Close to Home;
A Review of the Literature on Learning in schoolyards and nearby natural settings, 1980 to the present

Urban Affairs Center
The University of Toledo

5/04

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Table of Contents

Table of Contents

Introduction

It is quite clear that field experiences are valuable for K12 science education programs because they provide close contact with the natural world, stimulate curiosity, and provide clear opportunities for scientific inquiry. According to the National Standards for Science Education, “The physical environment around school can be used as a living laboratory for the study of natural phenomena…the environment can and should be used as a resource for science study” (NRC, p. 45). Educational researchers have suggested that children can discover nature and inquire about nature in a scientific way when they experience nature first hand, while engaged in field studies (Lock, 1998). The current standards-based consensus in science education is that scientific literacy includes scientific inquiry, both learning science through inquiry and learning about science as inquiry (AAAS1990; 1993). The National Research Council (1996) describes inquiry this way:

> *Inquiry refers to the diverse ways in which scientists study the natural world and propose explanations based on the evidence derived from their work. Inquiry also refers to the activities of students in which they develop knowledge and understanding of scientific ideas, as well as an understanding of how scientists study the natural world (p. 23).*

Inquiry is an inductive or discovery method of teaching and learning in which the learner can discover or construct ideas or concepts by interacting intellectually with the natural world in the natural world. This idea has a long history in American educational reform efforts. As De Boer (1991) states, since the reform initiatives of the 50’s, “If a single word had to be chosen to describe the goals of science educators…, it would have been inquiry” (p. 206). According to the National Research Council (1996), inquiry is a step beyond “science as process” and includes the “process of science” where students learn about “doing science” as well as learning scientific concepts. It includes learning “how we know” in science and understanding the nature of science (NRC 1996, p. 105). The teacher’s role in inquiry teaching is as facilitator, guide, or leader instead of authoritative dispenser of knowledge. These teaching metaphors are very familiar to environmental educators as they take children outside to learn.

Although this is hardly a new idea, it seems to be drawing public attention in popular environmental literature. For example, in the November-December 2001 issue of *Audubon* magazine, the cover article, “The Sky’s the Limit, ” the authors state that ”Students throughout Latin America are spilling out of classrooms and into schoolyards —and turning small observations into much larger life lessons” (Markels, 2001 November-December). The author describes “schoolyard ecology” that uses the environment around the school as an extension of the classroom. The Audubon Society’s Latin America and Caribbean Program took on the schoolyard ecology as its “flagship education project” (p. 44). Markels quotes Peter Feinsinger, a tropical ecologist he credits with developing the schoolyard-ecology concept, that “many of us think that this is the best long-term route toward conservation” (p. 42). Other articles and books such as Grant & Littlejohn (2001) suggest that schoolyard environmental education programs are popular and active in USA as well as in other countries.

This popular interest is also reflected in a collection of programs designed to help teachers and schools establish outdoor habitats for learning or outdoor laboratories. Examples include the National Wildlife Federation's "Schoolyard Habitats ®" program (National Wildlife Federation, 2002), which boasts of over 1500 certified sites in 49 states. NWF provides small seed grants as well as collaboration opportunities, planning and curriculum resources. Project Wild®, also provides resources, workshops, and advice for creating habitat sites on school property. The Center for Environmental Education (2002) which is affiliated with Antioch New England Grad School, provides teachers with help and support materials. In addition, the Connecticut Schoolyard Habitat Network (2002) provides resources, workshops, and advice for creating habitat sites on school property. There are12 affiliated Connecticut K12 schools listed on their website. Another support initiative is the *Green Teacher* magazine that is published for teachers interested in hands-on EE and schoolyard natural areas.

There is also monetary support available from a variety of sources. The Evergreen Foundation (Evergreen Foundation, 2002),is a national charity organization designed to help "bring nature to our cities" by helping schools create outdoor classrooms designed to help "bring nature to our cities" by helping schools create outdoor classrooms. Several states and government organizations also provide resources including the Georgia Wildlife Federation's Schoolyard Habitats and Florida Wildlife Extension Educator Resources and the Florida Schoolyard Wildlife Projects. In a handbook published in 1994, Habitats for Learning: Ohio takes a new look at school land labs booklet (Landis, 1994), 163 public schools are listed as having land labs or natural areas on or adjacent to school property. There are 88 resource specialists listed who volunteer to share expertise in starting, using, managing developing school sites. 37 Certified Wild School Site Leaders have completed training by Ohio Department of Natural Resources (ODNR) division of Wildlife and now serve as consultants. Although many teachers and environmental educators call these natural areas "land labs," ODNR prefers to call them "Habitats for Learning" because the word habitat implies an integrated view of living in and learning from nature. They claim that students learn better about the environment outside than in the traditional classroom. In another example, the Maryland Department of Education recently published a manual filled with suggestions for schools called "Conservation and Enhancement of the Natural Environment on School Sites." This resource is designed to walk planners through design considerations for school sites (Maryland Department of Education, 2002).

As researchers and science educators, we reflect on all this support and the popularity of schoolyard natural sites, and we wonder what evidence there is that using natural areas and taking children on field trips for environmental education actually results in measurable improvements in students' scientific literacy. According to Orion and Hofstein (1994), the outdoor environment as a science learning arena has been neglected by teachers, curriculum developers, and researchers. Mason also, in a 1980 review of literature found only 43 empirical studies that dealt in any way with field trips and learning outcomes of outdoor education (Mason, 1980). Lisowski and Disinger (1991) also remind us that most published research about "in-the-environment learning" concentrates on affective and non-cognitive learning and that there is a great need for studies that concentrate on cognitive learning outcomes. Lock (1998), as he surveys the research literature, suggests that field experiences provide a wide range of learning opportunities that in-classroom experiences can't. These include problem solving, increased knowledge, better attitudes, and opportunities to learn about science and scientific endeavors. One of Lock's more interesting points is that frequent and short visits to schoolyard sites, in his opinion, can have dramatic effects on student attitudes and science content learning (p.640). However, since 1980 there has been an increased interest in informal education and off-school campus sites such as museums, zoos, science camps, and science centers. In this report, although we give an account of the research relevant to field trips to natural areas on and off school property, our main objective is to survey the research published during the last three decades that has something to say about learning outcomes related to taking children outside to study in schoolyard natural areas.

Research Questions

Our research questions are:

1) What research has been published in education journals that gives empirical evidence that taking K12 students outside to schoolyard natural areas to experience nature is related to student learning outcomes (cognitive and affective)?
2) What research has been published in education journals that gives empirical evidence that taking K12 students outside to schoolyard natural areas to experience nature is related to improvements in scientific literacy as described in the National Standards for Science Education (American Association for the Advancement of Science, National Research Council)?

Methodology

Defining terms and deciding on the scope of this review

In this review, we are interested in curriculum-related planned field experiences when students are taken outside to a relatively natural area close to the classroom to learn science. Although learning might occur during unplanned schoolyard play and recess activities, we do not include any research related to this free-time activity. As stated above, planned trips to natural areas (field trips) are popular in American schools, the teachers we talk to are finding that extended field trips or over-night environmental programs are increasingly difficult to defend in a culture of limited funding for transportation and limited time for activities that are not directly and explicitly related to high-stakes proficiency testing. Although we certainly see the value of field trips to remote locations, for practical reasons, we have become very interested in the teaching and learning potential of nearby natural areas--metroparks, city parks, and land labs--that can be reached in a one-day field trip or a short walk from the classroom. We assume that short field trips to natural areas near almost any public school can have significant educative value and can happen more frequently, can be quite easily curricularized and institutionalized. Therefore, for this review, we define field trips as 1-day (or less) events planned by teachers to bring students outside to natural areas to learn science. We define natural areas rather broadly. It can be relatively undisturbed outside area such as woodland, wetland, field or stream habitats that are on, adjacent to, or near a K12 school. Preferably, the natural area should be within walking distance of the school.

The National Wildlife Federation gives these criteria for classification of Schoolyard Habitat sites and projects that use them: A site "… must provide food, water, cover and places for wildlife to raise young. …a project must also be student driven and used as an educational tool" (National Wildlife Federation 2002). My definition includes parks, metroparks, reserves, schoolyard habitats for learning and even parking lots if teachers use them for teaching science and other subjects. We take this broad view because we feel that there are educative opportunities unique to natural settings and impossible within classroom walls. Although many institutions are worthwhile destinations for field trips, such as zoos, science centers, museums, they are not natural settings and outside the parameters of this study. Field programs that take participants away from home and school for extended overnight periods and programs that are not clearly curricular programs are not included in this review. In addition, because our research focus is on K12 education, we do not include any programs for college-age or adult learners. We also do not include literature about outdoor learning programs that are not explicitly school programs and do not directly attend to students' science or environmental education. Some studies that fit this later category address questions about the affect of outdoor learning experiences on behavior, self esteem, socialization skills, and social attitudes. It should also be noted that my purpose is to report and analyze the findings of published research, not to criticize the research design, methods, reliability and validity of these studies.

What we did

We began our study with ERIC database keyword and subject searches using the following terms: outdoor education, experiential learning, nature centers, learning in nature, learning from nature, land labs, learning from the environment, outdoor activities, field trips, field instruction, resident camps, etc. Because we felt we might be missing relevant research with this method, we then physically paged through each issue of each volume of selected research journals published during the last three decades reading titles and skimming the abstracts of articles that seemed relevant. This final process identified several relevant articles that did not come to our attention with subject and keyword searches. Once we identified relevant research, we searched for other articles written by the same authors. We read all the articles that looked like they might be related to our research questions and paid particular attention to any citations and bibliographic references from this journal. Although we do not claim that our review is exhaustive, we do feel this report is a fair representation of relevant research.

We begin by briefly discussing other previously published reviews of literature published during the last to decades that explore various aspects of learning in nature. We then turn to our own review the research studies that directly address our central questions.

Literature Review/ Presentation of Data

A review of reviews

Six reviews of relevant research literature were published in education journals since 1980. First, I will list these reviews and then I will elaborate in following paragraphs. Three reviews were published in the 1980's. The first one is an annotated bibliography of field trip research (Mason, 1980). In the second, Disinger (1984) reviews research literature about learning in the environment and in the third, (Bachman & Crompton 1984-1985) compares research about learning outside to see if there are measured advantages to taking children outside. Later, during the 90's, Leeming, Dwyer, Porter & Cobern (1993) review environmental education studies since 1974. Their review includes outside-of-class programs while Rundman (1994) reports on the use and implementation of field trips. At the end of the decade, Zelenzny (1999), reviews the research on educational interventions on pro-environmental behavior. All these reviewers agree that there has not been much high-quality research conducted about student learning outcomes related to learning in the natural environment. We now turn to a more detailed description of these six reviews of relevant research.

Over three decades ago, *School Science and Mathematics* published an "Annotated Bibliography of Field Trip Research" (Mason, 1980). The author begins by saying that when analyzing research, there has been a lack of reports with respect to field trips. He provides a "comprehensive annotated bibliography" of objective field trip research studies. Mason includes forty-three references for articles in journals and graduate theses but does not claim that his list is exhaustive. Mason organizes his bibliography in four categories: research studies at the college, secondary school, elementary school levels and a category called "other." He claims that research results provide some evidence that field work is an effective teaching technique at all levels of the K-16 continuum. The author points out that although field trips do result in student learning, problems include (1) lack of opportunity in schools, (2) administrative hindrances, and (3) lack of teacher training (166).

Four years later, Disinger (1984) examined the literature about learning *in* the environment (ital. his). He criticizes classroom-bound techniques for their intrinsic sterility (159) and states that education *abou*t and f*or* the environment without education *in* the environment is incomplete, perhaps inadequate. Disinger searched the ERIC data base through 1983 and found 6672 entries under the descriptor environmental education in all its facets. Of these, 1526 articles were related in some way to learning in nature: 246 to field trips, 40 to outdoor activities, 1040 to outdoor education, 128 to nature centers, and 72 to parks. Disinger makes no distinction about whether or not these articles are research based or not. He provides a bibliography of 30 articles related to "Out-of-school activities" that he considers examples of the types of printed materials available for teachers who want to plan education in the environment. All of his citations are activities, field books, handbooks, and guides that teachers might want to use. He does not explicitly include any research articles in his short list of 30 articles.

At about the same time, Backman and Crompton (1984-85) compare the literature on learning outside in order to determine if the outdoors is more advantageous for learning in certain situations than in others. “Are there some situations in which the outdoor environment is uniquely suited for improving cognitive development, so students acquire more knowledge per unit time and better understand the material?” (p.4). The authors suggest that the outdoors might effectively stimulate critical thinking, problem solving, and deeper understandings of concepts. However, the authors also state in the end that “the evidence must be regarded as tenuous and uncertain” because there is a “relative paucity of empirical research evaluating the utility of outdoor education for facilitating cognitive development” (p.11). They consider it unfortunate that many of the research studies we had prior to the middle 1980’s employed poor research designs and therefore contribute little to our understandings of the value of outdoor education programs in terms of cognitive development.

Almost a decade later, Leeming, Dwyer, Porter, and Cobern (1993) conducted an analysis and critique of the literature on environmental education (EE) studies since 1974, dividing the research studies into two categories: in-class and outside-of-class programs. Some of the programs that fell into the outside-of-class category were field trips, camps, television programs, and workshops. Their stated purpose was to “critique the studies’ findings and methodologies” (p. 8). They claim that EE research lacks sensitivity to rigorous design and that research methodology is generally weak in environmental education studies (p.18). They also state “most of the studies reported only how an environmental education program affects attitude, knowledge, or both, and very few provided evidence concerning effects upon actual behavior” (p. 19). With this statement the authors point out that good quality research is needed to know what programs or procedures might change child and adult behavior in relation to the environment; how increased individual knowledge and attitudes might lead to pro-environmental action.

Then Rundman (1994) in *School Science and Mathematics* reviewed the research literature on use and implementation of field trips. She began with a brief historical view of field trips as non-formal education and then summarizes various studies of the implementation of field trips. The author found that, according to the literature, the general purpose of the field trips vary from sparking student interest, to introducing or culminating topics, creating relevancy, and allowing for students to make real world connections. Rudman points out that learning on field trips should involve student senses and that the learner should be able to manipulate items and use hands-on learning skills. The author also explains that the literature clearly suggests that careful teacher preparation for the field trips is vital and teacher preparation clearly effects student learning outcomes. She also found, perhaps counter-intuitively, that the environmental novelty of the field trip can inhibit the ability of a child to learn, and may also contribute to student behavior changes. Rundman leaves us with suggestions about taking these factors in consideration when implementing field trips in the curriculum.

At the end of the decade, Zelenzny (1999) searched databases for studies published between 1971 and 1996 that measure the effects of educational interventions on pro-environmental behaviors. The author, like Leeming et al. (1993) points out that critics of environmental education argue that few interventions actually encourage responsible behavior. She reasons that this is because these interventions seldom actively involve students in environmental issues (p.5). The author also is critical of the fact that the majority of the studies of nontraditional settings involved adults, and few involved school-age children. She concludes that high-quality research in EE is urgently needed, particularly with younger children and with high school students to advance understanding of environmentalism and how environmentalism is related to developmental maturation (p.13).

Summary

Although learning and understanding science concepts, learning efficiency, and environmentalism with responsible action are vital components of scientific literacy, so are the fundamental scientific habits of mind, performances and perspectives involved in scientific inquiry that are called for in the National Standards of Science Education (AAAS, NRC). There has not been a review that examines research into the relationship between taking school children outside and learning science *through inquiry*. Nor is there a review that examines how schoolyard programs can influence student learning *about science as inquiry*. Our review attempts to fill this void. The relevant research articles fell into two major categories. The first category includes a group of studies designed to measure student cognitive and affective learning outcomes as a result of outside, learning in nature learning experiences. The second category includes research into teacher attitudes and beliefs about learning in nature experiences for their students.

Research That Attempts To Measure Student Learning Outcomes As A Result Of Schoolyard Science Or Field Trips To Nearby Natural Areas

Attitudes, perspectives and values like curiosity, wonder, values and human responsibility are all part of being scientifically literate (AAAS 1990, 1993; NRC 1996). The science education journals have published several reports of research about student attitude and personal value changes as results of outside-of-school nature experiences. However, in most cases, these research studies involved residential camps, extended field trips away from school grounds, and/or wilderness experiences (For example, Carlson & Baumbartner 1974; Crompton & Seller 1981; Dettmann-Easler & Pease 1999; Lisowski and Disinger 1991; Palmberg & Kuru 2000). Because these extended field trips and camp programs are not clearly curricular programs, and because they often involve travel to distant locations, we do not include them in this review. However, two generalizations one can make from this body of literature merit attention because they might have implications relevant to school-based programs. First, there is evidence that the duration of these programs correlate with lasting change in participant attitudes and empathic relationships with nature. The longer the duration, the greater the measurable change in attitudes. This means that short, infrequent trips to natural areas have limited value. It might also mean that the accessibility of schoolyard natural areas, a quick walk across the parking lot, might facilitate more frequent use and better learning opportunities. The other factor is the apparent relationship between prior experience and lasting attitude change. Participants with few prior nature experiences seemed to experience greater, more lasting change than those with more experience. Perhaps the novelty of the event or the dissonance resulting from a strange and exotic environment encourages conceptual change while familiarity does not. This has dramatic implications for inner-city schools and for urban students who have limited opportunities to walk in the woods or explore natural wetlands.

Martin, Falk, and Balling (1981) researched the effects of different field setting on student learning and behaviors. These researchers set out to examine this assertion that novelty of some field settings can influence learning outcomes. The researchers studied sixty-three students performed ecology activities in both familiar (schoolyard) and non-familiar (natural site) settings in Maryland. In their study, groups of 10-13 year-olds performed ecology based activities in a familiar environment (their schoolyard) and then again in an unfamiliar or novel environment (a natural and unfamiliar site). The subjects completed a pretest, performed an ecology activity, and then completed the posttest to test understanding of ecological concepts. This process was repeated in both the familiar and unfamiliar environments. An observer also recorded non-verbal behaviors (facial expression, locus of attention) that occurred when the subjects were not directly involved in the activity.

The authors conclude that students learn more and learn more efficiently in a familiar environment, as opposed to a novel environment. The authors believe that novel environments place demands on students that have not been considered before by educators. These demands in unfamiliar settings are exhibited in negative student behaviors, such as hyperactivity, increased affiliation, and lack of attention. They suggest that schoolyard natural areas might be better destinations than off-site, more exotic locations.

Harvey's (1989-90) study of the relationship between eight- to eleven-year-old children's knowledge (as well as attitudes) and the amount of vegetation on their school grounds provides evidence for the usefulness of school grounds as learning environments (Harvey, 1989-90). This researcher chose a variety of schools that had a range of vegetation cover, from minimal to much vegetation. The researcher began with the hypothesis that "the more extensive their experience with vegetation, the more positive would be the children's environmental attitudes and the greater would be their knowledge of botany" (p.10). The author tested students on four variables: "general botanical knowledge, specific botanical knowledge about vegetation on the school grounds, 'human dominance'…the belief in man's right to use technology to adapt to and dominate nature, and pastoralism…the enjoyment of the natural environment" (p. 11). Analysis of the test results indicate that the more complex school grounds are highly correlated with three of the variables—general botanical knowledge, human dominance, and pastoralism. Data analysis suggests that sites with more vegetation show higher correlations for specific botanical knowledge. Overall, the author argues that in the case of this study, the more complex and "developed" the landscape, the more improvement in both students' learning of botany and improvements in beneficial attitudes about the environment. Harvey states that her study confirms the role of school landscapes as teaching resources and that developing useful "complex" learning environments are possible and worthwhile on most school grounds.

Ryan (1991) evaluates a program by the Meewasin Valley Authority (MVA) in Saskatoon, Saskatchewan. Teachers took their fifth-grade students on a one-day trip to Beaver Creek Conservation Area and the researchers wondered if there would be any long-term changes in perspectives of students of the conservation education program. Although the author does not provide much information on the activities in which the students participated at Beaver Creek, he does indicate that students watched videos, discussed, and played in the snow. The students who participated in the MVA program were given one questionnaire while those who did not were given a different questionnaire. Both questionnaires assessed students' perceptions of Beaver Creek and their ideas about conservation. They found inconclusive results and question whether or not visits to Beaver Creek have long-lasting and significant effects on learning or on environmental attitudes.

Another factor that influenced our thinking and our literature search is described by Orion and Hofstein (1991). They point out that, although there has been an "enormous amount" published about field trips in science education by the early 90's, only a few are actually research publications. Of those that are, most deal with cognitive outcomes and not with affective values. The authors also say that as of the early 90's, there were no definite conclusions about the values associated with field trips. They suggest that there is a wide gap between teachers' expectations and what research can contribute to actual learning value of field trips. Therefore, in their research, they measure attitudes toward field trips and attempt to measure factors that influence learning ability of students during field trips. They identify four dimensions of attitudes toward field trips: Learning aspect, social aspect, adventure aspect, and environmental aspect. In their trial studies using their inventory, it seemed that older students were more likely to view field trips as learning experiences than younger students. Younger students thought field trips were more of a social event than a learning experience. The inventory is included at that end of the article.

Later in the decade, Orion and Hofstein (1994) identified different factors that possibly influence the quality of student learning while on a field trip to a natural area. The authors looked specifically at "a) the nature of student learning during the field trip, b) student attitudes toward the field trip, and c) changes in student knowledge and attitudes after the field trip" (p. 1097). The authors attribute field trip quality to two factors. One factor is how well the field trip itself is actually structured and appropriately carried through. The second factor is what the authors call "novelty space." If students are not prepared or briefed on the events of the field trip, they tend to be preoccupied with exploring and becoming familiar with a new environment than in learning. If students have their "novelty space" decreased by means of a preparatory unit and briefing session, then students tend to achieve higher levels of learning and attitudes.

Orion and Hofstein's experiment exposed High school students to three different levels of preparation before their geology field trip. The first group of 98 eleventh graders, the Optimal Concrete Preparation Group (OCP), were taught a full, ten-hour unit centered on topics to be covered while on the field trip. After their field trip, the teacher taught a follow up summary unit. The second group of 101 ninth graders, the Minimal Concrete Preparation Group (MCP) were given a much shorter, abbreviated four-hour preparation unit before the field trip. The final group of 97 ninth-eleventh graders, the Traditional Frontal Preparation Group (TFP) were taught a thirty-hour course in geology with the field trip occurring later. The teachers of this third group perceived the field trip as a summary, or an enrichment to the material taught. The researchers used qualitative methods of data collection in the form of observations and interviews. They also incorporated quantitative methods in the form of questionnaires and tests.

The authors divided learning performance into three categories: high, moderate, and poor learning performance. They found that the three categories of learning performance correlated with the three different methods of approaching the field trip. Student from the OCP group achieved high learning performance. Students from the MCP group achieved moderate learning performance. Finally, students from the TFP group achieved poor learning performance. Between the OCP and the TFP groups, several significant findings emerged. The students in the OCP tended to have more positive attitudes than those in the TFP. The students in the OCP also gained more skills in rock identification ($p<.002$) and in answering questions relating to field phenomena ($p<.01$)(Orion & Hofstein 1994, p. 1113). The authors explain that if students are prepared for field trips, higher quality learning can take place. They suggest that learning is affected by three other factors: "(a) the place of the field trip within the curriculum. The earlier in the school year, the better; (b) the extent of the students' novelty space (or familiarity space) while going on the field trip. Extended and careful preparation before the trip decreases distractions of novelty space; and (c) the field trip program—learning materials, structure, and pedagogic strategies (p. 1116).

In another mid-1990's study, Milton, Cleveland, and Bennett-Gates (1995) examined the urban Park/School Program that is associated with the Yale School of Forestry and Environmental Studies. The program attempts to address the relationship of environment, self concept, and community structure by using a familiar natural park environment as an educational setting. The authors claim that as a result of the program, urban 5th-grade children using their own urban forest as a tool for learning improve self esteem each time they visit the park. Lessons are composed of many different planned experiences, from outside observation to indoor laboratory exercises. Elementary school children begin outdoor exploration of the park and then move inside to participate in laboratories that are designed to correlate with what they just experienced outside. As a culminating activity, the students present what they learned to their families, other elementary children, and community members. The Park/School Program includes a pre- and post-test to assess students' ecological knowledge. The researchers report that the average scores of the post-test improved 14% as a result of the Park/School program activities. Additionally, the researchers report that teachers, parents and other community members reported that they noticed an improved difference in behavior and academic achievement of the children who participated in the program. The authors also claim that students valued the program and expressed a desire to stay involved in the Park/School Program after its conclusion. Although they do not report specific evidence, the authors also claim that the content of students' questions revealed improvements in scientific thinking. Another reported benefit was that teacher/student relationships seemed to improve as a result of the program. In summary, these researchers report that students who participated in the program showed improvement in the cognitive and the affective domains.

Later, Manzanal, Barrerio, and Jimenez (1999) researched Spanish adolescents to determine the contributions fieldwork makes toward the understanding of ecology and student attitudes toward defense of a fresh water ecosystem. The sample population for this research consisted of 67 students (36 female, 31 male) between the ages of 14 and 16. The students were from middle class families, and many of them expected to go on to some kind of higher education in the future. The sample population was randomly separated into an experimental group (34 students) and a control group (33 students). All participants had previous experience with field trips. The experimental group participated in fieldwork at a local ecosystem along with a four-week long ecology unit presented in class sessions. The control group studied the same ecology unit in class sessions, but viewed slides about the ecosystem instead of taking the field trip.

Methods of data collection consisted of qualitative and quantitative measures. Pretests were administered to each student before instruction as an initial exploration of student knowledge concerning ecosystems. After the unit was completed, a posttest was administered to each student. The pre- and posttests consisted of knowledge-related questions. To measure attitudes, the researchers analyzed the teacher's class diary and conducted interviews with some of the participants one month after the fieldwork took place. The interviews were held with twenty-four, randomly chosen participants from each group.

Results from pre- and post- analysis showed that students in the experimental group were significantly better at expressing ecological concept organization, understanding and application of trophic relationships, and understanding of a-biotic components of ecosystems. The authors also believe that the experience with fieldwork helped students to analyze environmental problems, using their field experiences as frames of reference.

Knapp (2000) focuses his research on the retention of the knowledge and changes in student attitudes as a result of field trips. The subjects (n=71) in this study were third and fourth graders from a rural school district. The teachers took their students on a one- hour field trip to a close-by city park. One month and again 18 months after the field trip, students answered four open-ended questions designed to test retention. Only the results of student surveys completed at both intervals were used in data analysis. Consequently, attrition and other institutional constraints related to finding the same students 18 months later, reduced the sample size to 25.

Their survey asked participants to remember and name three of the activities on the field trip. Although children didn't remember specific details about activities the three mentioned most frequently were learning about plants, playing a game, and hiking. The researchers also asked students to recall an activity their teacher used to help them in understanding transpiration. One month after the field trip, only 42% of the participants answered this question correctly, and at the eighteen-month interval, only 20% remembered what the teacher had demonstrated. The final question asked participants to choose to study plants at one of three places: the same park they just took a field trip to, a different park, or no park at all. At both time intervals, over three-fourths of the students expressed a desire to learn about plants at their field trip site. Knapp believes that this last question indicates that even though the participants did not remember specific information from the trip, they did show interest in learning more. To increase the retention of lessons learned, the author suggests that teachers need to reinforce them in their classroom instruction.

Cronin-Jones (2000) after noticing that few studies have concentrated on comparing schoolyard science learning with traditional science learning, set out to study the impact of traditional classroom and outdoor schoolyard instruction on the ecological science content knowledge and attitudes of upper elementary students. Her sample population for this study consisted of 285 third and fourth graders in Florida. Students were divided into control (no instruction), traditional (indoor instruction), and experimental (outdoor schoolyard instruction) groups. All of the classes were given a posttest to measure content knowledge and environmental attitudes.

An analysis of the groups' posttest scores revealed that the content scores of the three groups were significantly different ($p<.05$) with the experimental group achieving the best performance (Cronin-Jones, 2000). The control group had lower test scores than both the experimental and traditional groups. Similarly, the content gain scores for the experimental group were significantly greater as compared to the traditional and control groups. However, interestingly, although the attitude posttest scores were higher than those of the control group, the attitudes of the traditional and experimental groups were not significantly different from each other (p.207).

Cronin-Jones concludes "elementary students learn significantly more about ecological science topics through outdoor schoolyard experiences than through traditional classroom experiences" (p. 207). She also concludes that outdoor instruction does not play a significant role in developing more positive attitudes about the environment. The author suggests it is the "quality" of the instruction that plays a more important role in developing positive attitudes than where the instruction actually takes place. In other words, quality instruction, whether it be outdoors or indoors, can and does induce positive environmental attitudes.

In another recent study of specific programs designed to affect student learning outcomes, Tudor and Dvornich (2001) provide a description of the *NatureMapping* Program in Washington State. The program, created by the Washington Department of Fish and Wildlife and the Washington Cooperative Research Unit Gap Analysis Project, allows schools and other volunteers to collect data about fish and wildlife "by mapping wildlife sightings and habitat" (p. 8). The authors explain that students take on the roles of researcher and scientist as they participate in a science activity that is not only meaningful to them but also to other wildlife experts who may not be able to observe every area themselves. The authors explain that *NatureMapping* brings together schools and communities so that they work together to sustain the environment in which they live. They also claim that the program results in motivated students, and a systemic change in curriculum through interdisciplinary inquiry. The Nature Mapping Program was selected to receive the 1995 fifth annual RENEW America National Award on Environmental Sustainability in the wildlife and habitat category. The authors also believe that this program serves as a model for other national and international initiatives.

More recently, Malone and Tranter (2003) discussed the importance of school grounds as sites for “environmental cognition.” Although the authors’ focus is on the type and quality of play of 8-10 year old children, they also claim to have data to show that the school ground environment does have a positive effect on student attitudes and learning about the environment. Their study Children’s Environments Project, a research project that investigates, using cognitive and behavior mapping techniques, teacher and student interviews and surveys to study children’s environmental cognitive development (p. 285). The purpose is to inform school communities of better ways of designing and utilizing school grounds to improve children’s environmental cognition. This paper is a discussion of research in progress and focuses on children’s perceptions of the role of schools grounds as a site for learning (p.286). Their sample is five Australian schools but they discuss in more detail, the perceptions of students in two representative city schools, one in Canberra and the other in Melborne.

The authors claim that the Orana School grounds in Canberra contribute to student learning more than the Melborne school, in part because of the Orana philosophy of education. “(T)he children focus on reconnecting with the natural space—getting fresh air, walking in the forest—one response being to return and complete a project that is already in progress—rebuild a cubby (p.298).” Their Steiner Philosophy (p.299), encourages the view that children are innately connected to the earth and that they should make maximum use of the earth—digging, reforming water channels, and use their imagination in the woods and with natural materials. The authors suggest that a school should tune its philosophy to make a difference in the quality of the outdoor experience of the children when brought outside. “Having a philosophical commitment to the value of school grounds for developing children’s environmental cognition is a vital ingredient “(p.300). The authors conclude by saying that although their evidence supports the potential of outdoor environments for student learning, in science and other curricular areas, comprehensive studies need to examine why teachers do not tend to use outdoors in formal teaching (i.e. Keown 1986; Orion et al., 1994).

Research About Teacher Perspectives on the Learning Outcomes of Outside Experiences Close to Home

Student experiences and the quality of their learning depend to a great extent on their teachers. The National Standards for Science Education (AAAS 1990, NRC 1996) include specific guidelines for teachers and teacher preparation programs that will help improve science literacy in their students. There is a very limited amount of research published that examines teachers’ opinions about and experiences with taking their students to natural environments to learn. The research suggests that teachers value outside learning experiences but also report disincentives and significant institutional roadblocks that stand in their way.

Mason (1980) sent questionnaires to secondary science teachers to ask them about their use of outdoor fieldwork. Mason found that over 60% of the 207 teachers reported at least four field trips during a normal school year and17% reported that they did not include an outdoor fieldwork during a school year. Teachers indicated that they would spend more time on field trips if they could, that they wished their school valued field excursions more, and that most of the outdoor fieldwork they did offer occurred on school grounds. The four most commonly reported barriers standing in the way of field trips were "(1) lack of planning time; (2) lack of resource people for assistance; (3) failure of the school to assume trip risk; (4) lack of a satisfactory method for covering classes" (p. 320).

In the middle 80's, Keown (1986) sent questionnaires to secondary natural science teachers around the United States asking them fifteen questions about their use of the outdoors in their curriculum. The research questions that drove the questionnaire ranged from: "How often and for what reasons do science teachers use outdoor resources in science?" To "What are teacher suggestions for using and improving the use of outdoor resources in science learning?" (p. 24). 5,000 names were chosen from the NSTA listing of biology, earth science, and environmental science high school teachers to receive the survey. The researchers report a 37% return rate. The article provides survey items with a chart of results for each. The majority of teachers in the different areas of science (ranging from 23-36%) reported taking their classes outdoors infrequently, about one to two times a year. Partly because of this infrequency, the researchers seemed surprised by how strongly a majority of teachers felt about the value of taking students outside. Interestingly, almost 83% of the respondents also felt that their school curriculum doesn't encourage natural science teachers to take learning outdoors. The researchers explain that conflicting class schedules, class size, lack of time, lack of college preparation, and liability issues were among the factors that kept most teachers inside most of the time. Of those teachers who did report taking their classes outside, almost 70% reported that most of the outdoor activities occur within walking distance of the school and require one classroom period of time. The authors conclude that if teachers are to use the outdoors in their teaching, they will need greater support, better courses and workshops that teach teachers to use the outdoors, and pre-service college preparation that includes "field studies and activities that concern improvement, understanding, and monitoring of the environment" (p.29).

Simmons (1993, 1998) works from the assumptions that teachers' perceptions of nature and of the importance of providing environmental education determines students chances of experiencing natural areas. In her earlier study, Simmons (1993) interviewed 39 urban elementary teachers for their perceptions and preferences of different natural settings. The researcher showed each teacher photographs of different types of natural areas, such as woods, parks, rivers and ponds, urban areas, and school grounds and asked them about their perceptions, uses, and possible uses of the sites. Teachers expressed a preference for environments with water and densely wooded areas over any of the other sites. Significantly, sites on school grounds received the least amount of preference. Findings indicate that teachers prefer settings that are more removed from people and removed from school buildings for environmental education purposes. For example, Simmons reports that one teacher, while looking at a photograph of a woodland, said that "This is unspoiled nature" (p. 12) and therefore preferable to disturbed settings. Simmons also reports that of all the possible activities they could choose from for student experiences, recreational and identification-type activities were mentioned most often. Only a minority of the teachers mentioned activities that involved ecosystems, insects, or the impact of humans and she found that teachers felt county parks provide recreational but few educational opportunities. In conclusion, Simmons suggests that teachers perceived distinct differences in nature settings and in their opinion, different settings were conducive to different teaching and learning opportunities. Simmons also suggests that teachers associated a need for different resources, support services, equipment, and logistic support with different settings. She concludes that teachers need training to expand on their repertoire of possibilities for different settings. Simmons also states that the way a natural area manager or environmental educator introduces a site to a teacher may well determine the fulfillment of educational goals.

In her second study Simmons (1998) again focused on what elementary teachers or urban minority students perceive to be benefits and barriers to different types of outdoor environments. Simmons again showed teachers photographs of different types of more or less natural settings. Again, she was interested in “personal comfort levels and their judgment of educational affordances, as well as their perceptions of potential barriers” (p.24). Similar to the findings of the previous study, wooded and water environments more chosen by teachers as more suitable than other sites for environmental education. However, teachers also identified these two environments as more dangerous and risky than parks or urban settings. They were concerned about safety, poisonous plants, and the possibility of getting lost. Most of the teachers surveyed say it is important to provide nature experiences in the curriculum, that their students would enjoy such experiences, and that outdoor experiences are worthwhile for students. They also reported confidence in knowing what to do with students in natural settings and were not particularly worried about not knowing the answers to student questions (p.31). As in the last study, teachers were not overly enthusiastic about urban nature as a learning setting and they were surprisingly ambivalent about county parks. Simmons also points out that teachers were apprehensive about their own preparation, comfort in teaching outside, and their training. Teachers expressed a desire for more training and felt more training would be required before they could take their students outside to natural areas. Simmons concludes that teachers were “both enthusiastic and somewhat confident, yet apprehensive, about teaching in natural areas” (p.31). The author believes that training programs should address these teacher views and directly confront their fears.

More recently, in an article about the NSF-funded Teachers in the Woods program in Washington state, Dresner (2002) states that a majority (90%) of the130 participating science teachers reported one year later that, as a result of teachers’ experiences, their students in turn showed improvements in their knowledge of science and environmental science. This result came after the teachers reported that they became more comfortable with forest ecology field studies themselves and in turn, began to incorporate similar field studies in their curriculum. Although Dresner does not report any data on student learning outcomes, it is significant that teacher participants reported that their students improved mostly in skills related to scientific inquiry (p,30):

1) Using observations and concepts to express scientific questions and frame an investigation
2) Designing an investigation to address a scientific question
3) Collecting, organizing and presenting data

One of Dresner’s concluding remarks is especially relevant to this review: Student field inquiry projects are best conducted at sites chosen for close proximity to school buildings to “… help to alleviate limitations in scheduling and funds for transportation to a more remote site” (p.31).

Comparative Analysis of the Research Literature

Looking at this research as a body, there are certain chronological patterns that emerge in the research about the relationships between schoolyard field studies and student learning outcomes. Although there were research studies published during the 70's and early 80's about outdoor residential programs and their affect on attitudes, environmental ethic and action, it wasn't until the middle 80's that research studies about cognitive learning outcomes began to appear. One set of studies, published during the period from 1986 through the 1990's, includes research concerning teachers' perspectives and attitudes about taking school children outside to learn. Researchers report that although teachers tend to value such experiences for their children and think their children would benefit from such programs, there are significant institutional roadblocks and barriers to making such field trips part of the curriculum. These roadblocks and barriers are powerful enough to significantly limit field trips even when natural areas are available to them a short walk from their classroom door. Some roadblocks are institutional in nature, including lack of support, lack of resources including transportation, and lack of time. Other disincentives include feelings of inadequacy and a lack of background knowledge that teachers feel is necessary to lead field excursions. Teachers also speak of a need for professional training and mentoring.

It wasn't until the early1990's, with one exception (Martin et al. 1981), that reports of research into the relationship to schoolyard field studies to cognitive learning outcomes for school children began to appear. There is convincing evidence that students actually do learn more science content and also retain more scientific knowledge as a result of field studies. The also seem to learn more content more efficiently and develop better attitudes and self exteem as related to the natural environment. The more plant life, the more complex the natural environment, the better for student interest and engagement. Schoolyard sites have distinct advantages over unfamiliar and remote locations. One particular recent study makes the important point that a school's philosophy can influence learning outcomes as well as the frequency and quality of teacher use of schoolyard natural settings (Malone and Tranter 2003).

In the middle Nineteen nineties research studies began to appear that specifically mention scientific habits of mind as a learning outcome. For example, Milton, Cleveland and Bennett-Gates (1995), although most concerned about mustering evidence that the Park/School Program had a positive effect on the self esteem of participants, they also suggest almost in passing that the content of student questions revealed improvements in scientific thinking. In a more recent example, Tudor and Duornich (2001) report that there were clear and significant improvements in students' environmental ethic when they are given the chance to "act as science researchers" observing, measuring, collecting data and testing hypotheses. The authors found empirical evidence that the award-winning Nature Mapping program motivates students as they are exposed to interdisciplinary inquiry. It is significant that this recent report is the only article we found that explicitly uses the term inquiry in a way that is congruent with the National Standards definition.

Conclusions

In a current atmosphere in schools where everyone is so concerned about high-stakes proficiency testing and intense pressure for standards-based educational reform, teachers and administrators in public schools naturally think first about student learning outcomes and the potential for improvements in scientific literacy when evaluating lessons or programs to improve K12 education. The National standards for science teaching and learning (AAAS 1990, 1993; NRC 1996) are quite specific about content, performances and perspectives that make up scientific literacy. Teachers are under extreme pressure to align their curriculum with national and state standards so that children's performance on their state's proficiency tests improve. Understandably, they have a hard time justifying any activities including field trips that do not have clearly articulated and convincing connections to standards-based learning outcomes.

The research literature makes the point clear that field studies and environmental education programs that bring students outside to learn in nature have significant impact on the third standard category—student perspectives; their attitudes, their individual land ethic and their concern for the environment. Other researchers present evidence that students improve cognitively, improving their scientific content knowledge and learn science more efficiently as a result of study in natural world settings. It is also clear from the research that although most teachers value such experiences for their students, few actually make them available as a sustained part of their curriculum. The research suggests that there are many possible reasons for this.

However, there is a striking lack of research that connects field studies with inquiry, a major tenant of the current national standards for scientific literacy. Of course, many authors mention "hands-on" activities, digging in the dirt, observing, and other experiences in which children engage with nature and natural settings. And, all these activities can lean to improvements in scientific literacy. However, the current standards-based consensus in science education is that scientific literacy includes scientific inquiry, both learning science through inquiry and learning about science as inquiry (see Introduction). As explained above, the teacher's role in inquiry teaching is as facilitator, guide, or leader instead of authoritative dispenser of knowledge. One of the clues that we see for the potential of science education in outdoor settings for improving student understanding of scientific inquiry is that these are also familiar metaphors for understanding scientists, naturalists and environmental educators when they go outside to learn. With this in mind, much more research is needed to find clear connections and empirical evidence about whether or not field studies actually result in improvements in scientific literacy, especially as it relates to scientific inquiry. Without this research, we do not have the evidence we need to convince others that these programs should be institutionalized and become an important part of the school curriculum and that science literacy as well as proficiency scores are likely to improve as a result of these experiences.

Implications of the Findings and Recommendations

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