of the instructional practices in terms of relation to the environment, curriculum integration, and problem-solving instruction. Each pair is compared over a variety of standardized tests, proficiency test passing rates, and portfolio analyses in readings, language, writing, math, science and social science over a period of 3 or 4 years. The results are presented for each pair in terms of which group did better on each test. For example, two of the 8 pairs were high school groups on the same campus. At one of the high school settings, the EIC students (9^{th} & 10^{th} graders) did not differ from traditional students at the same campus in comparative scores. At the other, EIC students (9^{th}-12^{th} grade) scored higher in 20 of 26 assessments. Key positive results for the EIC schools are provided for each pair. In summary the report states that EIC students scored higher on 73% of total assessments given, as follows:

- 69 of 71 Language Arts assessments (76%)
- 17 of 27 Math assessments (63%)
- 7 of 11 Science assessments (64%)
- 8 of 11 Social Studies assessments (73%)
- Attendance improved on 17 of 22 assessments (77%)

There is no overall analysis results presented for either the individual pairs or the whole study that look at complete test results by type of performance test to eliminate the non-standardized portfolio analyses, by grade level, or by any particular differences in the learning environment.

The report states that there were differences in data handling and reporting of data between sites and that the small sample size made it impossible to calculate the standard deviations required for statistical analysis of the results. There is no analysis of whether initial performance of the student groups is a significant factor or what the impact is of counting multiple tests in the same subject and the same year for the same populations. In addition, although score outcomes are summarized and generalized over the group, the instructional practice information for each pair is relatively vague, varies for each pair and is never provided in summary. Consequently, although the higher results on standardized tests are suggestive of positive impacts of EIC on academic achievement, there is no way to know conclusively whether these performance differences are significant or what factors were involved.

Summary of Lieberman, G.A., Hoody, L.L., & Lieberman, G.M. (2000):

Focus	Academic and behavioral impacts of EIC programs in classes and schools. EIC test groups had been using EIC strategies for at least 2 years prior to data collection.
Target	8 matched groups of k-12 students in EIC and traditional programs. Student data from three school years 1996-97 through 1998-99.
Program Type	EIC schools routinely used environment as a context for learning, varying integrated curriculum, student-led approach, issue- and project-based experiences, independent and collaborative learning; Varied levels of these characteristics in traditional programs, but less.
Support/Other Factors	Varies school to school, and group to group
Methods	Compared performance of matched pairs on variety of standardized and non-standardized tests over a three-year period, totaling # of times EIC outperformed traditional programs

Impact	Indications that EIC students outperform students in traditional programs in reading, writing, math, science, and social studies; uncertain due to sample size and analysis approach

Relevance	
Measured academic achievement	Yes
Instruction as part of a K-12 school day	Yes
Quality:	
Randomized control study	No- Eight paired program or paired school groups
Description of intervention and participants	Yes- partial
300 plus students or 50 classrooms/schools	Yes – 27 grade levels at 8 sets of paired schools
Valid outcome measures	Yes- but mixed standardized and non-standardized measures
Statistical tests on size/chance of impact	No

Lieberman, G.A., Hoody, L.L., & Lieberman, G.M. (2005). California Student Assessment Project, Phase 2: The Effects of Environment-Based Education on Student Achievement. San Diego, CA: State Education and Environment Roundtable. Retrieved from www.seer.org/pages/research/CSAPII2005.pdf

This is report from the second phase of the California Student Achievement Project. This study does a comparative analysis of four matched treatment and control pairs of elementary schools over five years, looking at scores from a total of 20 STAR standardized tests for each tested grade (2^{nd} through 5^{th}) on each tested subject (reading, math, language, and spelling). Students in the environment-based programs outperformed their traditionally educated peers. In 96% of all cases, EIC students scored as well or better than their paired group. In spelling, EIC schools scored significantly higher in 32.5% of tests, while control only scored significantly higher 2.5% of the time. In math, treatment scored significantly higher in 48% of tests, while control only scored significantly higher 8% of the time. In reading, treatment scored significantly higher in 46% of tests, while control never scored significantly higher. In language, treatment scored significantly higher in 40% of tests, while control only scored significantly higher 5% of the time. EIC schools significantly exceeded the control scores in 134 instances, while control exceeded treatment in 12 instances.

In this study, the research team utilized a survey tool to gather qualitative information comparing the instructional practices of the paired EIC and control schools including:

- Integrated interdisciplinary instruction
- Community based issue investigation and service
- Study of local natural and social systems
- Collaborative teaching, including interdisciplinary teaching teams, community, and informal education partners
- Learner-centered constructivist approaches
- Cooperative and independent learning
- Authentic assessment

The study summary indicates that all EIC schools used all these instructional practices and individual site variations are included in the pair descriptions. Control schools for each EIC treatment school were selected using the API maintained by the California Department of Education, including a mixture of demographic data called "Similar Schools Ranks" used to group schools facing similar challenges. All schools completed the qualitative survey of instructional practices and this information is summarized as a narrative to highlight the instructional differences for each matched pair.

There are some questions about the impact of combining scores from the same students over multiple years, since the factors related to individual skills of incoming students may just be compounded when the tests are totaled. It would be interesting to see whether there was an increase in relative scoring between the paired groups over time, more statistical analysis of results related to differences in instructional practices, and some baseline information for the test and control groups. However, this research meets the requirements for possible evidence of academic impacts of environmentally-related education on academic achievement.

Summary of Lieberman, G.A., Hoody, L.L., & Lieberman, G.M. (2005):

Focus	Academic impacts of established elementary school EIC programs.
Target	4 k-5 EIC schools over a period of five years
Program Type	EIC schools routinely use local environment and social settings, varying integrated curriculum, issue- and project-based experiences, combination of cooperative and independent learning, collaborative teaching, learner-centered teaching, and authentic assessment. Varied levels of these characteristics in traditional programs, but less.
Support/Other Factors	
Methods	Compared performance of API matched pairs on STAR tests over a five-year period, totaling # of times EIC students scored significantly higher than traditional programs over total of 20 tests for each grade in each subject.
Impact	Evidence that EIC students outperform students in traditional programs in reading, language arts, math, science, and social studies; Treatment significantly exceeded the control scores on STAR test in 134 instances, while control exceeded treatment in 12 instances

Relevance:	
Measured academic achievement	Yes
Instruction as part of a K-12 school day	Yes
Quality:	
Randomized control study	Paired schools matched with State API data
Description of intervention and participants	Yes
300 plus students or 50 classrooms/schools	Yes- over 3500 students
Valid outcome measures	Yes
Statistical tests on size/chance of impact	No

Sterbinsky, A., (2002) ***Rocky Mountain School of Expeditionary Learning Evaluation Report, Center for Research in Educational Policy***, The University of Memphis. Retrieved from http://www.elob.org/results/evaluation.html

Rocky Mountain School of Expeditionary Learning (RMSEL) is located in Denver, Colorado, and is founded on the principles and practices of Expeditionary Learning, which extends Outward Bound (an adventure and service-based education program founded by Kurt Hahn) into public schools. At RMSEL, traditional curriculum and classroom experiences are replaced by long-term, multidisciplinary explorations that include projects, fieldwork, service, and culminating performances. Through these expeditions, students learn to work together in teams, meet challenges, and serve the community. Over 300 students self-select from 4 area school districts.

A main research question was how do students' test scores at RMSEL compare to scores at schools in RMSEL's four feeder districts. For this, the comparison group used students from the four feeder districts and included students that most closely matched those attending RMSEL in terms of achievement scores. Student achievement scores from these four districts were then weighted to reflect the proportion of RMSEL students from each of the districts. Standardized tests mandated by the state of Colorado (CSAP) were used to compare RMSEL with the four feeder districts. Academic achievement tests were administered via the state protocol each academic year from 1998 through 2002 at the schools in the academic achievement comparison group. A total of 54 comparisons across all grades (3-10), years (1998-2002), and subject areas were made between RMSEL and the four-county weighted mean.

The mean achievement score for RMSEL across all grades, subjects, and years was 58.13, which was higher than the mean of 51.9 for the four-county weighted comparison group. These results indicate that on average, 58% of RMSEL students scored at the proficient or advanced level, versus 52% for the comparison group scoring at that level. Difference scores ranged from a high of 34 (10th grade writing scores in 2001) favoring RMSEL students, to a low of –21 (4th grade writing scores in 2000) favoring the four-county weighted average. The strongest average differences favoring RMSEL occurred in the 6th and 7th grades. The lowest difference score occurred in the fourth grade, but still favored RMSEL students on average. Four subject areas were included in this analysis (reading, writing, math, and science). RMSEL students scored an average of 11.9 percentage points higher than did the comparison group across all grades and years. The least favorable comparison for RMSEL students occurred in math. Across all grades and years, (in Math) RMSEL students scored an average of 3.4 percentage points lower than did the comparison group.

Summary for Sterbinsky, A., (2002):

Focus	How do students' test scores at RMSEL compare to scores at schools in RMSEL's four feeder districts?
Target	RMSEL grades 3-10, compared to the mean scores of the feeder schools
Program Type	Outdoor learning emphasis. interdisciplinary, integrated teaching approach. Long-term, project-based learning experiences
Support/Other Factors	
Methods	Compared Colorado state achievement tests of RMSEL students from 1998-2002 with scores of weighted control group to adjust for differences in RMSEL and feeder group student populations

Impact	RMSEL students do slightly better than the comparison group in reading, writing, and science, but not in math.

Relevance:	
Measured academic achievement	Yes
Instruction as part of a school day	Yes
Quality:	
Randomized control study	No- 317 students at RMSEL compared with the mean scores by grade and subject for 4 feeder schools
Description of intervention and participants	Yes
300 plus students or 50 classrooms/schools	Yes
Valid outcome measures	Yes
Statistical tests on size/chance of impact	No- because the comparison was to a set of mean scores.

Appendix B: Less Definitive Research

The following studies measure impacts of environmental education programs on increased academic achievement and are often mentioned in research reviews, but were considered less strongly supportive for a variety of reasons. Research included here may have had a small sample size, had missing information on subjects or learning experiences, used non-standardized testing mechanisms, or raised other issues that made the results less relevant and/or less conclusive.

1. **Abrams, Kathy Shea. (1999). Summary of Project Outcomes from EE and SSS Schools' Final Report Data. Florida Office of Environmental Education. Tallahassee, FL. Retrieved from http://www.seer.org/pages/research.html#other**

   This study reported the results of work with 13 Florida schools. Of the 13 schools, only four schools (3 elementary and one middle) tracked and reported academic achievement outcomes. An integrated environmental education program with integration connections was offered to the teachers along with training and resource opportunities described below by the report author. Student learning experiences were varied by class and school. Outcomes were determined by comparing the scores of participating 4th and 8th grade students with the scores of the previous year's 4th and 8th grade classes. Scores increased in varying amounts as reported below. Improved behavior and attendance were also reported in addition to academic achievement scores.

   In addition to the information in the summary cited above, the author provided the following detail on the program: For the students that improved on Florida Writes! or the FCAT, 1,452 students at three schools were involved. All three are elementary schools. As for the frequency of EE lessons, the participating teachers at the 13 schools that received funding grants agreed to integrate EE into daily instruction in subject areas such as reading, writing, mathematics, science, social studies, art, and physical education. We offered professional development seminars, guides to subject integration, teaching curriculum, and a resource box that contained a number of student books and related class materials.

   In this summary, while this research is strongly suggestive of positive academic impacts, it is not conclusive evidence, principally due to missing data on other nine participating schools and the research methodology of comparing the scores of two different groups of students without review of matching characteristics. There is also limited information on the variation among interventions at the different control and tested groups. The author noted that efforts to obtain subsequent funding to do statistical significance analysis of the results, as well as a more qualitative assessment of other variables such as parent involvement and teacher interest, were not successful.

2. **Basile, C. G. (2000). Environmental Education as a Catalyst for Transfer of Learning in Young Children. *Journal of Environmental Education*. 32(1), 21-27.**

   This study was based on a seven week unit of instruction with nature walk using "Nature at your Doorstep". The children who were taught the outdoor nature investigation program were able to transfer knowledge more than those children who were not taught the program. However, when each knowledge component was considered separately, only procedural knowledge (process skills) appeared to be used correctly in both near and far transfer situations.

   In summary study suggests positive impact on transfer of procedural knowledge. Results limited because did not use a standardized test and only included 45 students.

3. **Beard, L. J., (1998) The relationship between outdoor classroom learning experiences and achievement and attitude of eighth grade students, Unpublished Doctoral Dissertation, The University of Southern Mississippi**

   This study looked at the impact of an outdoor classroom on students who were randomly selected from those attending the school for three consecutive years and experienced the use of an outdoor classroom during that time, including hands-on interdisciplinary units. The EE group mean combined score on the ITBS was significantly higher than the non-EE group.

   In summary, study suggests a positive impact on academic achievement but is limited by a small sample size of only 104 students.

4. **Blake, Anthony, (2004). Helping young children to see what is relevant and why: supporting cognitive change in earth science using analogy, *International Journal of Science Education*, 26(15) 1855–1873**

   This study examined the effect of providing upper primary-age children with the conceptual structure of the rock cycle together with the analogy of aluminium can recycling on their understanding of rocks. Students made gains in knowledge of earth science. It was one of the few studies to use random sampling. The research was focused mainly on the use of analogy as a technique.

   In summary, this study used an interesting approach to set up its research group and show an outcome in a particular targeted curriculum area. Results suggest specific curriculum knowledge outcomes, although not overall academic achievement in a subject. The research measured results using a non-standardized instrument, and only included 60 students.

5. **Falco, Edward. (2004). *Environment-Based Education: Improving Attitudes and Academics for Adolescents*. South Carolina Department of Education. Columbia, SC.**

   GPA was used at one school for evaluative purposes in the first year of EE. There are plans to use PACT data in successive years in ten schools using an EIC approach. One site reported that 64% of the 7th grade EIC students achieved a 3.0 GPA compared with the same group of students as 6th graders when only 28% had a 3.0 GPA .

   In summary, this study of 1400 5th-8th graders is very promising but more information is needed.

6. **Hitz, W.H., Jr., (2000) *The effect of teaching methodologies on student achievement in mathematics: The traditional classroom method and the agricultural and environmental education project-based experiential method*. Unpublished doctoral dissertation, Pennsylvania State University.**

   This study involved 95 10th graders in seven geometry classes in a single private school. A three month unit of instruction was evaluated and supports both methods of instruction. The data shows that students taught through the traditional classroom method produced higher achievement scores immediately following the unit of instruction. Students taught through the project-based method of instruction had a greater level of retention as indicated scores on the posttest taken three weeks after the last unit of instruction

In summary, suggests that project-based instruction causes a greater level of retention of math knowledge, although traditional methods resulted in higher achievement scores immediately following the lesson. Non-standardized tests, limited relation to environmental education per se, limit the impact of the results.

7. **Klemmer, C. D., Waliczek, T. M., & Zajicek, J. M. (2005) Growing Minds: The Effect of a School Gardening Program on the Science Achievement of Elementary Students, *HortTech*, 15(3) p. 448-452.**

   The purpose of this study was to assess the effectiveness of school gardens for enhancing the science achievement of elementary students in the third, fourth, and fifth grades. Researchers used a study population of 647 students and a standardized instrument, the Texas Essential Knowledge and Skills test to measure change. They also performed statistical tests for certain variables. The impact of the study results is limited by the use of a quasi-experimental design with non-matched groups with no description of important demographic information and the collection of only post-experience test data. The study concluded that students who participated in hands-on gardening activities had higher science achievement scores versus those who did not.

8. **Parish, D, and Phillips, G. (2005) Effects of Outdoor Education Programs for Children in California, American Institutes for Research, Palo Alto, CA. Retrieved from: www.air.org/news/documents/Outdoorschoolreport.pdf**

   The study focused on the educational and social-emotional impact of the environmental education programs on 255 students from elementary schools primarily serving at-risk 6th grade populations of Latino, English Learner students. A Science Knowledge Scale was used without a control group. Treatment group students had gains of eight pts. on the scale, but had taken it a total of three times.

   In summary, study results are suggestive of positive impacts, but limited by lack of a control group and study methodology.

9. **Randall, J. M. (2001). *Enhancing high school student writing skills with Florida biodiversity education*. University of Florida, Gainesville, FL. Masters thesis. Retrieved from http://purl.fcla.edu/fcla/etd/ank7125**

   One hundred and thirty-two 9th and 10th graders were evaluating using a pre-test, post-test, and writing rubric after completing four lessons on biodiversity and one lesson on writing. Scores assigned using the FCAT Writing Rubric are significantly higher on the last writing assignment than on the first writing assignment. Results suggest a positive impact on writing skills, but are limited by sample size, lack of control group, and lack of analysis of other factors that could influence improved performance.

10. **Zwick, T. T. & Miller, K. W., (1996) A Comparison of Integrated Outdoor Education Activities and Traditional Science Learning with American Indian Students, *Journal of American Indian Education*, 35(2) Retrieved from http://jaie.asu.edu/v35/V35S2com.htm**

    This study examines the validity of outdoor-based versus classroom-based science education

experiences for American Indian students using a series of hands-on outdoor education activities and compared this experimental group with traditional textbook and classroom science education. Data collection utilized the California Achievement Test 85 (CAT) and compared the American Indian students and non-native students in both the experimental and control groups. Findings indicate the American Indian students provided with the outdoor-based science curriculum scored significantly higher than those presented with traditional classroom science methods. Also, there was no significant difference between the American Indian students and the non-Indian students in the experimental group.

The results are strongly suggestive of a positive academic impact, but is limited by study size, since there were only 49 students total in 4th grade, in two classes (experiment and control) including 22 total American Indian students.

Appendix C: Related Academic Outcomes Research

Some of the studies uncovered in the literature search primarily addressed skills or attitudes that can contribute to academic achievement, such as critical thinking or motivation to learn. Although they do not address the main focus of this survey, these studies are sometimes included in summaries of research supporting the positive impact of EE on achievement and are interesting peek into an area of education research that may inform future research directions.

1. **Athman, J. & Monroe, M. (2004) The Effects of Environment-based Education on Students' Achievement Motivation*, Journal of Interpretation Research*, 9(1) 9-25**

   This study of 400 9th and 12th graders found that (controlling for GPA, gender and ethnicity), EIC programs significantly raised scores on surveys measuring achievement motivation. Critical thinking gains were attributed to environmental themes, open-ended research projects, student voice and empowerment, connection to community. Motivation gains were attributed to learning experiences tailored to students' interests/strengths, and applied to real-life issues/problems.

2. **Barnett, M., Houle, M., Rosca, C., Strauss, E., Chavez, D. Lord, C. (2005) *Improving Urban Youth's Interest and Engagement through Field-Based Scientific Investigations*, Lynch School of Education, Boston College. Retrieved from www2.bc.edu/~barnetge/urslg/papers/barnett_SSAM_UEFSP.pdf**

   418 randomly selected UEFSP students and 228 not participating in the program were given a pre-test. At the end of the academic year, the same questionnaire was given to 335 UEFSP students and 184 control students, who were randomly selected from schools that had participated in UEFSP. Pre-Post tests were not administered to the same students. The instrument used was a modified version of the Scientific Attitude Inventory II, using 63 questions to measure interest in science and understanding of investigative methodologies. At the start of the academic year there was no difference in the experimental and control group on the scales related to Science methodology and Science as Authority. The control group lost interest in being a scientist over the academic year, while the experimental group showed a significant increase in interest and in scores on the Science methodology scales.

3. **Cheak, M., Hungerford, H., & Volk, T. (2002). Molokai: An investment in children, the community and the environment. Carbondale, IL: Center for Instruction, Staff Development, and Evaluation.**

   This study did quantitative assessments using the MSELI (Middle School Environmental Literacy Inventory) and the Critical Thinking Test of Environmental Education (CTEE) instruments. The 38 5th and sixth grade students studied in depth were compared to a control group and were found to be using a wider range of reading materials and more difficult and challenging materials; to be skilled analysts of complex issues; to have improved writing skills; and to be more motivated learners.

   In summary, this study strongly suggests positive outcomes in skills that contribute to academic achievement. The small sample size of 66 limits it's relevancy.

4. **Ernst, J., & Monroe, M., (2004) The effects of environment-based education on students' critical thinking skills and disposition toward critical thinking, *Environmental Education Research*, 10 (4) 507-522**

   Four hundred four 9th and 12th grade students from 11 Florida high schools participated in the study. Tests included the Cornell Critical Thinking Test to measure critical thinking and the California Measure of Mental Motivation to measure disposition toward critical thinking. The results of this research suggest students who participated in environment-based programs were more skilled in critical thinking than their peers, including peers who were in traditional environmental science classes.

   In summary, this study strongly suggests positive outcomes in skills that contribute to academic achievement.

5. **Nava-Whitehead, S. (2002) The effect of the Nature's Classroom environmental education program on middle school student performance, Boston College, Unpublished doctoral dissertation. Available for $30 from http://wwwlib.umi.com/dissertations/fullcit/3066227**

   The impact of a 5 day residential program on 110 6^{th} graders was measured using the School Attitude Measurement (SAM) instrument, in order to capture the concept of Disposition to learn. Findings indicate that the environmental education program, positively affects a student's disposition to learn.

6. **Von Secker, Clare. (2004). Bay Schools Project: Year Three Summative Evaluation. Chesapeake Bay Foundation. Annapolis, MD. Retrieved from www.seer.org/pages/research/BaySchools2004.pdf**

   Evaluation of a project at three elementary schools and two middle schools – that used in-depth problem-solving projects related to watershed-found that students' environmental knowledge, attitudes, and stewardship behaviors were increased, along with students' engagement in learning. Knowledge was measured related to the Chesapeake Bay. The schools provided their own comparison groups because the students were grouped according to the intensity of their EE experiences."

Appendix D: Literature Compilations and Analyses

There are seven reports in this category that vary in relevance to our search directives and rigor of their research analysis. They are widely cited and were primarily used to identify original research on the relationship of environmental education and academic achievement. They are described below in order to identify particular trends in recommendations about best practices or areas for future research.

1. ***ASCD Forum On EE And School Reform*, Edited Transcript (2002), Smithsonian Center for Education and Museum Studies, Washington, DC, Retrieved from http://eelink.net/ascd_forum_on_EE.pdf**

   Quote from Gary Heath: "Environmental education programs that are not aligned with NCLB are going to be in trouble, but those that show rigorous alignment will have new opportunities. The State Education and Environment Roundtable reports and research have been very helpful, but more data is needed from the schools and the environmental community demonstrating that environmental education programs are meeting the needs of children, including children in poverty. If such data is compiled, new funding will be available through NCLB. If it is not, funding will flow right back into "drill nd kill" reading and math instructional programs."

   "The accountability requirement of NCLB may also create opportunities for environmental education, and environmental educators should be ready to provide new solutions to educational challenges as they arise. For example, Maryland and many other states will measure reading at the tenth-grade level for the first time. Some schools in Maryland are using the "environment as an integrating context for learning" (EIC)1 model to ensure they meet this challenge."p.2

2. **Duffin, M., & PEER Associates. (2005). Place-based Education and Academic Achievement. Retrieved from http://www.seer.org/pages/research.html#other**

   This document reviews research and evaluation on impacts of place-based education on student academic achievement. Part 1 summarizes the results of ten studies from across the United States, involving over 1400 students and 342 educators. Part 2 summarizes the results from the Place-based Education Evaluation Collaborative (PEEC) and CO-SEED. This part also covers a pilot test of a dose-response measurement strategy, as an alternative to pre-post test measurements.
   - Standardized test scores (MCAS) showed that 8th grade students at Beebe Health and Environmental Magnet School (Massachusetts) scored higher than state and district averages in the life sciences, moving from 60% to 73%.
   - Standardized test scores (MCAS) showed that 8th grade students at Beebe Health and Environmental Magnet School (Massachusetts) improved in math and went from scoring below the district average to scoring at the state average, moving from 40% to 54%.
   - First-grade students at the Young Achievers School who received more place-based education outperformed peers on all measures.

3. **Glenn, J.L, (2000). Environment-based Education: Creating High Performance Schools and Students. National Environmental Education & Training Foundation, Washington, DC. Retrieved from http://www.neetf.org/pubs/NEETF8400.pdf**

   This report summarizes seven case studies of five individual schools, a model school program involving five schools, and a statewide program, all of which have adopted EE as the central focus of their academic programs. Also included is a case study of a school that participated in an

educational research project on the use of environment-based education in teaching transfer of knowledge. It appears that each of the studies has flaws from the perspective of current educational research standards. For instance, Hawley Environmental Elementary School, as reported by the DOE, had a new principal leading a school-wide reform effort that included data-driven decision making and parental involvement. Improved scores in reading and math are compared with similar Milwaukee schools. 330 K-5 students dramatically improved test scores; 83% of students were at or above Proficient Level in Reading, compared with 38% of students at similar income level schools, and 69% statewide. Hawley students scored 48% at or above Proficient Level in Math, compared with 15% of students at similar income level schools and 52% statewide. At the School for Environmental Studies, test data collected over two years shows that SES students have exceeded state and national norms, as measured by ACT raw scores, in all academic areas. Of 400 HS juniors and seniors, only 60-65% took the ACT test. Two studies included had 19 and 45 students respectively. Results from Pine Jog Model Schools show improved achievement as measured on two Florida assessment tests, Florida Writes and the Florida Comprehensive Assessment Tests (FCAT) when compared to prior year scores. This is problematic as scores for other schools may also have gone up from 1998-1999.

4. **Hart, P., & Nolan, K. (1999). A critical analysis of research in environmental education. *Studies in Science Education*, 34, 1-69. Leeds, UK: Centre for Studies in Science and Mathematics Education, The University of Leeds.**

   Hart and Nolan identified six broad categories of environmental education research:
   - Quantitative research on variables such as environmental knowledge, attitudes, and behaviour.
   - Qualitative research such as case study, narrative inquiry, action/participatory research.
   - Descriptive reports of research focusing on the efficacy of environmental education programmes or episodes, or on the results of large-scale status studies, policy analysis, and evaluative studies.
   - Focused inquiries on teacher thinking, student thinking, children's ideas, significant life experiences, cultural studies, and teacher education.
   - Meta-methodological discussions which included critical/analytical, theoretical, and philosophical discussions of method, methodology, epistemology, and ontology, as well as reviews of other environmental education research.
   - Research-based theoretical discussions about environmental education research and its meaning within education and global societies

   The review suggests that it would be difficult to identify "key characteristics of effective practice that lead to students developing and demonstrating the skills, knowledge, attitudes, values, and actions that support the aims of environmental education", the first research question for this review. It suggests that few studies in the field of environmental education have focused on the characteristics of different kinds of environmental education practices, and their subsequent effects, impacts, or outcomes for students. Few contain evaluative information about students' learning experiences or consequent outcomes of environmental education for students. (Unable to obtain a full copy.)

5. **Leeming, F., Dwyer, W., Porter, B., & Cobern, M. (1993). Outcome research in environmental education: A critical review. Journal of Environmental Education, 24 (4), 8-21.**

This review includes an analysis of the 34 environmental education studies published since 1974 that attempted to demonstrate changes in environmentally relevant knowledge, attitudes, or behaviors. The authors divide the studies into two major categories-in-class and out-of-class programs-and critique the studies' findings and methodologies. Although many of the investigations contained methodological difficulties, some of the findings indicate that future research can refine environmental education strategies and curricula.

6. **Neill, J. T. & Richards, G. E., (1998). Does Outdoor Education Really Work? A Summary of recent meta-analyses, Australian Journal of Outdoor Education, 3(1) 1-9. Retrieved from http://www.wilderdom.com/pdf/Neill&Richards1998DoesOutdoorEducationReallyWork.pdf**

   This article covers three meta-analyses of the effects of outdoor education have been conducted (Cason & Gillis, 1994; Hans, 1997; Hattie, Marsh, Neill, & Richards, 1997). Overall these studies, representing over 12,000 participants, show that outdoor education has a small to medium impact on typically measured outcomes such as changes in self-concept, self-confidence and locus of control. These effects seem not only to be retained over time but to increase still further, which is impressive. The most effective programs seem to be longer, involve adult-age participants and to be conducted by some particular organizations.

7. **Rickinson, M., Dillon, J., Teamey, K., Morris, M., Choi M.Y., Sanders, D., & Benefield, P. (2004). *A Review of Research on Outdoor Learning*. London: National Foundation for Educational Research and King's College London. Summary retrieved from www.field-studies-council.org/documents/ general/NFER/NFER%20Exec%20Summary.pdf**

   This report summarizes 150 outdoor learning research studies done between 1993-2003, internationally, in primary, secondary and tertiary education sectors. Outdoor learning studies are categorized as focusing on field work, outdoor adventure, and school grounds/community programs. It concludes that there is good support that outdoor learning has positive impacts on school students. It has been criticized for a lack of critical appraisal of research evidence, tendency to rely on significant test results rather than comparison/benchmarking of effect sizes, and lack of critical commentary on quality of instruments. A detailed review can be found at http://www.wilderdom.com/research/ReviewResearchOutdoorLearningRickinson2004.html

8. **Volk, T. & McBeth, B. (1997) Environmental Literacy in the United States. North American Association for Environmental Education, Rock Spring, GA**

   Volk and McBeth report that students who experience issues-based EE make significant cognitive and skill gains, with notable improvements in levels of measurable achievement. For example, students at Hawley Environmental Elementary School (also reported in Glenn above) exceeded the state average on both state tests and nationally-normed assessments , scoring higher than all other schools in Wisconsin with similar socio-economic status.

Appendix E: Articles and Reports

1. **The Acorn Group, (2005) The School Diversion and Environmental Education Law: School DEEL and environmental service-learning : case studies and technical support, California Integrated Waste Management Board, Sacramento, CA**

   36 page report on activities at schools as a result of The School Diversion and Environmental Education Law (SB373).

2. **Angell, T., Ferguson, L., & Tudor, M. (2001) Better Test Scores through Environmental Education? *Clearing*, 110, p. 20-22, Retrieved from www.wfpa.org/ee/WFPAEE/Current_action_research/Better_Test_Scores.pdf**

   This article briefly describes the Washington Environmental Education Assessment Project process and anticipated outcomes.

3. **Archie, M. (2001) Environmental Education, Moving into the Educational Mainstream, *InfoBrief*, Association for Supervision and Curriculum Development, 26. Retrieved 4/14/06 from http://www.ascd.org/ed_topics/ib_issue26.html**

   This article cites research including Glenn (2000) and Lieberman & Hoody (1999) and notes that the three largest national environmental education projects (Project WET, Project Learning Tree, and Project WILD) have correlated their curriculum materials to national and state standards. Although slightly out of date, it covers efforts to link EE to formal education.

4. **Archie, M. (2003) *Advancing Education Through Environmental Literacy*, Association for Supervision and Curriculum Development, Retrieved from http://www.ascd.org under Books/Curriculum**

   This brief article cites Glenn (2000), Lieberman & Hoody (1998) and the Washington Environmental Education Assessment Project. Article accompanies a CD of EE activities and resources.

5. **Austin, A. W., (1991) *Assessment for Excellence: the Philosophy and Practice of Assessment and Evaluation in Higher Education*. New York: American Council on Education, MacMillan Publishing Company**

   Referenced by Bartosh 2003 and this survey for a model of inputs, environmental and learning factors and academic outputs. (See Figure 1 of this report in Section III: Analysis)

6. **Ballantyne, R., Packer, J, & Everett, M., (2005) Measuring Environmental Education Program and Learning in the Field: Using an Action Research Cycle to Develop a Tool for Use with Young Students, *Australian Journal of Environmental Education*, 21, p. 23-34.**

   This paper reports on the development of a tool based on observation of 134 students, aged six to eleven, attending programs at an Environmental Education Centre in Queensland, Australia. The resulting instrument incorporates observations of students' engagement in learning processes as

well as measuring learning outcomes, and allows both of these aspects to be linked to particular components of the environmental education program. Test data using the instrument are reported to illustrate its potential usefulness.

7. **Boss, S. (2001) Schoolyard Science Takes Root, Northwest Teacher, NW Regional Educational Laboratory, (3)1. Retrieved on 4/14/06 from http://www.nwrel.org/msec/nwteacher/fall2001/schoolyard.html**

   Describes classroom experiences with outdoor education and notes that more than 1,000 schools nationwide have joined the Garden in Every School Registry maintained by the National Gardening Association and another 1,100 schools have launched Schoolyard Habitat projects, organized by the National Wildlife Federation.

8. **California Department of Education, Education and the Environment: Strategic Initiatives for Enhancing Education in California. Available from http://www.cde.ca.gov/re/pn/rc/ap/pubdisplay.aspx?ID=001571**

   This document suggests ways to improve and expand on the statewide infrastructure of educational programs centered on environment-based learning.

9. **Chard, S. C., & Flockhart, M. E., (2002) Learning in the Park, *Educational Leadership,* 60(3) 53-56 Retrieved from http://www.ascd.org/ed_topics/el200211_chard.html**

   Fourth and 5th grade teachers and students applied the project approach to study a local park, focus on reading and writing, and make connections across the curriculum.

10. **Coyle, K. J. (2004) Understanding Environmental Literacy: What Ten Years of NEETF/Roper research and related studies tell us about how to achieve environmental literacy in America, National Environmental Education & Training Foundation, Washington, D.C.**

    Includes a chapter on EE and achievement that describes work of SEER and others.

11. **Daas, P. M., (1999) Contemporary Environmental Issues: Creating Curricular Connections In K-12 Education, *Bulletin of Science, Technology & Society,* 19(2) 147-154. Available from http://bst.sagepub.com/cgi/content/abstract/19/2/147 $15 for one time view. Xerox copy.**

    Abstract: The nature of contemporary issues facing our society and the research being conducted to deal with them clearly crosses the boundaries of traditional academic disciplines. Hence, it is suggested that school education should provide students with interdisciplinary learning experiences in which students learn to use knowledge from various academic disciplines in an integrated format within the context of specific real-life issues. Trans-disciplinary approaches hold the promise of helping students see real-life issues in an organic rather than fragmented manner and be able to apply knowledge to deal with them in an organic manner. A majority of the contemporary issues facing our society relate to the environment. Hence, environmental issues can serve as excellent organizers for designing trans-disciplinary instructional units. Arguments in favor of organizing

trans-disciplinary instruction around contemporary environmental issues and an approach for doing so are presented in this article.

Cites Bruner (1971) and Reinsmith (1993) “Research in education points to the fact that most meaningful learning takes place when instruction happens within the context of real-life experiences, issues, and concerns.

12. Dyment, J. (2005) Green School Grounds as Sites for Outdoor Learning: Barriers and Opportunities., *International Research in Geographical and Environmental Education*. 14(1) 28–45. Retrieved on 4/18/06 from http://www.multilingual-matters.net/irgee/014/0028/irgee0140028.pdf

Environmental Education and Training Partnership (EETAP) (2004) How Environmental Education is Used in Schools, North American Association for Environmental Education, Rock Spring. Fact sheet that describes four broad approaches to environmental education: infusion, imposition, insertion, and framing.

13. Environmental Education and Training Partnership (EETAP) (1999) Environmental Education: A Tool for Making Education Reform Work, North American Association for Environmental Education, Rock Spring,

Brief article correlates aims of EE with reform. Describes ways in which the goals of environmental education and education reform are strikingly similar, in terms of curriculum, instruction, use of the school site and community, assessment.

14. Environmental Education and Training Partnership (EETAP) (2004) How Environmental Education is Used in Schools, North American Association for Environmental Education, Rock Spring,

Report describes four broad approaches to incorporating environmental education into schools, and curriculum, including infusion, imposition, insertion, and framing.

15. Franklin, J., (2004). Planting the Seeds of Knowledge, How Environmental Literacy Helps Students Achieve, *Curriculum Update*, Association for Supervision and Curriculum Development, http://www.ascd.org/affiliates/articles/cu2004summer_franklin.html

This is a brief report on Science Teams in Rural Environments for Aquatic Management Studies (STREAMS), a program that combines language arts instruction with math, science, and social studies under an environmental umbrella, and a call for more integration of EE.

"Environmental education has been squeezed out of many classes," says Vicki Newberry, a 6th grade teacher in Kaunakakai, Hawaii. "It's a very small piece of the pie, [but] more funds are being diverted into math and science" because they are on state tests. This diversion frustrates Newberry and others, because studies show that when students are actively involved with environmental education, they frequently perform better on state tests. "In almost every event when numbers have been correlated, students who take environmental education tend to test better in science, reading, and social studies," says Kevin Coyle, president of the National Environmental Education & Training Foundation. "They tend to have higher attendance and fewer discipline problems as well." (Also cites SEER research.)

16. Howe, R.W. & Warren, C. (1989) Teaching Critical Thinking through Environmental Education. *ERIC/SMEAC Environmental Education Digest No. 2*

Discussion of why environmental education is an important focus for critical thinking and an effective mechanism to enhance critical thinking. Report states that environmental education provides a good mechanism for developing critical thinking skills by (1) providing topics and problems that cut across the school curriculum and can enhance the integration of knowledge, (2) providing real problems that can be studied or simulated, and (3) by providing topics and problems that can be adjusted to the developmental levels of students..

17. Kennedy, C. (1999). In the Cascade Reservoir Restoration Project Students Tackle Real-World Problems. *ENC Focus* 6 (2), 18-25. Retrieved from http://courses.umass.edu/educ512f/Sept19Materials/classroominquiryexample.html

This is a report is a case study of a high school-based, environmental curriculum. Cascade High School's advanced biology course has evolved into a two-year program. Students join the class as juniors and work on their specific projects through their senior year. Class periods are 95 minutes long, allowing complex labs to be run during class time. Field trips are taken for half days, full days, and weekends. "The success of the Cascade Reservoir Restoration Project is a testament to the impact a non-traditional teaching approach can have not only on the students involved but on the entire community and its natural environment."

18. Lieberman, G.A., & Hoody, L.L (1998). *Closing the Achievement Gap: Using the Environment as an Integrating Context for Learning*. San Diego, CA: State Education and Environment Roundtable. Executive Summary retrieved from http://www.seer.org/pages/GAP.html (Full copy $21.17 from SEER)

This report presents the results of an early, principally qualitative nationwide study of the results of Using the Environment as an Integrating Context for learning (EIC), a term coined by the State Education and Environment Roundtable. Two subsequent quantitative studies involving these authors are included in the strongest research section of this report.

This study looked at 40 schools using various EIC techniques for at least two years, with an average of around seven years of ongoing programs overall. The research used site visits, interviews, and survey results to: 1) describe a range of successful EIC-based programs across the United States; 2) identify the major characteristics of successful EIC programs; and 3) analyze the implications of EIC-based education for student learning and instruction. The evidence gathered from the study indicates that students learn more effectively within an environment-based context that uses the particular pedagogical approaches of EIC than within a traditional educational framework. Participating schools also noted :

- reduced discipline and classroom management problems;
- increased engagement and enthusiasm for learning; and,
- greater pride and ownership in accomplishments.

Participants reported that EIC students also tended to read more, often beyond the requirements of their assignments. They retained more of what they learned and produced greater volumes of higher quality writing. They had more opportunities to apply mathematics and science in real-world contexts and better understood the concepts of these subjects.

19. Loveland, E. (2003) Achieving Academic Goals through Place-Based Learning: Students in Five States Show How To Do It. Rural Roots, 4 (1) 6-11

Reports on place-based learning efforts taking place in Alaska, Oregon, Colorado, Nebraska, and California. Place-based education roots learning in real issues and needs and helps students become both academic achievers and good citizens. This article profiles programs in five states that are fostering academic achievement. Two of the profiles included environmental education. The Alaska Rural Systemic Initiative (AKRSI) links Alaska Native culture and indigenous knowledge with the formal educational system and develops specialized curricula to relate basic math and science concepts to the local environment. 8th grade scores on CAT-5 math tests for four years in schools using place-based learning showed a gain in scores over schools that do not. AKRSI districts now have 24.3 percent of students in the upper quartile on these math tests, less than one percent below the national average. The Russian Mission School is one school in AKRSI that dramatically improved test scores and student attendance and dropout rates after local subsistence activities and Native culture were tied to the curriculum. In Tillamook, Oregon, students worked with the Oregon Department of Forestry to survey the status of logged areas and to create an interpretive walkway featuring animal tracks in concrete. No achievement measures cited.

20. Monroe, M. C., Randall, J. & Crisp, V, (2001) Improving Student Achievement with Environmental Education, Retrieved from http://edis.ifas.ufl.edu/BODY_FR114

This document provides background and reports on EE in Florida in relation to academic achievement.

21. National Environmental Education Advisory Council, (1996) Report Assessing Environmental Education in The United States and the Implementation of the National Environmental Education Act of 1990, EPA, Washington DC. Retrieved from www.epa.gov/enviroed/pdf/report.pdf

Provides recommendations for implementing the National Environmental Education Act of 1990. "Many goals of the education reform movement emphasize the importance of strengthening core subjects such as math, science, and geography as well as teaching in an interdisciplinary manner across subject areas…Environmental education has tremendous potential for contributing to the goals of the education reform movement… In fact, a 1993 federal interagency report on environmental education and training, concluded that:

". . . infusing environmental education into all subject areas can lead to overall improvements in the educational system, including improvements in teaching the core subjects."" p. 5

22. National Environmental Education Advisory Council, (2005), Setting the Standard, Measuring Results, Celebrating Successes. A Report to Congress on the Status of Environmental Education in the United States, Retrieved from http://www.epa.gov/enviroed/pdf/reporttocongress2005.pdf

Reports on 15 years of progress in implementing the the National Environmental Education Act of 1990 and further recommendations. The Council is an 11-member citizen body with diverse representation from across the country. It provides EPA with recommendations for enhancing

environmental education in the Agency. In addition, the Council serves as a national voice for environmental education and helps to provide a strategic vision in support of institutionalizing the field. A Web site www.eelink.net has been established as a resource. Their report states that:

- A sustainable and rigorous process for reviewing the quality of environmental education materials is in development. (p.27)
- "One of the most important ways to improve the quality of environmental education is with a body of empirical research that identifies strengths, weaknesses, and gaps in all aspects of the field. Investment in research is essential for showing the connection between environmental education and improved student achievement." (p.29)
- A significant body of research exists on various aspects of environmental education, including: The effectiveness of environmental education in improving student achievement and meeting education reform goals. The scope of this research, however, tends to be limited (particularly in terms of focus, methodology, geography, and populations), leaving gaps in what is truly known about the field. Comprehensive, long-term research initiatives are imperative to address these issues. (p.40)

In addition to the National Network for Environmental Management Studies Fellowship Program, the Office of Environmental Education has funded many initiatives in support of research. In conjunction with the North American Association for Environmental Education and the National Environmental Education and Training Foundation, the Office of Environmental Education developed a national research agenda for environmental education in 1998. Leading practitioners, providers, policymakers, and researchers in environmental education came together to develop a research road map that could be used to further the field. These individuals identified six research areas as crucial to understanding and improving environmental education and environmental literacy, including:

- What is the status of environmental literacy in the United States in terms of knowledge, attitudes, thinking skills, and behaviors across age groups and populations?
- What impact does environmental educationin the United States have on improving student academic performance?

The report lists action items related to measurement:

- Support collaboration between the Office of Environmental Education and other evaluation leaders in the field to develop the measurement framework and guidelines. Conduct research on what to evaluate, how to evaluate, and which evaluation tools are most appropriate.
- Ensure that the measurement framework and guidelines; existing, proven assessment tools; and new tools (as they are developed and tested) are accessible to users and easy to find.
- Ensure that environmental education grants funded by the Office of Environmental Education include a strong evaluation component and an appropriate amount of funding to support project evaluation.

23. National Environmental Education & Training Foundation (NEETF), (2000). Environment-based Education: Creating High Performance Schools and Students. National Environmental Education & Training Foundation, Washington, DC. Retrieved on 4/28/06 from http://www.neetf.org/pubs/NEETF8400.pdf

Report provides recommendations to the Department of Education as well as case study reports on seven school-based EE programs, including some academic results.

24. North American Association for Environmental Education, & National Environmental Education & Training Foundation. (2001). Using environment-based education to advance learning skills and character development. Washington, DC: Author. Retrieved from http://www.neetf.org/pubs/EnviroEdReport.pdf

Report argues that EE offers the ingredients of effective learning, builds character and prepares students to be employed and to act as leaders. NAAEE accepts the definition of EE from the National Project for Excellence in Environmental Education. “Environmental education is a process that aims to develop an environmentally literate citizenry that can compete in our global economy; has the skills, knowledge, and inclinations to make well - informed choices; and exercises the rights and responsibilities of members of a community.” They reviewed research abstracts to see if EE supports and sustains American values and benefits American Youth. They concluded that the research on EE is does support American values. They feel the research is academically rigorous and pays off in higher test scores, citing six papers to support that assertion. Several of these were reports on school-based activities, not research reports.

EBE Offers the Basic Ingredients of Effective Learning because it is Student-Directed, adapts to different learning styles, and the academic process is rigorous. “ It is well established that young people learn best when they develop their own paths of discovery. Most good environment-based programs use investigative approaches and student-directed learning. Several studies indicate that focusing on student needs empowers learners and leads to greater overall achievement levels and higher self-esteem. Rainer and Guyton (1999) confirm the premise that teachers who encourage students to make choices about their learning see a positive attitudinal influence.” (p. 8)

25. Rasmussen, K., (2000). Environmental Education Evolves, Developing Citizens, Furthering Education Reform, *Educational Update*, Association for Supervision and Curriculum Development 42(1) Retrieved from http://www.ascd.org/ed_topics/eu200001_rasmussen.html

One important reason to teach about the environment in K–12 education is that "schools can create a scope and sequence," so children don't learn the same things about the rain forest in 1st, 2nd, and 3rd grades, notes Rosalyn McKeown-Ice, director of the Center for Geography and Environmental Education at the University of Tennessee–Knoxville.

Moreover, content and skills taught in environmental education often correlate to national and state standards, says Simmons. As a result, "adding environmental education doesn't add another layer to the curriculum; it becomes the common fabric that holds the curriculum together," states Donnan Stoicovy, principal of Park Forest Elementary School in State College, Pa.

26. Shinn, G. C., Briers, G. E., Christiansen, J. E., Edwards, M. C., Harlin, J. F., Lawver, D. E., Lindner, J. R., Murphy, T. H., and Parr, B.A. (2003). *Improving student achievement in mathematics: An important role for secondary agricultural education in the 21st Century.* Unpublished manuscript. Texas A&M University. College Station, TX. Retrieved from http://www.teamaged.org/AgEdResearchWorkGroupMonographMathematics02Dec03.pdf.

This study makes the case for agricultural education as a means of improving math instruction, citing supportive research on math education and environmental education. “Contextual relationships have the potential to strengthen linkages among the learning environments of school, home, and community and add meaning to mathematics for students. Taylor and Mulhall (1997) concluded that agriculture, as a contextual relationship, can act as a unifying theme for curricula

and can add meaning to what students learn. Ewen (2002) concluded that the question of how to motivate students in the classroom has become a leading concern for teachers of all disciplines. Student motivation and student management (Cawelti, 1999; Wong, 2003) are especially relevant to mathematics education in light of recurring questions about how to get more students interested and involved in learning. Lesh (1985) concluded that if students were provided with everyday situations for practicing and learning the important uses of mathematics, they would develop such skills as "making inferences, evaluating the reasonableness of results . . . [and] using references to 'look up' what they need to know""

27. Volk, T. L., & Cheak, M., (2003) The Effects of an Environmental Education Program on Students, Parents, and Community. *The Journal of Environmental Education* 34 (4) 12-25

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This is a discussion of the relationships among place-based education, outdoor education, and environmental education.

Appendix F: Additional Information on People and Organizations

PEOPLE

Gabriele Phillips is a Senior Research Scientist with AIR in Palo Alto. In this role, she currently serves on the Statewide Data Collection and Evaluation of Proposition 10 Funded Programs team for First 5 California and the Evaluation of Family Literacy Programs for the LA Children and Families Commission. She recently began a project investigating the Impact of Outdoor Education on Sixth Grade Students in California for the California State Department of Education. Phone: (650) 843-8100

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3yr study on the effect of environmental awareness activities on student performance in 34 middle and high schools.

Listing of researchers in outdoor ed.
http://www.wilderdom.com/oe/doku.php?id=research:people

ORGANIZATIONS

ASCD Environmental Education Network
- Promotes awareness and understanding of environmental education, while also playing an advocacy role in support of environmental education
- Provides a forum for members to network and discuss issues related to environmental education

Network Facilitator, Bora Simmon, E-mail: boras@niu.edu
http://eelink.net/environmentaleducationnetwork.html

The Association for Experiential Education (AEE) is a nonprofit, professional membership association dedicated to experiential education and the people who work in the various fields that use it. They publish the Journal of Experiential Education.

GLOBE is an interagency program funded by the National Aeronautics and Space Administration (NASA) and the National Science Foundation (NSF), implemented through a cooperative agreement between NASA, the University Corporation for Atmospheric Research (UCAR) in Boulder, Colorado and Colorado State University. It is also a cooperative effort of schools in partnership with colleges and universities, state and local school systems, and non-government organizations. Internationally, GLOBE is a partnership between the United States and other countries. **31000** GLOBE-trained teachers from **17000** schools have contributed **14 million** measurements to GLOBE. This has been made possible through the efforts of **109** participating countries and **130** U.S. Partners
Contact: 1-800-858-9947 help@globe.gov.

California Environmental Education Interagency Network (CEEIN)
Consortium of environmental educators from California state agencies who supply environmental educational services, materials, and programs. http://www.calepa.ca.gov/education/CEEIN/

California Regional Environmental Education Community (CREEC) Network
A statewide project, directed by California Department of Education (CDE), providing educators with high quality environmental education resources.. http://www.creec.org/

The Centre for Research in Education and the Environment (CREE) is part of the Curriculum and Pedagogy Research Group (CP), Department of Education, University of Bath. Publisher of Environmental Education Research. http://www.bath.ac.uk/cree/research.htm

Environmental Protection Agency (EPA) - Office of Environmental Education
The EPA Office of Environmental Education is advancing and supporting education efforts to develop an environmentally conscious and responsible public and inspiring personal responsibility in caring for the environment.
http://www.epa.gov/enviroed/

EETAP - Environmental Education and Training Partnership
EETAP is a national leader in the delivery of environmental education training for education professionals. EETAP is funded by the U.S. Environmental Protection Agency's Office of Environmental Education through a cooperative agreement with the University of Wisconsin-Stevens Point. Website includes guidelines for excellence in EE.
http://eetap.org

National Environmental Education and Training Foundation (NEETF)
NEETF supports a wide array of EE efforts: research, conferences, training, communications, and programs for all ages. Challenge Grants focus on the areas of health, drinking water, business and educational excellence.
http://www.neetf.org/

NEEAP - National Environmental Education Advancement Project
Located at the University of Wisconsin-Stevens Point, NEEAP is a national organization which aids state and local environmental education leaders in promoting their environmental education efforts and develops informational resources for building state capacities for environmental education. The EE Advocate, NEEAP's newsletter, is available online.
http://www.uwsp.edu/cnr/neeap/

North American Association for Environmental Education (NAAEE)
"Established in 1971, NAAEE is a network of professionals and students working in the field of environmental education throughout North America and in over 55 countries around the world." It is host to the **National Project for Excellence in Environmental Education,** located at Northern Illinois University.
http://www.naaee.org/

State Education & Environment Roundtable (SEER)
http://www.seer.org/
SEER has state networks in California (27 schools), Florida (13 schools), Georgia (13 schools), Idaho (8 schools), Iowa (17 schools), Maryland (9 schools with CBF), Minnesota (12 schools in cooperative effort with the Audubon Center of the North Woods), Massachusetts (4 schools), New Jersey (10 schools), South Carolina (10 schools), Texas (13 schools), Washington (1 CSRD school). in Iowa, beginning in 2006, SEER and the ISDE will be kicking off an evaluation and student assessment project that will evaluate the changes in student achievement and instructional practices that have resulted from this joint program.

Appendix G: Educational Research and Evaluation Guidelines

From H.R. 3801 - Education Science Reform Act of 2002

The quality factors used in this study were drawn from the standards for evidence-based research listed in H.R. 3801, the Education Sciences Reform Act of 2002. The definition of scientifically-based research standards and scientifically valid education evaluation from the Education Sciences Reform Act of 2002 are listed below. The U.S. Department of Education, the Institute of Education Sciences, The National Center for Education Evaluation and Regional Assistance, and the National Science Foundation are all involved in efforts to clarify the role of evidence-based standards for research in education, particularly as those research standards are influenced by statistical methods and theory. In the United States, the concept of a gold standard for education research has been established and the potential impact of evidence-based research is global.

(18) SCIENTIFICALLY BASED RESEARCH STANDARDS.—

(A) The term ‘‘scientifically based research standards’’ means research standards that—

(i) apply rigorous, systematic, and objective methodology to obtain reliable and valid knowledge relevant to education activities and programs; and

(ii) present findings and make claims that are appropriate to and supported by the methods that have been employed.

(B) The term includes, appropriate to the research being conducted—

(i) employing systematic, empirical methods that draw on observation or experiment;

(ii) involving data analyses that are adequate to support the general findings;

(iii) relying on measurements or observational methods that provide reliable data;

(iv) making claims of causal relationships only in random assignment experiments or other designs (to the extent such designs substantially eliminate plausible competing explanations for the obtained results);

(v) ensuring that studies and methods are presented in sufficient detail and clarity to allow for replication or, at a minimum, to offer the opportunity to build systematically on the findings of the research;

(vi) obtaining acceptance by a peer-reviewed journal or approval by a panel of independent experts through a comparably rigorous, objective, and scientific review; and

(vii) using research designs and methods appropriate to the research question posed.

(19) SCIENTIFICALLY VALID EDUCATION EVALUATION.—

The term ‘‘scientifically valid education evaluation’’ means an evaluation that—

(A) adheres to the highest possible standards of quality with respect to research design and statistical analysis;

(B) provides an adequate description of the programs evaluated and, to the extent possible, examines the relationship between program implementation and program impacts;

(C) provides an analysis of the results achieved by the program with respect to its projected effects;

(D) employs experimental designs using random assignment, when feasible, and other research methodologies that allow for the strongest possible causal inferences when random assignment is not feasible; and

(E) may study program implementation through a combination of scientifically valid and reliable methods.

Bibliography

Includes all documents reviewed in the survey of literature on the academic outcomes of environmentally-based programs, including the following categories:

- Strongest Research
- Less Definitive Research
- Related Outcomes Research
- Literature Compilations and Analyses
- Related Articles and Reports
- Not Relevant Materials (*materials that are not about academically-related outcomes of environmental school-based programs)*

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