NOAA California B-WET Program
Best Practices for "Meaningful" Watershed Experiences
A Literature Review

Summary

Based on a review of the current published research literature, this summary lists "best practices" for activities and outcomes for "meaningful" watershed experiences as defined by California B-WET. This summary and the attached literature review are provided to help B-WET grant recipients plan, implement and evaluate successful projects.

Program activities/features for K-12 students

Based on a review of the published research literature, students are more likely to learn and change from outdoor experiences that include many of the following features:

- project-based activities, especially addressing local environmental issues
- inquiry-based learning, especially when the questions come from the students
- skills development related to issue investigation
- conservation action practice, such as planting trees, restoring habitats, etc.
- learning basic concepts and principles that underlie projects, inquiry or skills
- service-learning focus, that is, providing a community service/helping the community
- repeated exposure through multiple visits to the same site.

Other literature-based best practices for outdoor experiences suggest:

- assessing students' knowledge and attitudes about the outdoor site and experiences prior to the field visits to determine misconceptions and misgivings or fears.
- orienting students in a familiar setting (classroom or schoolyard) to the outdoor experience before the initial outdoor experience so they have a sense of structure. The orientation should consist of an overview of the outdoor site, a review of what will be happening outdoors, as well as addressing any concerns/fears students might have.
- allowing exploration (scavenger hunt or similar guided exploration) on the first field visit to help reduce the novelty and familiarize students with the site.
- allowing for exploration and reflection time at the site during each visit, in addition to doing meaningful "work."

Per research results, programs providing what B-WET calls "meaningful" watershed experiences have been shown to:

- increase learning, not only in science but other subjects as well
- increase critical thinking skills
- increase environmental concerns and attitudes, especially about local environments
- improve issue-investigation and environmental-action skills
- increase or improve conservation actions/behaviors
- increase the desire to spend more time outdoors/in the environment
- reduce attention-deficit/hyperactivity disorder symptoms
- be related to concern and feelings of responsibility for the welfare of others
- improve self-efficacy, feelings of competence.

Program activities/features for teachers

Based on a review of the published research literature, here are the most common characteristics of effective professional development:

- a specific definition of the target audience (not just teachers' grade level, but also phase of professional career and content/skill prerequisites)
- clearly stated outcomes (what teachers are to gain from the training and supposed to do back at school)
- content based on state education standards or local reform initiatives (so teachers will be supported by administrators and districts)
- an understanding of and building on teachers' prior knowledge
- activities/experiences that develop teachers' content knowledge and pedagogy, as well as special skills (if needed to teach the content) and student assessment skills
- modeling of exemplary pedagogy based on current research (teachers should experience the content in the same ways their students should experience it)
- time to reflect, practice and plan what to do in the classroom with their new knowledge and experiences
- time to address teachers' concerns/worries about changes in themselves, their teaching, their school and students as a result of the training.

We found few studies addressing the impact of "meaningful outdoor experiences" as part of professional development for teachers. A few suggest that such experiences:

- change teachers beliefs regarding teaching practice and their classroom teaching
- improve their understanding of environmental science concepts and issues, as well as abilities to conduct research-based field studies
- increase their level of competence and interests in science topics
- improve students' knowledge and skills (for those teachers trained to engage students in real-world investigations and science process skills).

As with students, it may be useful (although we found no research with teachers regarding these issues) to:

- assess teachers' knowledge and attitudes about the outdoor site and experiences prior to the field visits to determine misconceptions and any misgivings or fears.
- orient teachers in a familiar setting (classroom or schoolyard) to the outdoor experience before the initial outdoor experience so they get an overview of the outdoor site, a review of what will be happening outdoors and can address any concerns/fears they might have.
- allow exploration on the initial field visit to help reduce the novelty and familiarize teachers with the site.

Studies Regarding to Students

Program Description/Focus	Goal & Type of Evaluation	Findings/Results	Source
review of literature on outdoor education, defined as all school related academic education which takes place outdoors	• review of the empirical literature (meta analysis)	• environmental concepts may be learned more effectively if students are oriented in the classroom, so they have a sense of structure before going to the outdoor experience • outdoors may be effective in stimulating critical thinking and increasing problem-solving skills, and with developing concepts and understanding rather than with rote memory • independent field research is likely to be more useful with students who are more academic while the more guided traditional learning approach in the outdoors is likely to be most useful for slow learners • however, the evidence must be regarded as tenuous and uncertain as there is a paucity of empirical research [as of 1985] that meets scientific standards	Backman & Crompton, 1985
six formal and non-formal environmental education programs in Queensland, grades 5-12 and their parents (N=284 students, N=177 parents)	• surveyed and interviewed students and their parents regarding their perceptions about the program, the program's influence on their environmental learning, and the extent and nature of discussions that the program stimulated between students and their parents	• 95% of students reported learning something from a program and 32% reported that they had changed their behavior as a result of a program • regarding program parts that made students want to change, they most frequently cited the opportunity to test water or air quality in the local environment; the presentation or discussion of info about environmental issues (in particular in homes or local areas) as the second most important; next, environmental experiences (e.g., planting trees, cleaning creeks, canoeing, etc.) helped raise awareness and influence attitudes; finally, involvement in individual and group projects, esp. those requiring information collection or field research • 73% of students reported discussing the program with parents and for 28% that discussion was about actions in home or local community; parents reported discussions had arisen mostly as a result of students' projects that were required homework or presentations students were to give • educators can encourage discussion of environmental issues at home by engaging students in novel, hands-on, fun activities out of the classroom and related to local issues	Ballantyne et al, 2001
the impacts of service-learning on youth, schools and communities	• review of the data from 1990 to 1999 on the impacts of service learning	• service learning has a positive impact on students personal and social development, interpersonal development, sense of civic and social responsibility, academic skills and knowledge; it reduces engagement in "risk" behaviors; it makes students more knowledgeable and realistic about careers; it improves school climate and enhances the community's perception of students and schools	Billig, 2000

Program Description/Focus	Goal & Type of Evaluation	Findings/Results	Source
fears expressed by students to nature center in southeastern United States and the other in Texas with middle school and high school students (N=1,376, N=450)	• interviews of interpreters at urban nature centers	• urban students express a wide range of fearful responses to natural environments, and fear and anxiety pose barriers to enjoying and learning • repeated positive exposures to wildland areas through field trips should eventually lower the novelty of wildland areas and build a sense of environmental competence • long before urban students arrive at a nature center [and outdoors], they have developed misconceptions about wildland areas from other sources; for these students, outdoor field trips are corrective or remedial rather than formative experiences	Bixler & Carlisle, 1994
two studies of adolescent youth to clarify the relationship between childhood play (informal experiences) in wild environments and later environmental preferences in work, leisure and school	• questionnaires completed by two groups of public school students (N = 1,377, N = 450) to measure the frequency of childhood play in different environments and environmental perception and activity preferences	• respondents who played in wild environments had more positive perceptions of natural environments, outdoor recreation activities, and occupations in outdoor environments • no significant differences were found for preferences for environmental sciences activities conducted in schools • data was inconclusive regarding plan and an interest in environmentalism	Bixler et al, 2002
university class instruction on ecology with and without restoration field work	• 3 classes of university undergrads (N = 488), 2 treatment groups and 1 control, responded to post-program questionnaires w/ scales for the effects of ecological restoration field work and in-class instruction on ecological behavior, environmental attitudes and perceptions of restorative qualities in a natural environment	• ecological restoration work with in-class instruction had a more powerful effect than in-class instruction with limited field experience on general ecological behaviors and an attitudinal precursor, ecological behaviors intentions • in-class instruction (not field work) was associated with perceived restorative qualities of the study site and increases in perceptions of being away (feelings of getting away), coherence (lack of distraction) and fascination (finding a place fascinating)	Bowler et al, 1999
a 10-day environmental science course for high school students	• students (N = 475) responded to a pretest and posttest to assess their environmental knowledge and attitudes	• significant gains found for both knowledge and attitudes after exposure to environmental science course • after course completion students' environmental attitudes became more environmentally favorable • students having higher knowledge scores had more favorable environmental attitudes compared with students with lower knowledge scores	Bradley et al, 1999

Program Description/Focus	Goal & Type of Evaluation	Findings/Results	Source
an assessment of the environmental knowledge of 4th, 8th and 11th graders in Oregon	• interviews of individual students (n = 159) to determine their knowledge and misconceptions about concepts related to Oregon's marine resources	• the level of understanding of basic concepts and principles related to marine ecosystem dynamics, resource use, management and decision-making processes is low • students learn concepts in elementary grades; however, older students do not continue to elaborate or differentiate basic concepts. In some cases, there were little or no differences in understanding between grades • striking misconceptions that students held were o no one owns the ocean, there are no political boundaries; anyone can go anywhere and do anything. o the ocean is shaped like a bowl; the bottom is sandy rock. o water temperature changes with seasons and gets colder in winter; salinity is the same throughout the ocean. o if an animal's main food source is taken away it will die. o some plants (e.g., seaweed) at the ocean's bottom don't need sunlight to live; they grow in soil to get nutrients. o animals breathe oxygen in the water by breaking up the water molecule. o coral reefs exist throughout the oceans. • the misconceptions were common in that they were generally correct concepts that were incorrectly combined and related across disciplines • misconceptions bridge gaps between various concepts and as such form mislinkages of meaning that will affect subsequent learning. making the need for assessing prior knowledge important	Brody, 1996
the impact of foraging for natural things during childhood	• test the hypothesis that broad foraging for natural things in childhood develops personal competence in assessing the biodiversity of local habitats • questionnaire and biodiversity quiz administered to Canadian teenagers, ages 13 to 16, in two locations (N = 39; N = 112)	• people who forage for natural kinds of things in childhood have a better sense of biodiversity as adults • foraging is an important avenue by which children obtain learning experiences involving natural things and also biodiversity of local habitats; the wider the foraging, the better sense of biodiversity • those also formally instructed in biodiversity did no better on the biodiversity quiz than those receiving no instruction	Chipeniuk, 1995

Program Description/Focus	Goal & Type of Evaluation	Findings/Results	Source
program for 7th & 8th graders (N = 245) that used an "extended case study" method over several weeks to teach about wetlands	• research study with two experimental groups and one control group • 5 instruments tested for knowledge of ecological foundations, overt environmental behavior, locus of control, knowledge of citizenship action skills, and perceived skills in use of citizenship action skills • a modified pretest-posttest nonequivalent control group design administered to 15 intact classes	• formal instruction in issue investigation-evaluation and action skills training produces a positive increase in overt environmental behavior • instruction only in knowledge and awareness of environmental issues might be responsible for a slight increase in overt environmental behavior • classes instructed in ecological foundations, awareness, investigation and action training had higher levels of knowledge of citizenship action skills than those instructed in foundations and awareness only	Culen & Volk, 2000
nonformal, field program for Belizean high school students (N = 10)	• qualitative, formative program evaluation using participant observations, questionnaires, interviews and student work. • development of a model of positive environmental action to account for the relationships between learning and environmental action	• as a result of this program students learned and engaged in conservation activities • the Positive Environmental Action Model presented may be useful for those developing environmental programs, but due to the very small N for this program, more research is definitely need and this model should be used with that in mind	Emmons, 1997
impact of "environment-based education" programs at Florida high schools on students' (N = 404) critical thinking skills and disposition toward critical thinking. ("Environment-based" education's defining characteristics are interdisciplinary learning based on the local environment, project- and issue-based learning experiences, learner-centered instruction, and constructivist approaches.)	• pretest-posttest non-equivalent comparison group design (9^{th} graders) and posttest only nonequivalent comparison group design (12^{th} graders), plus interviews of students and teachers	• environment-based programs had a positive effect on 9^{th} grade students' critical thinking skills • environment-based programs had a positive effect on 12^{th} grade students' critical thinking skills and disposition toward critical thinking • the difference between 9^{th} graders and 12^{th} graders disposition toward critical thinking may be due to the multi-year exposure of 12^{th} graders to such a program • results suggest that students who participated in environment-based programs were more skilled in critical thinking than their peers, including peers who were in traditional environmental science classes	Ernst & Monroe, 2004
impact of an outdoor education setting (nature center in the woods) on the learning and behavior of urban 10 to 13 year students (N = 31)	• pretest-posttest design and observation of two groups, one familiar with the setting and the other unfamiliar with the setting • tested on knowledge of the setting and learning from an educational activity	• subjects in an unfamiliar environment failed to benefit from a structured educational activity • although both groups took approximately the same total time to do the task, the unfamiliar group tended to spend more time in behaviors not related to the actual activity, and in fact, behaviors which interfered with the activity • this indicates that a single educational strategy for drop-in, one-shot field trip classes can be problematic	Falk, Martin & Balling, 1978

Program Description/Focus	Goal & Type of Evaluation	Findings/Results	Source
outdoor field trips as novel experiences for 3rd and 5th grade suburban students	• study comparing the learning of different age groups of students in different settings to understand what factors affect student learning and behavior during outdoor field trips	• fifth graders saw their school setting as boring and showed the poorest learning; the same age group at a novel nature center environment showed the greatest learning • third graders found the nature center too novel and weren't able to learn; the same age group performed well after learning at their school setting • differences in setting novelty can have dramatic effects on students' behavior and learning: if a setting is too novel, younger children will not learn new concepts, but will learn about the setting; if the setting is too familiar, older children may have difficulty learning • repeated visits produce the best results of all; the first visit can emphasize familiarization activities while later visits can focus on more conceptual material • a successful approach to the problem of novelty effects on learning is to design field trip activities that allow structured exploration (such as a scavenger hunt) • significant cognitive learning can occur on field trips	Falk & Balling, 1980
a survey of 10th grade students (N = 787) in Virginia to determine oceanic attitudes and knowledge	• survey of students to determine the levels of marine awareness (knowledge and attitudes) and identification of the types of marine-related experiences in which the students had participated to see if they were related to knowledge and attitudes	• students had a fairly low level of knowledge about the ocean • students perceive marine-related television programs and movies to be the greatest influence on their knowledge about the ocean • students with higher knowledge scores also had more positive attitude scores • greater participation in three activities correlated to higher knowledge scores: Cousteau specials seen on TV, reading *National Geographic* and swimming ability • whites expressed a more positive attitude and higher knowledge than non-whites; science, marine recreation and mare careers were favored by white males	Fortner & Teates, 1980
a measure of American high-school students' abilities to understand basic environmental concepts in the context of science	• assessed the environmental knowledge base of a national probability sample of American high school students using data from the Longitudinal Study of American Youth (LSAY) (N = approx. 2,900) • surveys containing the same 7 multiple-choice questions were administered in 1987 & 1989 when the sample students was in the 10th and 12th grades respectively	• most 12th-grade students were able to recognize basic facts concerning environmental problems, but could not apply that knowledge to determine the consequences or potential solutions for those environmental issues • seniors had extremely elementary comprehension of environmental problems • there was extremely little growth in environmental knowledge from 10th to 12th grade	Gambro & Switzky, 1996

Program Description/Focus	Goal & Type of Evaluation	Findings/Results	Source
12-day outdoor adventure program in Canada with teenagers 14-16 years of age (N=8)	• examine the programs effectiveness in getting participants to incorporate their concern for the natural environment into their home environment • examine teen concept of nature through participant observation and post-trip interviews	• participants did report positive environmental concerns and a feeling of a connection to the natural world after completing the program but this did not become any cause for action at home • teens believed that nature was appealing but not present in their home environment • wilderness educators should help participants understand specific actions they can take home to protect the environment • to help participants in wilderness programs be aware of nature, even at home, it is important for the programs to teach and practice sensitivity towards the natural world • programs that take participants away from their home environment and into pure natural settings may be counterproductive to environmental education	Haluza-Delay, 2001
students attitudes toward science education and perceptions of the nature of science perceptions during a six-week experiential Upward Bound summer program (activities: marine biology lab lesson and agricultural field trip) in California	• an explorative case study of high-school students (N = 20) examining pre- and post-views of science instructional processes during the four activities and perceptions of the nature of science • methods included written responses and questionnaires, observations and interviews, as well as assignments, notes and reflections	• student post-perceptions of the nature of science showed improvement in comparison to their perceptions before the program • attitudes toward the lab activity declined after the program, likely due to the way the lab was presented • pre/post data comparisons suggest that interest in learning science could be improved by the following: o hands-on engagement and/or active participation in field settings o avoidance of too much talking or explaining, especially in technical terms o minimizing reading, writing and unnecessary classroom-related activities	Jelinek, 1998
six-day outdoor residential environmental education workshop in Illinois for high school students	• one treatment group received instruction in awareness of environmental issues and the other group received instruction in awareness of environmental issues and action strategies (N = 62) • pretest and posttest examined the effects that the two modes of training had on knowledge of, and willingness to participate in, responsible environmental behavior	• students receiving the issue awareness instruction failed to demonstrate an increase in their level of knowledge of environmental action and did not report participating in a significantly greater number of environmental behaviors • students receiving instruction in both environmental issues and action strategies demonstrated an increased level of knowledge of environmental action and reported participated in a greater number of environmental behaviors	Jordan et al, 1986

Program Description/Focus	Goal & Type of Evaluation	Findings/Results	Source
a 3-hour environmental science program at a community park in a midwestern city	• survey given 3rd- & 4th-grade students (N = 71) at 1-month and 18-month interval after field trip to determine memorable experiences associated with the field trip	• students' memories were nonspecific and disassociated from information given by the field teacher (memory probably decayed over time) • both tests yielded positive responses toward wanting to learn more about plants and wanting to return to the field trip site • results would indicate that, while not retaining specific objective-oriented content, students did gain a positive reaction to returning that continued over the long-term	Knapp, 2000
an examination of the relationship between 1) novelty and exploratory behavior, 2) novelty and cognitive learning and 3) exploratory behavior and cognitive learning during a field trip to a science museum	• 6th-grade students (N = 64) participated in a posttest-only control group design • one group received treatment designed to decrease the novelty of a field trip, while the other group received no novelty-reducing treatment (placebo treatment), then both visited the science center • this study was designed to replicate work by Falk and others, only in a different setting and to measure the effect of exploratory behavior on cognitive learning	• exploratory behavior was shown to be positively correlated with cognitive learning • reducing the novelty of the site (via a slide/tape presentation as if visiting the science museum) apparently had the desired orienting effect by minimizing diversive exploration while on site and raising on-task exploration • novelty-reducing preparation was shown to be highly effective on boys (increasing on-task exploratory behavior and greater cognitive learning) but had no effect on girls. Hypothesize that this could be due to the science focus of the museum	Kubota & Olstad, 1991
the impact of relatively natural settings on children's attention-deficit/hyperactivity disorder symptoms	• parents nationwide via an online survey rated the after-effects of 49 common afterschool and weekend activities (indoors and outdoors) on children's symptoms (N = 452)	• activities in natural outdoor environments reduced symptoms significantly more than did activities conducted in other settings, even when activities were matched across settings • findings were consistent across age, gender, income, community types, geographic regions and diagnoses • natural outdoor settings appear to reduce ADHD symptoms in children across a wide range of individual, residential and case characteristics	Kuo & Taylor, 2004

Program Description/Focus	Goal & Type of Evaluation	Findings/Results	Source
impact of "environment-based education" programs on students and schools	• a collection of case studies of schools in Texas, North Carolina, Wisconsin, Minnesota, Kentucky and Florida using the environment as an integrating context for learning	• 3rd-grade students' reading scores improved in Wisconsin • 4th-grade students' standardized math test scores improved in North Carolina • students' social studies and science test scores almost always exceeded those of students in traditional programs • 3rd-grade students who took part in a research-based environment program successfully solved problems involving natural habitats and sharpened higher-level thinking skills in Texas • increased student motivation was observed in all of the schools and classrooms that used nature as an outdoor laboratory • improved classroom behavior was observed by virtually all of the teachers in the schools studied	NEETF & Glenn, 2000
impacts of outdoor activities (nature trips and overnight camps)	• assessment of the impact of outdoor activities on 11- and 12-year-old pupils in Finland • qualitative research methods comprised case studies involving questionnaires, individual interviews, drawings, photographs and participant observations	• nature experiences developed the pupils' self-confidence and feelings of safety, which in turn increased their willingness to participate in future outdoor activities • comparing pupils who experienced outdoor activities with pupils who did not, it was found that the former seemed to have a strong and clearly definable empathic relationship to nature; they also exhibited better social behavior and higher moral judgments	Palmberg & Kuru, 2000
impact of education in issue investigation and action training	• in this pretest-posttest design, eight 8th-grade classes (N = 96): 4 classes received education in issue investigation and action training (treatment group) and 4 classes received science education (control group)	• the treatment group demonstrated significantly higher knowledge of environmental skills and action behaviors than the control group • instruction in environmental issue analysis, investigation and resolution promoted responsible environmental behavior on the part of 8th-grade students • this training promoted subjects' group locus of control, that is, the instruction seemed to foster subjects' beliefs that they had greater control in the resolution of an issue acting as a member of a group • this training promoted many of the cognitive and affective variables that were indicated by prior research to be significant predictors of responsible environmental behavior in adult populations	Ramsey, 1993

Program Description/Focus	Goal & Type of Evaluation	Findings/Results	Source
the effects of service-learning programs on social responsibility and academic success	• three schools with grades 6 to 8 with service-learning programs/projects were selected based on certain criteria • half of the students selected were taking service-learning classes and half were not (N = 1,153) • study used a variety of previously developed scales, student GPAs and school conduct scores	• over the school year, service-learning students maintained their concern for others' social welfare, whereas control students declined on those concerns • service-learning students, especially girls, declined significantly less than did controls in their frequency of talking with parents about school • students with substantial hours of service-learning, a lot of reflection and a high degree of motivation attributed to service-learning significantly increased their belief in the efficacy of their helping behaviors, maintained their pursuit of better grades and their perceptions that school provided personal development opportunities and decreased less in their commitment to classwork	Scales et al, 2000
what values do student environmentalists hold	• college students (N = 62) active in environmental organizations completed surveys that examined the relationship between knowledge and environmental issues and levels of verbal, actual and affective commitment to environmental issues and their personal values	• environmentally active students placed significantly more importance on the values of responsibility and concern for the welfare of others • they de-emphasized the importance of personal affluence and political accomplishments • knowledge about environmental problems was not related to environmental behaviors or affective involvement • results suggest that environmental education experiences may be more effective when they are structured to increase a sense of identification with, and responsibility for, others • a sense of appreciation for, and pleasure in, nature and the connectedness of all life forms are most likely to be effective in increasing environmental concern and action	Shean & Shei, 1995
environmental sensitivity among Wisconsin high school students	• two phase study: phase I used focus group (n = 20 students) and phase II used a paper survey (N = 64 students)	• the influence on environmentally sensitive students most frequently cited as most important was time spent outdoors • the second most frequently mentioned influence was teachers or school role models (more often than parents or other family members) who were friendly/available • media may also play a role, but the extent wasn't clear	Sivek, 2002
effects of "environment-based education" on student achievement (environment-based education is defined as interdisciplinary, collaborative, student-centered, hands-on and engaging with school surroundings and the community)	• a study of 8 schools involved in environment-based education (treatment group) and compared to 8 equivalent schools (control group) in California	• treatment schools o scored higher than controls on 72% of academic assessments o scored higher than controls on standardized measures of academic achievement in language arts, math, science and social studies o scored higher on attendance assessments	SEER, 2000

Program Description/Focus	Goal & Type of Evaluation	Findings/Results	Source
study of 14 to 17 year olds who participate in local natural resource work programs of 5 to 7 weeks duration	• survey given to program participants (N = 182) to study the influence that attachment to a local natural resource has on environmentally responsible behavior in an individual's everyday life	• there is a connection between place attachment and place dependence & place identity—as individuals develop an emotional connection to their local natural resources, they appear to act responsibly in day-to-day activities as well as at the setting • results suggest that specific environmentally responsible behavior in a natural resource setting (i.e., participating in the youth work program) encourages environmentally responsible behavior in everyday life (e.g., talking with friends about environmental issues, water conservation, etc.)	Vaske & Kobrin, 2001
5-year in-school program investigating and evaluating environmental issues and actions (IEEIA) on Molokai, Hawaii	• control group study evaluated the impact of the environmental education program on 5th- & 6th-grade students (treatment group (N = 51; control group N = 50)), their parents and the community	• treatment group were more skilled in the use of critical thinking and other cognitive strategies than the control group; they also appeared more knowledgeable about ecology, the environment and environmental issues • quantitative data regarding environmental action participation was inconclusive; qualitative data indicated that students had a feeling of competence with taking environmental action • students in the treatment groups used a wider variety of materials and technologies and more difficult (higher level) materials when researching information than did control group students • treatment students' writing skills, oral communication and "poise" appeared to improve as well	Volk & Cheak, 2003
analysis of the literature on developing environmental responsibility	• a review of 13 studies from 1977 to 1996	• elements of successful activities and programs include outdoor experience and involvement, autonomous student behavior and problem solving, development of environmental action skills, focus on specific issues, small-group discussion. reflection, mentoring, long-term follow-up, and connection to the local community	Yerkes & Haras, 1997

Program Description/Focus	Goal & Type of Evaluation	Findings/Results	Source
analysis of the literature on the effectiveness of educational interventions in improving environmental behavior	• a review of 18 studies from 1971 to 1996	• classroom interventions improved environmental behavior more effectively than interventions in nontraditional settings [camps, workshops, meetings, etc.] • interventions that most effectively improved environmental behavior actively involved participants and used young participants [18 years old or younger] • active participation was more likely in interventions implemented in classrooms than in nontraditional settings • however, the interventions in nontraditional settings more often involved adult participants and consisted of short-term programs with no active participant involvement and most of the studies measured self-reported or inferred environmental behavior (e.g., energy use) rather than observed environmental behavior, which could be inconsistent with actual behavior	Zelezny, 1999

Studies Regarding to Teachers

Program Description/Focus	Goal & Type of Evaluation	Findings/Results	Source
two-year professional development project in Illinois to facilitate teachers' ability to execute inquiry-based investigations in a local outdoor environment	• pretest/posttest, control group study design to determine the change in teaching by 4th- thru 11th-grade teachers (N = 23) • cognitive posttest to students of teacher participants and a comparison group of students to assess knowledge about scientific process	• significant changes in treatment teachers' beliefs regarding constructivist teaching, that is, engaging students in real-world investigations and the science process (treatment group were more in agreement with constructivist epistemology on posttest; no change in control group) • students of teacher participants showed a significant increase in knowledge about scientific process than the comparison group • findings indicate that this model of professional development was successful in changing teachers' self-reported endorsement of constructivist epistemology and their students showed gain in knowledge about the process of scientific inquiry	AbuSharbain, 2002
professional development	• evaluated the features of teachers' professional development and its effects on changing teaching practice in math and science (N = 207 teachers)	• professional development focused on specific instructional practices increases teachers' use of those practices • specific features, such as active learning opportunities, increase the effect of the professional development on teachers' instruction	Desimone et al, 2002
effective teacher professional development	• a review and content analysis of 13 research-based lists characterizing teacher professional development to develop a list of characteristics common to effective professional development	Common characteristics of effective professional development are: • a specific definition of the target audience (not just grade level, but also phase of professional career and content/skill prerequisites) • clearly stated outcomes (what teachers are to gain from the training and supposed to do back at school) • content based on state education standards or local reform initiatives (so teachers will be supported by administrators and districts) • an understanding of and building on teachers' prior knowledge • activities/experiences that develop teachers' content knowledge AND pedagogy AND special skills (if needed to teach the content) AND assessment skills • modeling of exemplary pedagogy based on current research (teachers should experience the content in the same ways their students should experience it) • time to reflect, practice and plan what to do in the classroom with their new knowledge and experiences • addressing teachers' concerns about changes in themselves, their teaching, their school & students after the training	Guskey, 2003

Program Description/Focus	Goal & Type of Evaluation	Findings/Results	Source
field course (in geoscience) for university undergraduates and K-12 teachers to develop problem-solving skills, help them develop and test their own ideas and learn to use tools and methods employed by research scientists by doing scientific research	• performance was evaluated by a pre- and post-exam, attitudinal surveys, journals and self-assessments (N = 15)	• despite the small sample, the data suggested that the field course had an immediate, measurable positive impact on its participants, increasing their level of competence and interest in geoscience	Huntoon et al, 2001
effective teacher professional development	• a review of professional standards and related materials developed by ed professional to develop a common understanding of what effective professional learning experiences look like	• best professional development experiences for science and math educators follow seven principles: o driven by clear, well-defined image of effective classroom learning and teaching o provide teachers with opportunities to develop knowledge and skills and broaden their teaching approaches so they can create better learning opportunities for students o use instructional methods to promote learning for adults which mirror the methods to be used with students o build or strengthen the learning community of science and math teachers o prepare and support teachers in leadership roles o consciously provide links to other parts of the educational system, such as district initiatives, state standards, etc. o include continuous review and assessment	Loucks-Horsley et al, 1996
professional development program about watersheds, water quality, and stream monitoring that engages teachers in designing and conducting local environmental science research projects	• pretest/posttest of teachers' (N = 39 pre, N = 29 post) understandings about watersheds, water quality, and stream monitoring	• generally, teachers' understandings of watersheds, water quality, and stream monitoring improved pre to post • professional development programs that engage teachers in conducting environmental science research positively affect their understandings of environmental science concepts and issues as well as their abilities to design and conduct research-based field studies	Shepardson et al, 2002
the ENVISION professional development model, which uses active teacher involvement in inquiry and inquiry-based teaching to enhance teachers' understandings about inquiry-based study of local environmental problems and teaching science using inquiry	• teacher teams, grades 4 – 9, participating at Level I by receiving training from ENVISION staff and at Level II by receiving training from Level I teachers • used observations of classroom practice and trainings, interviews, pre & post-lesson profiles, and surveys to evaluate the effectiveness of this dual-level professional development strategy	• within the first two years, Level I participants enhanced their understanding in inquiry and inquiry teaching, with 83% changing their classroom practice • Level II participants (68%) changed their classroom practice as a result of participating in training by Level I teachers • peer training that involved modeling and practicing techniques and activities was particularly effective in producing change in practice for Level II teachers	Shepardson & Harbor, 2004

Literature Review References

Student Impact Literature

Backman, S. A., & Crompton, J. L. (1985). Education experiences contribute to cognitive development. *Journal of Environmental Education, 16*(2), 4-13.

Ballantyne, R., Fien, J., & Packer, J. (2001). Program effectiveness in facilitating intergenerational influence in environmental education: Lessons from the field. *The Journal of Environmental Education, 32*(4), 8-15.

Billig, S. H. (2000). *The impacts of service-learning on youth, schools and communities: Research on K-12 school-based service-learning, 1990-1999*. Retrieved 12/1/2004, from http://www.wkkf.org/.

Bixler, R. D., Carlisle, C. L., Hammitt, W. E., & Floyd, M. F. (1994). Observed fears and discomforts among urban students on field trips to wildlands areas. *The Journal of Environmental Education, 26*(1), 24-33.

Bixler, R. D., Floyd, M. R., & Hammitt, W. E. (2002). Environmental socialization: Quantitative tests of the childhood play hypothesis. *Environment & Behavior, 34*(6), 795-818.

Bowler, P. A., Kaiser, F. G., & Hartig, T. (1999). A role for ecological restoration work in university environmental education. *The Journal of Environmental Education, 30*(4), 19-26.

Bradley, J. C., Waliczek, T. M., & Zajicek, J. M. (1999). Relationship between environmental knowledge and environmental attitude of high school students. *Journal of Environmental Education, 30*(3).

Brody, M. (1996). An assessment of 4th-, 8th-, and 11th-grade students' environmental science knowledge related to Oregon's marine resources. *Journal of Environmental Education, 27*(3), 21.

Chipeniuk, R. (1995). Childhood foraging as a means of acquiring competent human cognition about biodiversity. *Environment & Behavior, 27*(4), 490-512.

Culen, G. R., & Volk, T. L. (2000). Effects of an extended case study on environmental behavior and associated variables in seventh- and eighth-grade students. *The Journal of Environmental Education, 31*(2), 9-15.

Emmons, K. M. (1997). Perspectives on environmental action: Reflection and revision through practical experience. *The Journal of Environmental Education, 29*(1), 34-44.

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

Falk, J. H., & Balling, J. D. (1980). The school field trip: Where you go makes the difference. *Science and Children*, March. pp. 6-9.

Falk, J. H., Martin, W. W., & Balling, J. D. (1978). The novel field-trip phenomenon: Adjustment to novel settings interferes with task learning. *Journal of Research in Science Teaching, 15*(2), 127-134.

Fortner, R., & Mayer, V. (1991). Repeated measures of students' marine and Great Lakes awareness. *Journal of Environmental Education, 23*(1, Fall), 30-35.

Gambro, J. S., & Switzky, H. N. (1996). A national survey of high school students' environmental knowledge. *Journal of Environmental Education, 27*(3).

Haluza-Delay, R. (2001). Nothing here to care about: Participant constructions of nature following a 12-day wilderness program. *The Journal of Environmental Education, 32*(4), 43-48.

Jelinek, D. J. (1998). Student perceptions of the nature of science and attitudes towards science education in an experiential science program (pp. 1-22). Paper presented at the 1998 NARST Annual Meeting, San Diego, CA.

Jordan, J. R., Hungerford, H. R., & Tomera, A. N. (1986). Effects of two residential environment workshops of high school students. *Journal of Environmental Education, 18*(1), 15-22.

Knapp, D. (2000). Memorable experiences of a science field trip. *School Science and Mathematics, 100*(2), 65-72.

Kubota, C. A., & Olstad, R. G. (1991). Effects of novelty-reducing preparation on exploratory behavior and cognitive learning in a science museum setting. *Journal of Research in Science Teaching, 28*(3), 225-234.

Kuo, F. E., & Taylor, A. F. (2004). A potential natural treatment for attention-deficit/hyperactivity disorder: Evidence from a national study. *American Journal of Public Health, 94*(9), 1580-1586.

NEETF. (2000). *Environment-based Education: Creating high performance schools and students.* (A report available at www.neetf.org). Washington, D.C.: The National Environmental Education & Training Foundation (NEETF).

Palmberg, I., & Kuru, J. (2000). Outdoor activities as a basis for environmental responsibility. *Journal of Environmental Education, 31*(4), 32.

Ramsey, J. M. (1993). The effects of issue investigation and action training on eighth-grade students' environmental behavior. *The Journal of Environmental Education, 24*(3), 31-36.

Scales, P. C., Blyth, D. A., Berkas, T. H., & Kielsmeier, J. C. (2000). The effects of service-learning on middle school students' social responsibility and academic success. *Journal of Early Adolescence, 20*(3), 332-358.

Shean, G. D., & Shei, T. (1995). The values of student environmentalists. *The Journal of Psychology, 129*(5), 559-564.

Sivek, D. J. (2002). Environmental sensitivity among Wisconsin high school students. *Environmental Education Research, 8*(2), 155-170.

SEER. (2000). *California Student Assessment Project: The effects of environment-based education on student achievement.* (A report available at www.seer.org/pages/csap.pdf). San Diego, CA: State Education & Environment Roundtable (SEER).

Vaske, J. J., & Kobrin, K. C. (2001). Place attachment and environmentally responsible behavior. *The Journal of Environmental Education, 32*(4), 16-21.

Volk, T. L., & Cheak, M. (2003). The effects of an environmental education program on students, parents, and community. *Journal of Environmental Education, 34*(4), 12-25.

Yerkes, R., & Haras, K. (1997). *Outdoor education and environmental responsibility.* (ERIC Digests Report EDO-RC-97-6).

Zelezny, L. C. (1999). Educational interventions that improve environmental behaviors: A meta-analysis. *The Journal of Environmental Education, 31*(1), 5.

Teacher Impact Literature

AbuSharbain, E. (2002). Enhancing inservice teachers' constructivist epistemology through the development and redesign of inquiry-based investigations together with their students. *Electronic Journal of Science Education, 7*(1).

Desimone, L. M., Porter, A. C., Garet, M. S., Yoon, K. S., & Birman, B. F. (2002). Effects of professional development on teachers' instruction: Results from a three-year longitudinal study. *Educational Evaluation and Policy Analysis, 24*(2), 81-112.

Guskey, T. R. (2003). Analyzing lists of the characteristics of effective professional development to promote visionary leadership. *NASSP (National Association of Secondary School Principals) Bulletin, 87*(637), 38-54.

Huntoon, J. E., Bluth, G. J. S., & Kennedy, W. A. (2001). Measuring the effects of a research-based field experience on undergraduates and K-12 teachers. *Journal of Geoscience Education, 49*(3), 235-248.

Loucks-Horsley, S., Stiles, K., & Hewson, P. (1996). Principles of effective professional development for mathematics and science education: A synthesis of standards. *NISE (National Institute for Science Education) Brief, 1*(1), 1-6.

Shepardson, D. P., & Harbor, J. (2004). ENVISION: The effectiveness of a dual-level professional development model for changing teacher practice. *Environmental Education Research, 10*(4), 471-492.

Shepardson, D. P., Harbor, J., Cooper, B., & McDonald, J. (2002). The impact of a professional development program on teachers' understandings about watersheds, water quality, and stream monitoring. *The Journal of Environmental Education, 33*(3), 34-40.

Other Resources to Consider

Additional Outdoor/Environmental Teaching Resources

Aram, R. J., Brake, M., Smith, D., Wood, G., & Hamilton, P. (2000). Testing the waters: The standards saturate schoolwide water theme. *Science and Children, 37*(4), 41-45.

Brown, J. S., Collins, A., & Duguid, P. (1989). Situated cognition and the culture of learning. *Educational Researcher, 18*(1), 32-42.

Davenport, J. C. (2003). *Waves, Wetlands, and Watersheds: California Coastal Commission Science Activity Guide*. San Francisco, CA: The California Coastal Commission.

Leslie, C. W., Tallmadge, J., & Wessels, T. (1999). *Into the Field: A guide to locally focused teaching*. Great Barrington, MA: The Orion Society.

Monroe, M. C. (2003). Two avenues for encouraging conservation behaviors. *Human Ecology Review, 10*(2), 113-125.

Niedermeyer, F. C. (1992). A checklist for reviewing environmental education programs. *The Journal of Environmental Education, 23*(2), 46-50.

Orion, N., Hofstein, A., Tamir, P., & Giddings, G. J. (1997). Development and validation of an instrument for assessing the learning environment of outdoor science activities. *Science Education, 81*(2), 161-171.

Sobel, D. (2004). *Place-Based Education: Connecting classrooms & communities*. Great Barrington, MA: The Orion Society.

Woodhouse, J. L., & Knapp, C. E. (2000). *Place-based curriculum and instruction: Outdoor and environmental education approaches.* (ERIC Digests Report (ED448012)).

Additional Professional Development Resources

Krajcik, J. S., Blumenfeld, P. C., Marx, R. W., & Soloway, E. (1994). A collaborative model for helping middle grade science teachers learn project-based instruction. *The Elementary School Journal, 94*(5), 483-497.

Marx, R. W., Blumenfeld, P. C., Krajcik, J. S., & Soloway, E. (1997). Enacting project-based science. *The Elementary School Journal, 97*(4), 341-358.

Evaluation Resources

Bringle, R. G., Phillips, M., & Hudson, M. (2004). *The Measure of Service Learning: Research scales to assess student experiences*. Washington, DC: American Psychological Association.

Guskey, T. R. (2000). *Evaluating Professional Development*. Thousand Oaks, CA: Corwin Press, Inc.

Hart, D. (1994). *Authentic Assessment*. Menlo Park, CA: Addison-Wesley Publishing Company.

Marcinkowski, T.J. (2004). *Using a Logic Model to Review and Analyze an Environmental Education Program*. Monograph No. 1. Washington, D.C.: North American Association for Environmental Education (NAAEE).

Patton, M. Q. (1997). *Utilization-Focused Evaluation* (3rd ed.). Thousand Oaks, CA: Sage Publications.

Payne, D. A. (2000). *Evaluating Service-Learning Activities & Programs*. Lanham, MD: The Scarecrow Press, Inc.

Web-based Resources

Bond, S.L., Boyd, S.E., Rapp, K.A. et al. (1997). *Taking Stock: A practical guide to evaluating your own programs*. Chapel Hill, NC: Horizon Research, Inc. Available at http://www.horizon-research.com/reports/1997/taking_stock.php

National Science Foundation. (2002). *The 2002 User-Friendly Handbook for Project Evaluation*. Washington, D.C.: Directorate for Education and Human Resources, Division of Research, Evaluation and Communication. Available at http://www.ehr.nsf.gov/rec/programs/evaluation/handbook/

W.K. Kellogg Foundation. (2001). *Evaluation Handbook* and *Logic Model Development Guide*. (Two documents that are part of the Evaluation Toolkit from the WK Kellogg Foundation.) Available at www.wkkf.org/Programming/ResourceOverview.aspx?CID=281

Wiltz, L.K. (2000). *Proceedings of the Teton Summit for Program Evaluation in Nonformal Environmental Education*. Kelly, Wyoming: Teton Science School and Ohio State University. Available at http://www.ag.ohio-state.edu/~eetap/pdf/teton.pdf