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The Educational Efficacy of Environmental Education

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The Educational Efficacy of Environmental Education

INTRODUCTION

A study of environmental education (EE) efforts by federal and state education agencies, school districts, universities and environmental organizations was conducted in 1994. As part of the study nine directors from successful state EE programs assembled to identify the actions needed to build a stronger knowledge base for the field of environmental education. In the subsequent document, Proposal for a State Environmental Education Network (Lieberman, 1995), "collection and analysis of evidence of the pedagogical efficacy of EE methodologies and content" were identified as high priority critical components for the successful implementation of state-based EE programs.

The study also included a national survey of 43 organizations that identified "evaluation and assessment research to gauge student achievement and the effectiveness of different programmatic approaches to EE" as one of the seven categories needed to increase the impact and effectiveness of EE.

A primary reason for establishing the State Education and Environment Roundtable (Roundtable) was to motivate education systems toward incorporating both methods and content modeled by EE. Additionally, the Roundtable serves to promote improved learning through systemic education reform efforts. Environmental education has much to offer the education reform movement. Fundamental to EE are pedagogical methods that include: hands-on activities; relevant subject matter; and topics that engage students, encouraging their active participation. Education reformers recognize EE as an effective tool in capturing students' enthusiasm for learning in subject areas ranging from science and math to literature (Lieberman, 1994).

As proponents of education reform and educational systems that fully integrate environmental education, the Roundtable recognizes the need for a strong foundation of research to generate and direct activities. This document is a preliminary report of the first of four major studies that the Roundtable will be conducting.

PURPOSE OF STUDY

The purpose of this study was to locate research that assesses the educational efficacy of EE; specifically, studies that analyze the influence of EE methods and

content on students' ability to learn in subject areas throughout the curriculum. Additionally, the study was designed to find research that evaluates educational programs in EE that use decision-making and problem-solving processes to develop higher level thinking skills.

The following report summarizes the research studies that have been identified and reviewed thus far in the process. It is the intention of the Roundtable staff that this interim report will generate additional professional contacts and lead to discovery of further research projects in the areas outlined within this summation.

If you are aware of any other references or resources for related research please contact: Ms. Linda Hoody, State Education and Environment Roundtable, 16486 Bernardo Center Drive, Suite 328, San Diego, California, 92128; telephone (619) 676-0272, fax (619) 676-1088, e-mail (round@millennianet.com).

RESEARCH METHODS AND INFORMATION SOURCES

Initial information resources were generated by performing a literature search through the ERIC database. Phone interviews were conducted over the course of several months in 1995. Bibliographies were collected from a number of leading national and international educators. Subscriptions to several research forums sponsored by the American Educational Research Association (AERA) on their ListServer system elicited additional responses to requests for applicable studies.

Over 150 documents were examined in the process of this study. Professional journals were the primary source of articles. The ERIC educational microfiche library was a valuable source for some conference presentations and unpublished documents.

It should be noted that the literature search focused on studies measuring the impact of EE on K-12 student experiences. Research describing teacher in-servicing, college level courses and community education programs were not included in this review.

A survey[1] was developed to identify research that has been conducted in the Roundtable's areas of interest. Almost 500 survey forms were mailed to registrants of the North American Association of Environmental Education (NAAEE) conference held in Portland, Maine in September 1995. Additional surveys were sent to prominent

[1] Appendix A is a copy of the survey form.

educational contacts generated by telephone conversations. Resources available on the Internet were also explored.

At present (11/14/95), approximately 95 survey forms have been returned. Hopefully, surveys yet to be received will identify more research projects.

All research reports were not readily available. Some masters theses and doctoral dissertations were difficult to locate and some research reports ordered from universities have not arrived as of the date of this report.

Terminology

Some distinctions need to be made concerning key terms. Most often "interdisciplinary" is used in the literature to indicate the use of two or more educational disciplines. "Transdisciplinary" signifies theme-based learning that emphasizes use of a wide range of knowledge and skills, not coming from a particular discipline (Hug, 1995)[2]. The term "interdisciplinary" is used in this report since it is the predominant term in the surveyed literature.

In recent years the term "environmental literacy" (EL) has come into widespread use. EE practitioners have worked under the assumption that EL would join the ranks of the more firmly established literacy definitions for English, geography, science and math.

Scientific literacy, for instance, has been defined as,

> "*...the knowledge you need to understand public issues. It is a mix of facts, vocabulary, concepts, history and philosophy. It is not the specialized stuff of the experts, but the more general, less precise knowledge used in political discourse. If you can understand the news of the day as it relates to science, if you can take articles with headlines about genetic engineering and the ozone hole and put them in a meaningful context...you are scientifically literate.*"
>
> (Hazen and Trefic, 1991)

A number of sources identified the need to establish EL standards for students (Brouillet, et. al. 1986, Hungerford 1987, Roth 1992). Measurement of literacy would then presumably focus on environmental knowledge including understanding the basics in areas such as ecological concepts, biogeochemical cycling, biodiversity, etc.

Leading environmental educators have, however, defined EL as a multi-dimensional guideline. As outlined by the Environmental Literacy Framework,

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[2] Appendix B is a collection of definitions prepared by John Hug (1995).

developed by the Environmental Literacy Assessment Consortium (ELAC), EL has: cognitive dimensions (knowledge and skills); affective dimensions; additional determinants of environmentally responsible behavior and personal and/or group involvement in environmentally responsible behaviors. C. Roth (1992) similarly defines EL as “essentially the capacity to perceive and interpret the relative health of environmental systems and take appropriate action to maintain, restore, or improve the health of those systems." While Hungerford and Tomera describe "environmentally literate" citizens as an individuals competent and willing to take action.

Roth’s definition exemplifies a trend in the EE community to define EL as going several steps beyond acquisition of knowledge. He stresses the students’ ability to interpret and act to maintain or improve the environment. This goal for EL emphasizes the need for complex strategies and action based on higher level procedural thinking. It more accurately approximates the advanced abilities of experts in the field.

The various definitions of environmental literacy call for well-developed skills in perception, interpretation and environmentally-based actions. Most of the assessments for levels of EL, however, appear to be content-driven rather than measuring action, as promoted by proponents of environmental literacy.

RESEARCH RESULTS

Organization of Results

This report was designed to review research publications in a systematic effort to locate studies that address the influence of EE on learning. During the literature review, distinct classifications of research projects emerged as characterized by different research and evaluation goals. The three major groupings of research include studies directed at measuring: knowledge and attitudes, attitudes only and behavior.

Affective and cognitive domains have long been recognized by educators as important fields of study. Research projects that measure cognitive outcomes range from analysis of basic knowledge acquisition (e.g., recall) to higher order thinking skills (e.g., synthesis and application). Studies that examine the affective domain explore the students’ emotional reactions to a given subject.

The research projects reviewed here are divided into three subsections: affective domain, cognitive domain and a combination of the two. Studies of knowledge and attitude generally use instruments that combine measurement of

environmental content with opinions or feelings regarding environmental issues (cognitive and affective domain). The attitudinal studies assess the students' environmentally-centered emotional responses (affective domain). The behavioral studies attempt to measure the students' actions in response to environmental concerns (reported as higher level cognitive domain).

Representative studies are cited as examples of each subcategory of research. This process helps to clarify the types of studies that do not address the research needs and objectives of the Roundtable and helps define the types of studies that are necessary to meet our objectives.

The conclusions and recommendation's section, focuses on postulation of reasons for the lack of research in the desired areas and recommendations for future study. Further discussion identifies the challenges of locating studies that meet the Roundtable's research objectives.

Studies to Measure Knowledge and Attitudes (Cognitive/Affective Domains)

Statements concerning attitudes and knowledge are often found in the objectives listed for EE programs. Iozzi (1989) points out that the cognitive and affective domains function cooperatively. Many research projects have used instruments to collect data that combine knowledge and attitude questions (Bennett, 1974, R. Roth, 1976, Fortner, 1978, Leeming, Dwyer, Porter and Cobern, 1993).

Studies in this research subcategory are characterized by instruments designed to assess knowledge and attitudes. These assessments combine questions measuring basic environmental and ecological knowledge with items to document students' feelings toward environmental issues and concerns.

Case 1

Hungerford, Bluhm, Volk and McBeth (1995) designed an evaluation instrument based on the Environmental Literacy Framework to measure the EL of middle school-age students. The instrument was designed to measure knowledge, perceived skill and action (relying on self-reported behavior). Their Middle School Environmental Literacy Instrument (MSELI) was used to collect field study data from six sites in five states.

The MSELI data were generated only during the design phase of their research work, lack of funding limited its broader usage. The project developers recommended conducting a comparative study between

students receiving in-depth EE curricula and those learners not receiving such instruction. This research has not yet been conducted.

Case 2

Bryant and Hungerford (1979) analyzed the effects of environmental instruction on two classes of kindergartners. Bryant simultaneously taught two classes a one week introductory unit on basic environmental concepts. For three weeks thereafter, the experimental group received activity-oriented instruction on pollution and solid waste. The conventional curriculum taught to the control group did not involve environmental issues. The treatments were then reversed. Each child participated in an interview consisting of four knowledge and opinion questions asked before and after the treatment. The evaluators reported a significant change and suggested that kindergarten children are capable of forming concepts concerning environmental subjects.

Case 3

Ramsey and Rickson (cited in Iozzi, 1984) investigated knowledge and attitudes associated with pollution issues. Their study included a stratified sample of 482 twelfth grade students.

Results indicated a skewed pattern of responses on the student's knowledge of ecological concepts. These researchers suggested that increased knowledge about the cause of pollution generates more positive attitudes toward corrective measures.

Ramsey and Rickson further commented on the nature of gaining knowledge and attitudes stating a belief that knowledge may lead to the beginning formation of attitudes which in turn leads to further knowledge acquisition. (This appears to be a common, but unproven theme in EE literature.)

Case 4

Fortner (1978) developed the Survey of Oceanic Attitudes and Knowledge (SOAK), to measure knowledge and attitudes of tenth grade students and relate those attributes to the students' marine experiences. She used three types of surveys covering 63 items to measure both knowledge and attitudes. Statewide, the 787 students who participated in the study demonstrated a knowledge level of fifty percent (50%). The results also indicated that their attitudes toward marine issues were moderately positive.

Discussion

With the exception of oral interviews of kindergartners in the Bryant and Hungerford study, questionnaires are generally used for data collection in this class of research. The research projects in this subsection do not immediately address our research objective.

Although the knowledge/attitude class of research includes measurement of EE content, it does not address instruction that is a marriage between content and methodology. These instruments strictly measure recall of facts combined with emotional reactions to environmental topics.

Studies to Measure Attitudes (Affective Domain)

The studies reviewed in this subsection sought to measure attitudes toward environmental subject matter. Many researchers express a desire to record development of positive affective outcomes following environmental instruction. Attitudinal studies are characterized by questionnaires using Likert scales and semantic differentials.

In A Summary of Research in Environmental Education, 1971-1982 (Iozzi et al., 1984), the greatest number of EE studies dealt with the affective domain. The point is then made that in other disciplines researchers tend to focus more heavily on the cognitive domain. Affective studies deal with the domain of emotions, expression of opinions and feelings. Extensive studies were conducted in the 1970's that primarily used instruments with semantic differentials and scales to measure the subjects' feelings about environmental issues.

Case 5

In one notable 1976 project by Bohl (cited in R. Roth, 1976), a national inventory was distributed to over 15,000 students . The outcome indicated that at equivalent grade levels, students generally have a poor grasp of factual knowledge, although they tended to express positive environmental attitudes in response to affective questions. These findings were reinforced by two similar national EE assessments completed during the same period.

Case 6

In two studies by Blum (cited in Iozzi, 1984), an open-ended inquiry instructional method was found to have a positive impact on attitude changes. In a 1978 study by Hepburn (cited in Iozzi, 1984), attitude changes appeared to be greatest when interdisciplinary

approaches were used. These studies appear to be examining methodologies of interest to our project. However, they focused strictly on attitudinal outcomes. (The original studies were not reviewed, only brief summaries could be found.)

Case 7

Jaus (1982) reported on an experiment with 53 fifth grade students. One class was given 40 minutes of EE instruction on 15 consecutive school days. Each lesson included lecture, discussion, laboratory activities and homework. The control class of fifth graders at another school did not receive any environmental instruction. A 20-item, 5-point Likert scale instrument, developed by the investigator, was used to measure environmental attitudes. The experimental group expressed 22% more “positive” environmental attitudes than the control group.

Case 8

In 1980, Wilson and Tomera conducted a study on the effects of simulations combined with case studies on attitudes toward environmental issues (cited in Leeming, Dwyer, Porter and Cobern, 1993). Two classes of 10th graders were used for the experiment. For a three day period, the general biology class was supplemented with simulation and environmental case study exercises. The control class received the standard curriculum. The treatment and control groups were then reversed. A significant effect of treatment was reported for the first issue following analysis of pre- and post-measures. However, the effect with the second measure failed to demonstrate statistical significance.

Wilson and Tomera indicated that since the students in the control group had received the treatment earlier during the course, their environmental attitudes had already been raised. Leeming et al., point out that the treatment group received three additional days on the target subject, a significant factor that possibly influenced results.

Case 9

One of the few reports to measure a program's longitudinal impact on attitudes was conducted for the outdoor science school of the Orange County (California) Department of Education. During the 1975-76 school year 3,278 sixth graders attended the Forest Home Outdoor School. The researcher located seniors at local high schools who had attended the

outdoor school during 1975-76. Surveys were received from 449 students (13% of the total enrollment). Ten topics were represented by questions on the instrument including: interest in natural sciences, appreciation of the environment, peer and cabin leader relationships, interest in camping, impact on attitude toward home responsibilities, feelings about conservation/preservation and potential value of outdoor school for other students.

Overall the Orange County data indicated a positive impact on the students. Pie charts displayed students' responses that indicated: 59% increased interest in natural sciences; 80% increased appreciation for the environment; increased positive feelings about conservation and preservation of wilderness and national forest areas were developed by 77% of the students; 76% felt that the experience raised their interest in camping and other outdoor activities; 95% thought that the experience is one that every sixth grader should have.

Discussion

This class of studies differs from the research we are seeking in that attitudinal research studies concentrate on the affective domain. This type of research does not assess the cognitive influence of EE methods and content on learning.

Studies to Measure Behavior/Action (Cognitive Domain)

There is growing effort among environmental educators to develop a citizenry that both behaves responsibly and is actively working to protect the environment. Roth, Stapp, Hungerford and Peyton (cited in Hines, Hungerford and Tomera, 1986) state that the development of environmentally responsible behavior (ERB) and active citizens has become the ultimate goal of environmental education. Overt environmental behavior and development of action skills are underlying themes in many recent EE articles. Assessments of these types of EE programs assert their foundation in measurement of higher order cognitive skills.

Case 10

A program called issue investigation and action training (IIAT) was designed to focus on development of responsible environmental behavior. IIAT directs instruction to address specific variables that have been empirically related to ERB. The principal elements of IIAT include: knowledge of environmental issues; values related to the environment;

individual and group locus of control; environmental sensitivity; knowledge of and skills in environmental action strategies; and knowledge of ecological concepts (Ramsey, 1993).

IIAT was reported to promote ERB, in populations of eighth graders, when EE instruction focused on the predictor variables of responsible environmental behavior [Ramsey, (1981 and 1989) and Klinger, (1980), both cited in Ramsey, (1993)]. However, Ramsey (1993) reports that in both prior studies the instruction was delivered by the evaluators, thereby possibly influencing the research results.

Case 11

Another study was designed by Ramsey (1993) to measure the influence of the IIAT program. Six interdisciplinary modules provided training in investigation and action skills. Students were introduced to environmental issues, skills needed to analyze issues, skills to investigate issues, skills for information processing and skills needed by responsible citizens to apply action.

Eight heterogeneously grouped eighth grade classes participated in the study using a modified pre-test/post-test design. Four classes received 18 weeks of the experimental instruction, the other four control classes received standard physical science instruction. The control groups were taught by teachers trained in IIAT methodology. Data focused on dependent variables: overt environmental behavior; individual locus of control; group locus of control; environmental action knowledge; perceived knowledge of environmental action skills; perceived skill in the use of environmental action skills; and environmental sensitivity.

Data were collected from five instruments that included Likert-scale items, self-reporting on overt behavior and naming/defining a solution to an environmental issue. A scoring protocol was developed to assess appropriate responses that met the criteria of directness, action and focus. The post-test analysis of variance indicated that at least a 0.05 significance level was achieved for five variables: overt environmental behavior; group locus of control; knowledge of environmental action skills; perceived knowledge of environmental action skills; and perceived skill in the use of environmental action skills. These findings nearly paralleled the results reported by Ramsey and

Hungerford (1989) in a similar study with seventh graders following IIAT instruction.

Case 12

Culen (1994) reported on an evaluation using the issue investigation/evaluation and action skills training model to assess the effects of an extended case study on the subject of wetland issues. A modified pre-test/post-test nonequivalent control group design was used with fifteen intact seventh and eighth grade classes.

Experimental Treatment I (four seventh grade and two eighth grade classes), including four levels of instruction, ran 10-14 weeks. Experimental Treatment II (two seventh grade and two eighth grade classes) was completed in four to six weeks and only included two levels of instruction. The control group (two seventh grade and three eighth grade classes) received 12 weeks of traditional science instruction. Experimental treatments were presented by four teachers who had participated in investigation and evaluation of environmental issues and action (IEEIA) in-service training.

Five different instruments were used to collect data. Post-test data were collected to measure the variables of: overt environmental behavior; knowledge of ecological foundations; individual locus of control; group locus of control; knowledge of citizenship action skills; and perceived skill in the use of citizenship action skills. Covariance analysis compared means of treatment groups and the control group. Statistically significant differences were found for the overt environmental behavior variable. Results indicated that the two treatments were more effective than the control. Full treatment was more influential than the partial treatment in increasing overt environmental behavior.

Discussion

A concern identified throughout the literature is the “moderator variable” of self-reported measures of behavior versus relying on observance of actual behavior. As reported by Brickman, Deutscher and Wicker (cited in Hines, Hungerford and Tomera, 1986), what people indicate on a questionnaire is often inconsistent with their actual behaviors.

Robottom and Hart (1995) question the individualist ideology of the behaviorist/applied science approach used in the research of responsible

environmental behavior. They maintain that this type of research focuses on personal variables of the individual to shape ERB. They believe the historical, social and political contexts within which individual and group actions take place are key factors being overlooked in this type of research effort.

This research subcategory is closest to the body of research we are seeking. Behavior-based research is, however, oriented toward EE programs that focus on the application of "environmental knowledge and skills." The desired outcome is to measure the students' "environmentally-related action" in response to "environmental" issues.

Higher-level thinking strategies are emphasized and environmental content is applied during instruction. However, this type of research focuses on the behavioral outcomes as a result of environmental advocacy-driven instruction, not learning outcomes *per se*. This does not meet our need to find research that analyzes the impact of EE methodologies and content in areas throughout the curriculum.

Other Related Findings

Research Methodology in EE

"Paper and pencil" instruments (e.g., questionnaires) were the method of measurement used most often in the EE evaluation research surveyed in this study. Presumably, ease of distribution, administration and data analysis made this the preferred research method. Consideration of which evaluation design to use in assessing the impact of EE has recently led to controversy in the field. Quantitative methods that use standardized measures to fit diverse information into predetermined response categories have been traditionally used in EE analysis.

There is growing interest in the benefits of qualitative methods that permit the evaluator to study selected issues and events in more depth and detail. Direct quotation, careful description of program situations, events, interactions and observed behaviors provide for the open-ended narrative of qualitative measurement (Patton, 1987).

Consistently, research articles described studies that: failed to evaluate long-term treatment effects or follow-up measures; measured variables immediately following intervention; utilized small sample sizes (often a single class); provided inconclusive results; were poorly designed; lacked appropriate controls; failed to clearly describe administration of the instrument; lacked validity and/or reliability; used weak statistical analysis; were subject to confounding factors; or may have been influenced by effects of the researcher's expectations.

In the early eighties, Lewis (1981-82) reviewed studies of instructional strategies and classroom methodologies. He concluded that a majority of the reports had instruments of questionable validity and lacked sufficient methodological detail. Leeming, Dwyer, Porter and Cobern (1993) reported that few changes have occurred in the years since Lewis made his statements concerning the weakness of EE research methodology.

Leeming, Dwyer and Bracken (1995) discussed the need for research instruments with sound psychometric properties. They raised the concern that oftentimes the individuals who develop EE materials and programs also design the evaluation instruments to assess their own projects. This "conflict of interest" brings into question the validity and reliability of many of these instruments. Another concern about these evaluations is that few of the EE program designers have had in-depth training or experience in the development or implementation of evaluation instruments.

The lack of validated instruments also makes it impractical or meaningless to make comparisons among different studies. Leeming, Dwyer and Bracken also criticized the development and selection of instruments by a limited number of knowledgeable "experts" and proposed that researchers use other forms of scale validation. Robertson (1994) maintained that "research methodologies and resulting knowledge claims are consequences of the epistemological stances adopted by the researchers."

NAAEE Research Commission Survey of Priorities

The Research Commission of the NAAEE and personnel from the National Science Foundation conducted a Delphi survey to rank research priorities in the EE field. The survey was distributed to a random sample of 200 NAAEE members and all members of NAAEE's Board of Directors. Fifteen of the 26 members of the Board of Directors and 61 of the 200 NAAEE members returned the survey.

Three of the highest ranking research topics identified by the survey are: a national longitudinal study of changes in K-12 student behavior as a function of formal EE instruction; a national cross-sectional study of the status of environmental literacy among K-12 students; and an analysis of K-12 EE curricular models and the environmental literacy-related outcomes associated with each of these national surveys.

The results of the survey are interesting but may only indicate that research priorities reflect the current philosophical structure of EE. The predominant thrust of EE appears to have gone from its historical "educational" perspective to a role in

environmental advocacy, subsequently narrowing the focus of most EE assessments. Therefore, identifying "environmental literacy," "environmental attitudes" and "environmentally responsible behavior" among the highest research priorities simply mirrors the advocacy philosophy of the EE community, not a pedagogical philosophy.

Robertson (1994) states, "emphasis is often placed on the 'environment' interest of environmental education, with little regard for educational considerations .... Unless environmental education researchers attend to the educative aspects of their practice, in terms of both underlying epistemology and theory of learning, one is at a loss to frame a study within a particular epistemology."

DEFINING THE NEED

Ultimately, education should focus on the development of lifelong learning skills: communication, problem-solving, decision-making, critical-thinking, evaluation, participatory citizenship, valuing, aesthetic appreciation and a sense of ethics (Hug, 1995). Each student's environmental behavior will be a result of his or her progression through development of these skills.

"To be consistent with democratic principles students should be exposed to the plurality of environmental ideologies, and that through a process of inquiry, critique and reflection they can be assisted to develop and defend their own set of environmental beliefs and values....it should be each student's choice to pursue actions deemed necessary and justifiable for achieving environmental reform in accordance with the ideological position he or she supports." (Stevenson, 1987)

Education reformers recognize the need for greater strides to be made in educational systems that provide students with the skills and knowledge they need to formulate responsible choices concerning their relationship to the world around them (Lieberman, 1995). Those involved in the reform process see the potential value of EE methodologies that incorporate problem-solving, hands-on learning approaches, scientific method, complex thinking strategies, cooperative learning, relevant subject matter and topics that engage students in the educational process. There is also support within the environmental education community for an interdisciplinary approach to EE (R. Roth, 1976, Stapp, 1976, Voelker, 1973, Bennett, 1974, Brogdon and Rowsey, 1977, Disinger, 1981).

Throughout the course of this study, no compelling research was located that measured the effectiveness of interdisciplinary EE methods. Although some studies

analyzed projects containing educational components of interest to our search, none satisfactorily measured the cross-curricular impact of EE content and methodology.

Case 13

Only one group of studies approximated the desired conditions for the Roundtable's research analysis, four evaluations by Seever (1991) analyzing environmental science magnet schools for the Kansas City School District, Missouri. Trailwoods Environmental Science Magnet Elementary School, Nowlin Environmental Science Magnet Middle School, Knotts Environmental Science Magnet Elementary School and East Environmental Science Magnet High School were the subjects of these studies.

Three of the evaluations were formative, following the first or second year of implementation, only Knotts School had a summative evaluation after the third year of operation. Demographic data indicated that each school came close to the district's desired 60/40 minority to non-minority split. Iowa Tests of Basic Skills (ITBS), the Missouri Mastery and Achievement Test (MMAT), Degrees of Reading Power Test (DRP) and Tests of Achievement and Proficiency (TAP) were used to produce achievement scores.

The Missouri magnet schools' standardized test scores were consistently strong across all grade levels in science and social studies. In most other subject areas the students scored near the national norm. When compared to their district and state-wide counterparts, grade level scores demonstrated varying degrees of weakness in language arts and reading. The measurement stressing successful infusion of the environmental science magnet theme took the form of observations of hallways and classrooms to document the number of visible displays (aquariums, live or preserved animals, posters and art work), the presence of theme related activities (e.g., Earth Day celebrations) and associated field trips.

During classroom visits the evaluator observed hands-on learning and activities designed to improve problem-solving and critical-thinking skills. The research indicated that students were demonstrating changes in behavior, attitudes and knowledge based on impact of the environmental science theme. Although, it was unclear how the evaluator arrived at these conclusions.

Hale and Levine (cited in Seever, 1991) caution in the Long Range Magnet Plan, "a school's effectiveness should not be determined during its first year of operation ... during its early years (evaluation) should be designed with the intent of improving, modifying and revising program implementation."

Keeping in mind the infancy of these school operations, it was encouraging to find at least some formal evaluation to examine the effectiveness of an interdisciplinary EE program. While statistical information was contradictory, the evaluator's interpretation indicates that program implementation is demonstrating steady positive impact.

The summative evaluation of the Knotts School reported test scores that were significantly higher than the scores of schools with fewer years of theme implementation. Of the 221 randomly selected Nowlin School students polled, two-thirds said that they had learned problem-solving and decision-making skills that they had been able to apply in their lives outside school. A high percentage (98% in one study) of the 200+ parents polled believed their child was acting more environmentally responsible and that the family had thus been encouraged to behave more responsibly. Over two-thirds also said that they might want a career in the field of environmental science.

It would be beneficial to explore assessing the impact of environmental methods on instruction. High test scores in science and social studies may be indicators of positive influence of EE methods. Although these methodologies were observed, no direct assessment of their effectiveness was measured. In-depth qualitative evaluations, involving students and faculty, would complement more detailed studies using control groups from demographically comparable traditional schools in determining program efficacy.

Discussion

Our search failed to find evidence that directly points to the positive influence of EE content and methodology. Some of the behavior-based research discusses application of lifelong learning skills. The reason these studies did not match our research objective is that they went beyond the instructional level to measurement of environmentally-related actions. The higher level thinking skills entertained in the behavior-based research were strictly in an environmental context, not across

disciplines. Ideally, these critical-thinking skills and strategies need to demonstrate transferability into all curricular areas.

According to Monroe and Kaplan (1988) other elements important in solving environmental problems may include: knowledge of the environment and of issues; knowledge of action strategies that help resolve issues; locus of control and empowerment, a sense of responsibility and communication skills. Historically however, "...schools were not intended to develop critical thinkers, social inquirers and problem-solvers, or active participants in environmental and political (or even educational) decision-making." (Stevenson cited in Robottom, 1987)

The role of EE when knowledge-based, can be comfortably accommodated by the structural organization of traditional schools. Methods that involve critical-thinking strategies or action-oriented approaches, on the other hand, represent a much greater challenge for orthodox educational systems.

The present challenge is to define the classification of research that would address the original research goal. That task is to locate studies that analyze the cross-curricular impact of EE methods and content.

SUMMARY AND CONCLUSIONS

Ideally, schools, as one of the societal systems responsible for the development of citizenry, should be charged with developing cognitive skills, across a variety of disciplines, to equip students with the ability to make responsible decisions. Business and industrial sources report the inability of many employees to think critically in job situations. The complexities of the modern world and our democratic society necessitate effective processing of information to determine a course of action. The ability to think critically is essential in a student's capacity to make choices and judgments of appropriate actions.

As stated over twenty years ago, "... we are at that point in time when rhetoric and opinion must be substantiated by consolidating existing research efforts and focusing future efforts ... we must now be about the business of validating the assumptions and utilizing a research base if EE is to continue to advance" (Voelker, 1973).

R. Roth (1976) expressed the need for continued development and strengthening of environmental education programs through evaluation of such programs. He recognized the need for increased sophistication of methods and techniques used in empirical research involving EE.

Our review found that interdisciplinary-based research in EE is poorly represented in the literature. Some members of the national EE community alluded to the scarcity of such studies during phone interviews and e-mail correspondence. Candid comments by those interviewed included: "I'm doubtful you'll find anything like that out there," and "In my research, in a related area, I have not come across anything of this nature, despite looking for it."

There are several possible explanations for a lack of research that reinforces the pedagogical strengths of EE. Among the possible reasons are: lack of funding and/or planning for program evaluation; difficulties incorporating assessments of problem-solving and critical-thinking skills into traditional school structures; lack of relevant case examples of interdisciplinary model programs; and most EE researchers are evaluating program outcomes related to environmental attitudes and behaviors rather than assessing general educational impacts of EE.

Regarding funding and program planning, one of the comments heard repeatedly during phone interviews of EE program directors was, "I don't have the funding for evaluation." Just as "effective assessment should be integrated into instruction" (Jonassen, cited in Klein and Merritt, 1994), so should effective evaluation be an integral part of any educational program. The decision-maker bases his actions on the unambiguous scientific findings provided by the researcher (Stapp, 1976). Evaluation results drive decisions about on-going revision and necessitate examination of instructional design, curricular goals and the effectiveness of instructional methods.

Measurement of student learning within interdisciplinary EE curriculum presents complications for traditional educators. Even with the recent movement toward authentic assessment it is difficult to evaluate students' abilities to investigate, evaluate, make decisions or demonstrate environmental action through standardized testing (Jonassen, cited in Klein and Merritt, 1994).

At the same time, organizational conditions that engage students in critical analyses of environmental issues are generally not encouraged within traditional education systems. Teachers and administrators expect to maintain order and a competitive atmosphere rather than emphasizing the types of learning methods used in EE.

Another reason it is difficult to find studies analyzing the use of cross-disciplinary EE content and methods may be that the educational structures in which they would successfully be integrated are virtually nonexistent. Until the educational systems are restructured to incorporate learning modeled by EE methods (e.g., critical-

thinking, problem-solving, hands-on activities and use of relevant subject matter), evaluation of its effectiveness can't take place.

There are apparently few pilot programs that have incorporated EE methods and content into traditional educational systems. At least, there is a scarcity of case examples describing these model programs, such as “environmental magnet schools”.

The focus of most EE researchers has not been on assessing the all-inclusive educational importance of EE methodology. Primarily, the evaluation projects in the field have centered on assessing student outcomes relating to environmental knowledge, attitudes and behaviors.

We set out to find research evidence related to the effectiveness of EE as an educational tool. The motivation for this search was to locate documentation that demonstrated the educational efficacy of EE. We believe this research could then be used by the EE community to begin building a more effective dialog with the education community. This is the basis for helping to advance EE into a parallel position with other efforts in education reform.

We had hoped to locate studies that demonstrated the influence of using EE content and/or methods on student learning in math, language arts, social studies, etc. Documentation focusing on this type of research would help answer questions such as: Do students learn to be better readers when the topic is animals, plants or other environmental content? Are students more motivated to learn about science while studying chemistry, math or physics, in pursuit of answers related to the environment?

Answers to these and other questions, if responded to affirmatively, might help to promote the full integration of environmental content and methods across the curriculum. Perhaps, capitalizing on a child’s "intrinsic interest" in the natural world and actively engaging that child in the educational process would create an enthusiastic learner for a lifetime.

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APPENDICES