

ENVIRONMENTAL EDUCATION

RESEARCH BULLETIN

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ABOUT THE RESEARCH BULLETIN

The Environmental Education Research Bulletin is a project of NatureBridge in partnership with Dr. Nicole Ardoin at Stanford University. It is designed to synthesize and summarize recently reported research from journals of interest to environmental educators. The bulletin was created for an audience of NatureBridge educators, so the emphasis is on field science, stewardship behavior, and residential settings, among other topics. The Research Bulletin is available online through the NatureBridge website. Please send questions and feedback to jmorris@naturebridge.org.

DEVELOPMENT TEAM

PROJECT LEAD

Dr. Nicole Ardoin, Stanford University

PROJECT ADVISOR

Jason Morris, NatureBridge

EDITORS

Rachelle Gould

Jess McNally

Christy Merrick

SENIOR WRITER

Christy Merrick

CONTRIBUTING WRITERS

Sharon Beltracchi

Matt Biggar

Jennifer Bundy

Rebecca Castro

Stephanie Chang

Elise DeBuysser

Ethan Estess

Grace Goldberg

Yari Greaney

Mattias Lanas

Sabina Perkins

Lisa Peterson

Mila Re

Dana Thomas



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BEHAVIOR

COMMUNITY RESPONSIBILITY AND ENVIRONMENTAL AWARENESS MOTIVATE AUSSIE YOUTHS

Researchers in Australia were alarmed by recent findings that Australian youths exhibited minimal concern for the health of the environment and were largely unmotivated to help solve environmental problems. They postulated that these findings may have been linked with the “bystander effect,” in which youth feel powerless to change large-scale problems because the locus of control is outside of them. In this paper, the researchers examined how Australian youths perceive the locus of control in addressing environmental issues, as well as whether they believe responsibility to address environmental problems lies with the government or their local communities. The researchers examined whether these perceptions are correlated with higher levels of self-reported environmental knowledge, pro-environmental intentions and behavior, and environmentally harmful behavior.

The authors used an online survey to assess 3,731 participating youths aged 12 to 24. They used two sample groups, one consisting of 12- to 17-year-olds in secondary school and the other 18- to 24-year-olds in post-secondary school and in the working world. The 12- to 17-year-olds were recruited via contacting their schools. The 18- to 24-year-olds were recruited via emails acquired from a commercially purchased list of names and through survey links sent through youth, community, and tertiary sector (e.g., university) networks. Sample groups were composed of an even mix of males and females, and all participants lived in the state of Queensland in predominately metropolitan areas. The students in both groups completed the surveys as part of an in-class activity during the final week of their semester, and the non-students (40 percent of the older study group) completed the survey on their own.

The questionnaire measured environmental knowledge and concern by asking how much participants knew about and were concerned with major environmental issues such as climate change. The survey assessed whether youths perceived that the government or their local community was responsible for addressing specific environmental issues. To assess environmental attitudes and behaviors, the survey asked how likely youths would be to undertake certain environmentally friendly activities, such as recycling and conserving



water, and how often they perform those activities. Finally, the survey asked how often youths perform a variety of environmentally harmful activities, such as putting recyclable items in the trash, and asked participants to indicate the main barriers that prevented them from engaging in pro-environmental activities.

The authors analyzed the data to search for predictors of environmental behavior. They found that pro-environmental behaviors like recycling and water conservation were positively correlated with a sense that the surrounding community was responsible for taking care of the environment. Additionally, pro-environmental youths were more likely to have more knowledge and concern for the environment, as well as a heightened belief that their actions could make a positive difference. Across both groups, females and older students were more likely to be pro-environmental, and there was a negative correlation across the board between the belief that the government was responsible for solving environmental problems and pro-environmental behavior. In other words, those who believed that solving environmental problems was not the responsibility of the government, but rather the responsibility of individuals, were more likely to undertake pro-environmental behavior. The study found that younger participants overall performed more environmentally harmful behaviors, and that the most common barriers to pro-environmental action include self-reported laziness, perceived lack of time and money, and the belief that individual actions don't make a difference.

THE BOTTOM LINE: The researchers found that, among this population of 12- to 24-year-olds, environmentally friendly behaviors were motivated by the sense that their surrounding community was responsible for taking care of the environment. Pro-environmental behaviors also were associated with heightened concern and knowledge about environmental problems, and youths were likely to become more environmentally friendly as they became older. Environmentally harmful

behaviors were reported to stem from laziness, perceived lack of time and money, and the belief that individual actions don't make a difference. These findings suggest potential strategies for motivating youth involvement that include emphasizing the opportunity and responsibility to contribute to one's community through pro-environmental actions; an increased focus on building a foundation of environmental awareness in early education; and encouraging easier, less time-consuming pro-environmental actions for youths to overcome barriers of laziness and time constraints.

Fielding, K. S., & Head, B. W. (2012). Determinants of young Australians' environmental actions: The role of responsibility attributions, locus of control, knowledge and attitudes. *Environmental Education Research*, 18(2), 171-186.

PERSONALITY PREDICTS ENVIRONMENTAL ENGAGEMENT

Although studies indicate that personality traits may predict environmental engagement, previous research tends to focus on specific personality traits and associations with individuals. This paper reported on three studies conducted using data from previous studies and surveys to determine whether the Big Five personality traits correlate positively to environmental engagement. The Big Five dimensions of personality are neuroticism, openness to experience, agreeableness, conscientiousness, and extraversion. This paper also extended existing research by examining these associations at both an individual and country level.

In the first study, researchers sampled 6,507 participants from the 2009 New Zealand Attitudes and Values Study. A four-item measure of each of the traits in the Big Five model determined personality dimensions. To assess environmental values, the authors extracted data from one item asking participants to rate the importance of "protecting the environment (preserving nature)." This

study found strong correlations between environmental value and the personality traits of agreeableness, conscientiousness, and openness to experience.

The second study was an extension of the first. Still looking at the individual level, the authors sought to connect personality with environmental engagement through specific behaviors. The researchers analyzed data from 377 participants in the 2008 Social Attitudes Survey in New Zealand, which took place in three “waves” from June 2008 through January 2009. A ten-item personality inventory measured the Big Five dimensions, and 13 items asking participants to rank how often they performed electricity-conserving actions (e.g., “Turn the lights off in the room that are not being used”) were used to determine environmental engagement. Again, agreeableness and conscientiousness were strongly associated with environmental engagement, as well as neuroticism.

With the third study, the authors determined the relationship between country-level personality and environmental engagement. Mean scores of each of the Big Five personality traits were gathered for 51 countries from a study conducted in 2005 as part of the 79 Members of the Personality Profiles of Cultures Project. Four separate indices were used to assess country-level environmental engagement. The authors determined that agreeableness, openness, and extraversion were consistently associated with environmental engagement at the national level, as well as conscientiousness, to a lesser extent.

The findings from the three studies aligned with findings from other research. Agreeableness and conscientiousness consistently have positive associations with environmental engagement. Agreeableness in particular has been related to self-transcendence, which is in turn related to environmental engagement. Individuals with a strong tendency towards agreeableness also tend to act pro-socially, which the authors argued is a driving force behind the actions of environmentalists. Conscientiousness is related to a “future time perspective.” Individuals high in conscientiousness plan ahead, including with regards to the environment.

Openness to experience was associated with environmental engagement to a slightly lesser degree. The authors theorized that these individuals are curious and tend to have unconventional beliefs that, in many cases, include those of the environmental movement. Extraversion only had an association with environmental engagement at the country level, indicating that the personality traits have different effects when considered at different levels of analysis. The authors linked extraversion with a “disbelief in the role of fate” and connected the rise of the post-material culture in many countries to increasing concern for environmental protection. Neuroticism, while having a positive association with environmental engagement in the second study that focused on specific behaviors, had a negative association for both the first and third studies. This difference in relationship may be attributed to neurotic individuals’ concern with negative outcomes and the consequences that are happening in the moment—such as specific behaviors—rather than projecting into the future.

The authors concluded with a look at meta-traits that combine the Big Five into two categories of stability (neuroticism, agreeableness, and conscientiousness) and plasticity (extraversion and openness). Environmental engagement seems to link to both stability and plasticity, but the connection to stability is slightly stronger and indicates an “underlying need to maintain a stable environment,” whereas plasticity is indicative of change. However, although the authors acknowledged these connections, they called for more empirical investigations linking meta-traits with environmental attitudes.

THE BOTTOM LINE: The personality traits that relate to pro-social behavior and planning for the future, such as agreeableness and conscientiousness, were those most strongly linked to environmental engagement for both individuals and nations. In general, personality traits may be used to predict environmental engagement on both an individual and a national level. Understanding the general behavioral tendencies of individuals and cultures may also lead to more effective educational efforts that encourage particular behaviors and attitudes. In addition, this study

suggested that promoting agreeable and conscientious behavior in general may concurrently be creating a fertile ground for environmental engagement to take root.

Milfont, T. L., & Sibley, C. G. (2012). The big five personality traits and environmental engagement: Associations at the individual and societal level. *Journal of Environmental Psychology*, 32(2), 187-195.

PERCEIVED MOTIVES OF SCIENTISTS AFFECT BELIEVABILITY OF CLIMATE SCIENCE

Much research in climate change science communication has focused on how the construction of the message—such as the words and the framing—affects the recipient's understanding, acceptance, and willingness to act on the information. This paper reported on two studies that take a different approach, looking instead at the perceptions a recipient has about the role of the person communicating the message.

The first study looked specifically at how the perceived agendas of scientists, either to simply inform or to persuade toward a particular action, affected the recipient's trust of scientists and willingness to act in line with the climate change message. Participants included 14 men and 43 women who averaged 28 years old. The researchers presented participants with one of two descriptions of climate scientists: In one description, the scientists' primary function was to inform; in the other description, the scientists' function was to persuade. The researchers then asked the participants to rate their agreement with the following two statements: "Most climate scientists believe that their aim is to provide impartial information" and "Most climate scientists believe that their aim is to persuade the public to take action." Finally, the participants were asked to rate their trust in scientists and how likely they would be to participate in recommended environmental activities.

As expected, participants introduced to the inform

description rated climate scientists' primary goal as being to inform, and participants who were conditioned to choose persuade chose persuade as being the primary goal of scientists. Interestingly, those who had received the treatment that influenced them to choose inform also reported higher levels of willingness to participate in environmentally conscious actions than those who received the persuade treatment. When people perceived an intention to persuade, trust suffered. Although participants were not shown any actual data from climate scientists, the perceived hidden agendas influenced trust and intent to engage in environmental behaviors.

The second study was a follow-up of the first, and addressed the question of how the perceived motives of climate scientists influenced the response to different kinds of messages, specifically those written in an informative versus persuasive style. Research participants included 37 men and 77 women with an average age of 26. The participants were again divided into two groups and received the same treatment as the first study to manipulate their perceived bias towards scientists.

The participants were then asked to read a short text about the consequences of climate change that they were led to believe had been written by climate scientists. Half of each group in the first manipulation was asked to read an "informative text" about climate change, and half of each group was asked to read a "persuasive text" on the consequences of climate change, so that in the end there were four distinct treatment groups. The "informative text" was presented as a list of "Facts about Climate Change." The "persuasive text" included the same list of facts, but with each fact preceded by a "fiction" statement that the fact then proved wrong. All participants were asked to rate whether they thought "the purpose of the article was to persuade people to take action on climate change" in order to make sure the text manipulation was successful. Finally, all participants were asked to complete a survey that tested measures of trust in climate scientists, environmental concern, and intention to engage in environmentally sustainable behavior.

The researchers found the response to the different styles of text was strongly linked to the participants' expectations of the scientists' communicative goals. The most effective communication occurred when the style of the text matched the participants' expectations about scientists' intentions. For example, participants who were conditioned to see the scientists' role as to inform and read the "informative text" rated their environmental concern, trust in scientists, and intention to engage in environmental behavior higher than those who read the same text but expected that the scientists' role was to persuade. The opposite was also true: Those expecting persuasive scientists were more responsive to the persuasive text.

THE BOTTOM LINE: Recipients of a message are more likely to trust the message and be willing to undertake environmentally conscious behaviors if the message from the climate scientist matches their expectations, whether that message is designed to persuade or inform. This study suggested that understanding public opinion about the role of scientists in communicating climate science is critical.

Rabinovich, A., Morton, T. A., & Birney, M. E. (2012). Communicating climate science: The role of perceived communicator's motives. *Journal of Environmental Psychology*, 32(1), 11-18.

CONCEPT OF POWER INFLUENCES INDIVIDUAL BEHAVIOR

Current debate around environmental action examines why people become involved in collective action, with a citizen group, for example, versus changing individual behavior, such as consumer habits. This study sought to understand what influences the conscious choice between individual or collective-level engagement. Previous research suggests that an individual's choice to engage in collective or individual action stems from their viewpoint on environmental problems and solutions. In this study the authors examined a different possibility: that individuals' environmental decisions stem from how they conceptualize their own power over particular behaviors

and the degree to which they believe the behavior can create change.

This study focused on the nature and role of power in decisions about how people will act in the face of climate change specifically. The study sample was comprised of 12 environmentally-aware young adults between the ages of 25 and 35. The authors purposefully selected study participants with similar knowledge of climate change problems and solutions so that the observed behavioral differences would relate to factors other than conceptual knowledge. In this exploratory study, the authors used in-depth interviews to collect data that helped illuminate how behavior of environmentally conscious individuals is based on concepts of their power to create change.

The study yielded five important findings on a person's beliefs and their corresponding behavior. First, respondents identified feeling powerless in the context of climate change. They reported that any individual action seemed to be negligible compared to the magnitude of the problem.

Second, the authors could find no simple way to distinguish social- and individual-level action, as they had originally set out to do. All participants who were active on the collective social level were also engaged in individual behavior change. However, the opposite was not the case: Many respondents were engaged in individual behavior change but not collective action.

Third, all respondents were critical toward people who try to convince others to change their individual behavior and toward education actions promoting this, such as awareness-raising campaigns. The "paternalistic" or "blaming" character of these actions was commonly cited as the respondents' reason for their disapproval of these approaches. This finding suggests that measures such as awareness-raising campaigns can have a counterproductive effect on environmentally aware citizens.

Fourth, the authors found that many respondents gave opinions that seemed contradictory or at odds with each other. The researchers observed that one reason for this

lack of coherence is an apparent gap between analysis and strategy. For example, one participant articulated capitalist economy (social structure) as the problem driving climate change, however, his/her solution was for people to “stop consuming” (individual behavior).

Finally, there was a discord in respondents’ proposed abstract and concrete strategies. In response to one interview question, participants advocated collaboration between large manufacturers and environmental interests; however, when pressed in a separate question to respond to an actual problem (a polluting power company), all changed their stance to a conflict-oriented approach. This discord between abstract and concrete strategies may say something about the coherence of analyses, strategies, and visions within the current environmental movement.

The study concluded that many environmentally aware citizens engage in individual action because they feel powerless to solve the larger-scale, societal causes of climate change. Feeling bound by an imposed system, they engage in actions within their reach as an attempt to minimize their personal negative impact; however, none of the participants identified their actions as having meaningful impact. Combating this disconnect between knowledge of problems, knowledge of action strategies, and perceptions of efficacy is crucial for empowering environmentally aware citizens.

THE BOTTOM LINE: This study’s findings suggested that environmentally aware citizens may not need additional conceptual knowledge of environmental problems. Rather, they need action-oriented knowledge to craft coherent environmental strategies and visions. By taking this next step, a specialized education strategy can change an individual’s concept of power (or powerlessness) over environmental outcomes, thus allowing a person to perceive action as meaningful in the face of climate change.

Kenis, A., & Mathjis, E. (2012). Beyond individual behaviour change: The role of power, knowledge and strategy in tackling climate change. *Environmental Education Research*, 18(1), 45-65.

CREATING A CONSERVATION CULTURE

Rocky Mountain High School is a school of over 1,700 students located in Fort Collins, Colorado. Between 2001 and 2007, the school reduced its energy use by 50 percent, outperforming other schools in the same district. Interested in what led to this phenomenon, the authors conducted a case study of the school’s holistic approach to sustainability education. They focused on the roles of models of sustainable behavior in the form of individual role models, facilities and operations, governance, and school culture.

This study’s authors looked for evidence of individual role models in the form of administrators, teachers, and students. Several individuals and groups were seen as leaders and educators who inspired others. The principal was firmly behind the conservation program. Students credited the environmental studies teacher for helping them understand the importance of environmentally responsible behavior. This teacher’s encouragement and reminders also motivated other teachers. The teachers and staff overall strove to serve as role models through their own conservation behavior. The environmental club modeled environmentally responsible behavior, spread conservation messages, and inspired others to act. All together, these individual role models helped develop school pride around conservation.

School governance structures also contributed to the conservation education at the school, involving many stakeholders in conservation and resource use decisions. For example, the head custodian was involved in administration meetings and given responsibility to make decisions. The custodians then felt empowered to make changes in their routines to conserve energy and resources. Some changes implemented by custodians included turning off the regular lights after the school day and using only the emergency lighting during the evening. Students were also involved in decision making. The environmental club was given money from rebates on energy conservation and spent it on purchasing wind power. Participatory governance enhanced both individual and group efficacy in conservation efforts.

School culture, another component of modeling, also played an important role in conservation education. The school embraced conservation and it pervaded the organization. The school newspaper often featured articles on environmental topics. Through the principal's leadership, school slogans of "the Lobo [school mascot] Way" and "Care and Repair" were widely understood as energy conservation, and caring for existing equipment and repairing things, respectively.

In addition to modeling, communication also served a vital role in the school's energy conservation. The four types of messages that affected conservation education and action were: behavioral expectations; knowledge; energy and resource data use; and conservation accomplishments. In particular, school stakeholders noted the importance of "receiving information about their energy use and the outcomes of their actions." This took the form of interpersonal communication, emails, announcements, school newsletters, the school newspaper, and posters. Overall, the communication was found to be educational and inspirational.

The authors concluded that interactions within the four modeling and communication components created a successful energy conservation program. Education efforts both contributed to and benefited from the integrated nature of the energy conservation program.

THE BOTTOM LINE: This study highlighted the value of an integrated approach to conservation for changing environmental behavior within an organization. Charismatic role models for sustainability, both staff and students, can play an instrumental role in creating a school-wide culture of environmental awareness and behavior change. In particular, this study highlighted the importance of not just classroom activities but also school practices, governance, and extracurricular experiences in sustainability education.

Schelly, C., Cross, J. E., Franzen, W. S., Hall, P., & Reeve, S. (2012). How to go green: Creating a conservation culture in a public high school through education, modeling and communication. *Journal of Environmental Education*, 43(3), 1-41.

EVALUATION

FRAMEWORK HELPS ASSESS FIELD TRIPS IN NATURAL SETTINGS

Learning during field trips to informal learning centers often has focused on built environments such as museums and zoos. But, the authors of this paper argue, “the field trip in nature differs in many ways from a museum, planetarium or science centre visit, as it allows direct experiences with natural phenomena and wildlife.” As a result, the authors believe that outdoor field trips deserve an assessment framework of their own, and they propose the Field Trip in Natural Environments (FiNE) framework.

Developed from previous frameworks for outdoor education field trips, this framework diverges in that the authors believe that the FiNE framework “provides a more holistic view of the field trip experience than most other works do,” because it assesses the field trip from the planning stages through the teaching methods used in the field to the learner outcomes after the experience.

The authors developed the framework based on their observations of 22 field trips to natural and archaeological sites in Israel from 2006-2009. The four- to eight-hour field trips consisted of 20 to 30 students in fourth through sixth grades brought by their teacher to an outdoor site. The students were met by a professional facilitator who led the field trip, which typically consisted of a guided walk and sometimes also included other prepared activities. The researchers observed these field trips, and also conducted interviews with 41 students from seven schools a day before and a day or two after the field trip.

The key components of the FiNE framework follow. The authors provided scoring rubrics for many of the components of the framework to help evaluate each of the field trip’s various aspects.

PLANNING

Classroom preparation—covering important information about the upcoming trip, including when and where the trip will be, the purpose of the trip, what to wear and bring, etc.

Collaboration—communication between the facilitator and the teacher or school to clarify learning goals and mutual expectations



Connection to curriculum—making explicit connections between the field trip content and the students’ classroom curriculum

PEDAGOGY

Clarifying the goals—making the goals for the experience clear during the field trip, so that students understand the purpose of the visit and how to participate

Using the environment—making effective use of the surrounding environment to enhance learning

Connection to everyday life—providing meaningful connections between the content of the field trip and students’ everyday life

Social interactions—designing experiences to facilitate social learning, whether they are interactions between students or between students and adults

Facilitator’s performance—the facilitator’s appropriate use of interpersonal, communication, and logistical skills

ACTIVITY

Physical activity—using physical activities such as climbing trees, crawling through caves, wading through rivers, and so on to enhance the learning experience

Active learning—using planned activities to facilitate learning

(The researchers believe that each of these activities should be assessed from both the students’ point of view, through interviews, and the researchers’ point of view, through observations, for a total of four data points related to activities.)

OUTCOMES

Feelings, attitudes, and beliefs—students express feelings about nature, especially related to the value of nature

Knowledge and understanding—students demonstrate detailed understanding of key concepts, using examples to demonstrate understanding

In the authors’ view, the 22 field trips they observed scored poorly in the framework, missing points for oversights such as insufficient planning, failing to communicate goals, leading activities that lacked social interaction or interesting physical activity, and so on.

Although the authors believe that this framework is ready for use by schools and organizations, they acknowledged that it was built from research drawn from a fairly small sample. And they hope to further refine the instrument with a written survey that can complement the student interviews for a more quantitative measure of the outcomes. They concluded, “We presume that our findings regarding the large-scale administration of the questionnaire will pave the way for its use in other countries and contexts.”

THE BOTTOM LINE: The FiNE framework for assessing outdoor field trips, presented for the first time in this article, can serve as a useful reminder of many of the important aspects of field trip planning and execution, and the rubrics provided in the paper can help observers better gauge a field trip’s success. However, the framework is not based on extensive experimental research or drawn from a large body of observational research. It also cannot help predict any particular outcomes. For example, high scores in some parts of the framework do not guarantee high scores in the outcomes of the field trip.

Morag, O., & Tal, T. (2012). Assessing learning in the outdoors with the Field Trip in Natural Environments (FiNE) framework. *International Journal of Science Education, 34*(5), 745-777.

TEACHING METHODS

USING INQUIRY-BASED ACTIVITIES TO TEACH SCIENCE

A conflict inherent in teaching canonical science concepts in an inquiry-based framework exists. Can students be asked to explore for themselves, while also being taught testable scientific concepts? In this scenario, tension forms around how much guidance a teacher gives to foster authentic discovery and understanding of the scientific process, while still teaching important scientific information. This study asks: What happens when we use an inquiry-based model for teaching science?

The study analyzed the speech between teachers and students to understand how this tension manifests in classrooms in Singapore. Video and audio recordings of 10 science teachers were taken in two phases, first as a baseline, and, second, after a teaching strategy intervention. During the baseline, classrooms typically used a traditional teaching model in which the teacher led the class.

The lesson examined by the study taught transfer of energy from elastic potential energy to kinetic energy, using rubber-band group experiments and class discussion of energy concepts. The intervention asked teachers to plan an inquiry-based lesson, which included the five features of inquiry: questions, evidence, explanation, connections, and communication. Also, the 5E model of inquiry was used by the teacher examined in the case study, with the goal of having students engage, explore, explain, elaborate, and evaluate. Both of these inquiry models aimed to teach students the scientific process by carrying it out themselves.

The researchers transcribed and studied the lessons, specifically observing how teachers moved between a dialogic and authoritative role in the classroom. Dialogic conversation is where the talk moves between the teacher and students (two-way conversation), and authoritative is where the talk moves only from teacher to student (one-way conversation). The paper closely followed one case study, in which the teacher moved between dialogic and authoritarian communication strategies, successfully engaging students in discussion while maintaining authority on the subject. By keeping this control, she was able to meet content teaching goals. However, by emphasizing the correct results of the activity, she may have



decreased the degree to which the students explored and discovered concepts on their own—a pillar of inquiry-based learning. Specifically, during class discussion, strong guidance from the teacher led students to give “correct” answers or passively wait for her to tell them the “correct” answer. This undermined exploration by the students and an authentic understanding of the scientific process, and may have given the students the impression that science is fixed.

The researchers concluded that teachers must “reexamine their roles in classroom discussion or talk and learn to promote learning by exploring ways to make their classroom discussion more participatory and learning-centered for the students.” When teachers have greater awareness of learning goals and execution of their teaching strategy, they will be more effective in balancing inquiry and factual content in their lessons.

THE BOTTOM LINE: This study examined the tension between inquiry-based science education and the pressure to teach the “right” answer when teaching scientific content. By following 10 science teachers and using one as an in-depth case study, the researchers closely observed the use of one-way conversation (teacher to students) versus two-way conversation (dialogue between teacher and students) in the classroom. They found that when too much guidance is given by the teacher, students are not free to explore authentically. Instead, the students simply seek out or wait for the correct answer, rather than gain experience in scientific inquiry. The authors suggested that using an inquiry-based method while maintaining authority may be an effective mix to meet teaching goals and still have students explore the scientific process.

Tan, A.-L., & Wong, H.-M. (2012). ‘Didn’t get expected answer, rectify it’: Teaching science content in an elementary science classroom using hands-on activities. *International Journal of Science Education*, 34(2), 197-222.

INTERACTIVE CLIMATE CHANGE SIMULATOR AN EFFECTIVE LEARNING TOOL

The issue of climate change is controversial among policymakers and the public. Many opt for the wait-and-see approach, hesitant to take any drastic actions toward mitigation and response. Researchers are concerned that this cautious approach is a result of incorrect assumptions about how carbon dioxide (CO₂) emissions relate to carbon dioxide concentration levels. In an effort to address these misconceptions, the authors of this paper developed and tested an interactive climate change computer simulation, where participants received continuous feedback about the results of their actions. They also looked at differences in learning between adults who had majored in science and technology (STEM) and those with non-STEM majors.

The study aimed to address two common misconceptions about climate change science. The first misconception is that a decrease in CO₂ emissions directly and immediately leads to a decrease in atmospheric CO₂ concentration. Though these two are certainly connected, the feedback loop is neither linear nor quick. The second misconception is that even if emissions are in excess of absorptions, CO₂ concentrations can still stabilize (a violation of mass balance).

Two sets of variables were tested: (1) whether misconceptions decreased after study participants completed the computer-simulation “experience” condition versus the control “description” condition, and (2) whether misconceptions decreased for those with STEM backgrounds versus those with non-STEM backgrounds. The research study targeted 120 total participants, ages 18 to 55. Among the participants, 60 were randomly assigned to the experience condition and 60 to the description condition. Within each condition, 30 had STEM backgrounds and 30 had non-STEM backgrounds. In total, participants spent about 30 minutes in the activities.

The main difference between the experience and description conditions lay in whether the activity provided immediate feedback to the participants. The description condition was a paper-and-pencil CO₂ stabilization activity. Participants were given some information about CO₂ processes and historical CO₂ concentrations over the last 150 years. Next, they were asked to draw an estimated line graph of future CO₂ absorptions and emissions, corresponding to a given line graph of CO₂ concentration from 2001 to 2100. In other words, they were asked to stabilize CO₂ concentration at the given level for each of 100 years, based on absorptions and emissions.

The experience condition included an additional task, in which participants performed the same CO₂ stabilization activity using the dynamic climate change simulator (DCCS). For every value of CO₂ emission and absorption that participants chose per year, the DCCS responded with immediate feedback, showing the resulting effect on CO₂ concentration levels. Following the simulation activity, participants in the experience condition also performed the baseline paper-and-pencil task. The overall CO₂ stabilization activity, whether on paper or the computer, specified a goal of 938 GtC (gigatons of carbon), a CO₂ concentration level that participants aimed to reach by 2100. All participants also explained their drawings and reasons after completing the tasks.

Generally, the authors found that participants—no matter what their background—tended to rely more on preconceived and incorrect notions of correlation and mass balance if they took part in the description condition. All participants who worked with the DCCS and received feedback on their decisions relied less on these assumptions, and also did better on the paper-and-pencil task that followed the simulation.

With regard to differences based on educational background, the results were interesting. Both sets of participants with STEM and non-STEM backgrounds relied on their flawed correlation heuristics in the description condition, but in the experience condition the STEM participants performed significantly better

than those with non-STEM backgrounds. In looking at the concept of mass balance, the authors found that STEM participants generally did better than non-STEM participants in both description and experience conditions.

Based on their findings, the authors concluded that the computer simulator activity allowed participants to gain immediate and repeated feedback based on their decisions. This feedback corrected their errors and assumptions, leading them to better understand the relationships between CO₂ emission, absorption, and concentration. The simulation learning experience also transferred to the paper-and-pencil task, particularly for those with STEM backgrounds.

The authors suggested that future research studies may focus on creating simulation tools that are effective for learners with STEM and non-STEM backgrounds, as well as designing dissimilar tasks that test knowledge transfer.

THE BOTTOM LINE: In communicating complex topics and relationships, feedback-based simulation activities do a better job of disrupting incorrect assumptions and teaching accurate cause-and-effect relationships than non-feedback-based tasks. Those with STEM backgrounds also perform significantly better in these experiential conditions, perhaps due to their prior experiences in forming connections and creating structures of comprehension.

Dutt, V., & Gonzalez, C. (2012). Decisions from experience reduce misconceptions about climate change. *Journal of Environmental Psychology, 32*(1), 19-29.

WRITING-TO-LEARN ACTIVITY HELPS BUILD ECOLOGICAL LITERACY

Many college students have a solid understanding of ecological, social, and economic facets of environmental issues, but are not given the opportunity to process the interconnectedness and relevance of these topics. This study examined whether writing-to-learn exercises, which encourage expressive writing and connection of concepts,

improved students' ecological literacy. The researchers defined an ecologically literate person as "involved in making decisions that are based on ecological knowledge and accepting responsibility for personal actions." In addition, the researchers used student writing to assess the differences in the ecological worldview between college students with different science education and cultural backgrounds. Specifically, they examined whether these students' writings reflected ecosystem-centered, community-centered, or individually-centered concerns in response to learning about an environmental issue.

The researchers examined three populations of college students: 42 biology majors and 47 elementary education majors at a four-year college, and eight native studies students at a tribal college in the United States. The study was conducted as part of biology class: introductory biology laboratory (for biology majors), general biology (for elementary education majors), and general biology (for native studies majors). As part of the study, students read articles about hypoxic waters and dead zones. The four-year college students read two Science News articles about hypoxia and dead zones as well as a fact sheet published by the Ecological Society of America. The native studies students read a World Watch Institute article on hypoxia and other issues, which the professor had already chosen for the course. During class, students participated in inquiry activities and engaged in conversation about the topic with peers. Over the period of the study, they wrote three essays on a given prompt, outside of class.

Researchers analyzed the essays, looking for clues in the language to make conclusions about the students' internalization of the concepts and ability to use ecological information in decision making. They coded the essays as superficial, subjective, objective, or authentic, depending on the students' ability to make affective (emotional) and conceptual connections to the ecological concepts and support those connections with ecological understanding. Superficial writers did not make any meaningful affective or conceptual connection to the ecological concepts being discussed. Subjective writers were able to make affective connections, but were unable to support their ideas with

ecological evidence. Objective writers communicated conceptual understanding and supported these ideas with ecological evidence, but did not make affective connections. Finally, authentic writers were those who made both affective and conceptual connections to the ecological concepts and were able to support their ideas with evidence.

The researchers also coded essays for clues about the students' ecological worldview. They classified each essay as either *ecosystem-centered*, *human community-centered*, or *individually-centered*. An example of an ecosystem-centered essay was one that described the negative consequences of fertilizer runoff on ecosystems. Human community-centered essays used the plural active voice (we) in reference to the human community being adversely affected by dead zones. Individually-centered essays used the singular active voice (I) in reference to the writer's personal life being disrupted by dead zones. In addition, the researchers examined whether the essay described a personal dilemma that the writer or someone else (such as a fisherman or farmer) had, and whether the essay included a decision to resolve the dilemma.

Both four-year college groups showed some increase in ecological literacy, with biology students demonstrating a 17 percent increase and education students demonstrating a 23 percent increase. All of these increases came from students who started with objective essays. The tribal college population had a very small sample size of eight students, but findings indicated a 50 percent increase in ecological literacy.

The researchers looked at how individual students moved between these designations throughout the activities, as well as how levels of ecological literacy differ between groups of students. For both biology and education students, most of the first essays were objective. In both groups, no students who started with superficial or subjective essays were classified as authentic by the third essay.

The researchers found that biology students were more human-community centered and self-centered than education students, who were more ecology-centered in their essays. Native studies students were dominantly ecology- and human-community centered, with human-community centered comments often alluding to an understanding of human communities as part of a greater ecological system.

Researchers concluded that, because of the setting of the writing-to-learn activities, it was expected that students would begin with objective essays, written in a style more similar to assignments they are asked to write in science classes. In reflection, they concluded that prompts are valuable in guiding writers toward authentic exploration of environmental issues. In-class discussion also allows students to explore these issues. The authors concluded that the expressive writing activity was effective in developing ecological literacy in the students.

THE BOTTOM LINE: Writing assignments that allow personal expression and exploration result in integration of knowledge into a usable decision-making framework. This study found that writing-to-learn activities, which are based in expressive writing in everyday language, improve ecological literacy and create greater potential for environmental stewardship and informed decision making by college students.

Balgopal, M. M., Wallace, A. M., & Dahlberg, S. (2012). Writing to learn ecology: A study of three populations of college students. *Environmental Education Research*, 18(1), 67-90.

CONTINUOUS REFINEMENT IMPROVES CURRICULUM EFFECTIVENESS

Complex concepts such as global climate change can be difficult to comprehend, but when guided by effective educational tools and lessons, students can begin to understand such systems. This study's authors designed and tested two versions of computer-based lessons featuring

interactive visualizations, which were intended to help middle school students understand factors involved in climate change. The researchers used feedback from the first round of implementation to improve the version used in the second round, a design-based approach they referred to as "iterative refinement."

The participants in the study were 186 sixth-grade students from culturally diverse classrooms in the U.S., taught by three middle school teachers. Some students interacted with an original version of the lessons, Global Climate Change Unit 1 (GCC1), and others used the modified design, GCC2. GCC1 was itself a redesign of an existing computer-based climate change education unit called Global Warming. The redesign was created in partnership between the paper authors, teachers, technologists, content experts, and other researchers at a retreat that reviewed work from the global warming unit. A major focus of the redesign was incorporating "inquiry learning." Inquiry learning encourages students to generate and test ideas, conduct investigations, and organize problem-solving techniques, and the authors incorporated these practices into the software. The lessons included visualizations and correlated scientific concepts with experiences visible and relevant to the participants.

GCC2 was based on feedback the researchers received from teachers and students after the first classroom implementation of GCC1. GCC2 revised several activities within the program, with the aim to increase the emphasis on energy transfer and transformation and to improve the comprehensibility of some of the visualizations.

To examine the effectiveness of the lessons, the researchers administered embedded assessments, pre- and post-tests, and coded student explanations of scientific phenomena with a rubric to compare student understanding before and after completing the lessons.

Assessment results indicated greater student understanding of aspects of global climate change after interacting with either version of the lessons. GCC2 students in general had greater improvement in pre- and post-test

scores. GCC2 students also gained a more integrated understanding than GCC1 students, mentioning energy transformations more frequently and giving responses that showed understanding of cause-and-effect relationships in the atmosphere.

THE BOTTOM LINE: Instructional activities that encourage students to generate and test ideas, conduct investigations, and organize problem-solving strategies help increase student understanding, making it possible to learn about complex systems and concepts such as global climate change. Iterative refinement of lessons during the design and development phase helps create lessons that are more effective in reaching educational goals. Findings such as these—related both to the curriculum content and structure, as well as to the design process—can help guide the development of more effective science activities and lessons that deal with complex, systems-based environmental issues and that take into account important considerations related to assessment and evaluation.

Svihla, V., & Linn, M. C. (2012). A design-based approach to fostering understanding of global climate change. *International Journal of Science Education*, 34(5), 651-676.

EXPERIENCED TEACHERS LEAD BY EXAMPLE

When it comes to observing the classroom environment, experience counts. Research reveals that expert teachers are able to observe a classroom with a broader perspective and can attend to more details than novice teachers. Experts can also react quickly to situations that require intervention, often without even being aware of their actions.

These findings may be true in a classroom, but what about outdoors? What tools do expert outdoor teachers use to observe both their students and the environment? According to the authors of this study, “Field-work studies focusing on teachers are rare.” The authors explain that it’s far more common to study students, not teachers, in outdoor settings. The researchers studied the behavior of

two expert ecology teachers. Using a cognitive model lens, the authors explored how the teachers think about and transfer knowledge to their students.

The science teachers included in the study each had more than 10 years of teaching expertise. Referenced under the pseudonyms of Eric and Carl, the teachers work at two universities in Sweden. Eric led a group of 12 pre-service preschool and primary school science teachers, while Carl led a mixed group of both prospective biologists and biology student teachers. Both teachers covered similar content on a field trip to a natural environment on trips that lasted six and nine hours, respectively.

The researchers took photographs and made video and audio recordings of the trips. Video recordings included both videos shot from the students’ perspective and footage captured from a video camera mounted on the head of one of the instructors in order to capture the teacher’s view. After the excursions, the authors sifted through all collected data and interviewed the teachers in a stimulated recall setting, whereby the teachers were prompted with photos, videos, or transcripts to solicit their impressions.

The theoretical framework behind this study employs dual processing, a psychological model implying that there are two different systems for reasoning, judgment, and social behavior in the brain. These have come to be understood in the context of learning as the implicit and the explicit systems. The explicit memory system is conscious and analytic, and deals with facts, episodes, and rules. It uses working memory to scope out details and systematically identify objects through feature-by-feature matching with respect to a generic example. The implicit memory system is, in turn, non-conscious, using rapid, automatic, and holistic pattern recognition to process information. It makes use of what we perceive in the environment through all senses and is built up by past experiences to the point that working memory is not employed.

The study showed that the teachers made use of two different strategies to teach the students how to identify natural objects: The first was alerting the students to rules

or specific characteristics, and the second was drawing comparisons between an unknown and familiar object. The authors highlighted a myriad of observed examples in which one or both teachers employed the use of the implicit system in making sense of their environment and then trying to explain how they recognized that information through verbalizing key features of the environment (thus working the explicit system). The authors determined that experience is especially valuable for student understanding, and observed how the teachers tried to help the students create memorable experiences by pointing out critical details in their surroundings. The teachers worked with their environment, making use of their observational skills to teach while being open to the unpredictable nature of the excursion.

In particular, the researchers noted that teachers used two key strategies to help their students identify natural objects. The teachers either described specific rules for identifying something (for example, naming the specific characteristics of a type of grass), or they compared the new natural object to something more familiar to the students. Those comparisons might be drawn from other natural objects or from objects familiar from everyday life. For example, one of the teachers compared different types of soil to different household objects such as toothpaste or flour. These explicit techniques helped build the students' observational skills, which in turn helped them build more robust implicit memories of the experience. "Since implicit knowledge has shown to be more long-lasting than explicit knowledge," the authors explained, "this may mean that the students will feel familiarity with the object even if they have forgotten its [name]."

Altogether, it became clear that the teachers used a holistic approach to teach their students in the natural environment, working unconsciously to recognize patterns that could then be worked consciously and verbalized for the students. The researchers explained that the teachers they studied have built their skills over long experience, and that their knowledge about teaching is now implicit. As such, the teachers could not explain how they teach to their students, most of whom will be teachers themselves.

But the authors explained, "However, in being there and experiencing how the teachers acted, the students learnt teaching strategies by example."

THE BOTTOM LINE: Experienced teachers learn effective teaching techniques over time, and then use those skills without even knowing it. The authors of this paper studied the teaching techniques of two experienced outdoor educators and concluded that they use a variety of techniques to help their students learn about natural environments. In particular, the teachers were especially skilled at helping the students make comparisons to more familiar objects when encountering something new, and building new sensory experiences for their students that will build their long-term knowledge. The experienced teachers also were deft at changing course as they taught when opportunities arose in the natural environment and in response to their students' interest and energy level.

Stolpe, K., & Björklund, L. (2012). Seeing the wood for the trees: Applying the dual-memory system model to investigate expert teachers' observational skills in natural ecological learning environments. *International Journal of Science Education*, 34(1), 101-125.

POSITIVE EMOTIONS LINKED WITH SCIENTIFIC LITERACY

Previous research has shown that while scientific knowledge tends to have an ephemeral quality, emotional factors such as feelings of interest, enjoyment, and curiosity about science tend to be enduring. In this paper, the researchers examined whether these positive emotions are correlated with greater levels of scientific literacy in 15-year-old students. In addition, they examined a potential link between these emotional factors and subsequent public engagement with science as adults.

This study was conducted using two distinct groups of participants. One group included 8,815 students aged 15 years from a variety of schools in international cities, towns, and villages. This data was taken from the Programme for International Student Assessment (PISA)

2006, conducted by the Organisation for Economic Co-Operation and Development (OECD). The 4,621 males and 4,194 females were given paper-and-pencil surveys, each with 108 total questions. Several questions addressed attitude and emotion by asking the students to rate their interest levels and enjoyment in learning science on a four-point scale. The test also included science-related stories that were meant to assess their scientific literacy and their future interest in learning about science. For example, after reading a story about acid rain, the students were asked to identify scientific issues, explain scientific concepts, and use scientific evidence to draw conclusions based on content presented in the story, all to measure scientific literacy. In addition, students were asked how much interest they had in learning about technologies that minimize the emission of gases that cause acid rain, as a measure of future interest in science.

The other group of participants was made up of 2,024 adults in Taiwan, using data drawn from a separate 2009 study. These participants were surveyed regarding their interest in learning about science topics, engagement in viewing science-related television content, and engagement in reading articles in magazines such as National Geographic and Scientific American.

First, the researchers examined whether the performance of the 15-year-old students on the scientific literacy test correlated with their current levels of interest in science. The authors found that higher levels of interest, enjoyment, and engagement correlated with higher scientific literacy scores. Second, they examined whether these emotional factors also affected their reported level of interest in learning about science in the future. Again, the results showed that there was a high correlation between their current interest, enjoyment, and engagement and their interest in future learning of science.

Next, the authors compared the interest levels in science of the 15-year-old students with the adult group. They found that the percentage of 15-year-olds with medium-to-high interest in chemistry was very close to the percentage of adults with an interest in scientific discoveries (48.1

percent versus 49.8 percent). Similarly, 68.4 percent of students rated a medium or high interest in human biology, which corresponded closely to the 69.4 percent of adults with an interest in medical discoveries.

Finally, the authors looked at differences between the students and adults in ways that they engage with science through TV science programs and science articles from newspapers. They found that fewer students reported watching TV science programs compared to adults; only 18.6 percent of students reported watching science on TV “regularly or very often” compared to 60.7 percent of the adults surveyed. The differences between the two groups with regard to reading science articles were less noteworthy.

Students’ emotional associations with science may be used as indicators of their academic performance in science, as well as their future interest and participation in the fields of science. The authors argued that these emotional perceptions of scientific topics should not be ignored when designing curriculum. Additionally, the authors suggested that future research studies focus on science activities outside of the school context—whether visiting science museums or participating in community projects that connect science to real life—to determine their impact on students’ interest, engagement, and enjoyment.

THE BOTTOM LINE: Promoting positive emotional associations with science—such as enjoyment, engagement, and interest—may be an effective tool for increasing students’ academic performance in science, as well as a means of promoting continued interest in science throughout life.

Lin, H.-S., Hong, Z.-R., & Huang, T.-C. (2012). The role of emotional factors in building public scientific literacy and engagement with science. *International Journal of Science Education*, 34(1), 25-42.

CULTURE AFFECTS CHILDREN'S VIEWS OF ENVIRONMENT

How much of a role does culture play in children's everyday ideas about science? The author of this paper explored this question through an analysis of what children in three countries see as "the environment." Although it is largely recognized that the foundations of science learning are put into place by children's everyday ideas, little previous research has sought to legitimize these ideas or consider differences in cultural perspectives. The author analyzed the everyday ideas that emerged from children regarding their relationship with the environment across the United States, China, and Singapore. The study revealed that culture plays a significant role in shaping children's everyday ideas about the environment.

While the students came from three different countries, all shared Chinese as a common language spoken either at home, at school, or both. Because all students shared a common language, the author argued that differences in the three test groups could be attributed to cultural rather than language construction differences.

The research team was comprised of two individuals plus the author; as a group, they have knowledge of the different countries. One of the researchers is a native Chinese speaker from Taiwan, a second researcher is a native of Denver with no prior experience with Chinese culture, and the author is a native of Singapore.

Students completed a "draw-and-explain" task in which they drew a picture of the environment and then defined it in their own words. In analyzing the data that emerged, the researchers created categories including *built environment*, *nature*, *stewardship*, *harmony*, *pollution/no pollution*, *utilitarian*, and *poetic*. Although some of these categories overlapped with prior research, the categories of built environment, harmony, and poetic are not well documented and became the focus of a case study analyses.

Differences in culture underlie perceptions of children's views concerning the environment. In the category of built

environment, children from all three countries displayed a relationship between natural and manmade structures, but differences emerged in the types of dwellings they drew. Children in Singapore represented the places where people live expanding upward, while children in the United States drew buildings expanding outward, which the authors attributed to differences in culture and land resources in the different countries.

A representation of the environment using written poetry was seen only in the group from China. The author theorized that the inclusion of poetry in Chinese language classes may affect children's everyday ideas about the environment. Likewise, the concept of harmony was only reflected in children's drawings and descriptions from China and Singapore. The author stated that harmony is a concept that is "deeply embedded in Chinese culture," as well as emphasized explicitly in Singaporean schools.

This study demonstrated that culture and everyday ideas about the environment and science are intricately connected. This suggests that it is important for teachers to serve as "social developers" rather than merely knowledge providers. Practically, this means guiding children in forming connections between their experiences and science content. In terms of cross-cultural implications, the author stressed that cultural differences greatly affect children's everyday ideas in science. Therefore, techniques that are successful in one country may not directly correlate to another. Educators should be aware of cultural differences when applying successful techniques from other countries. Furthermore, the author argued that test score comparisons between countries do not lend any valuable information with regard to these inherent cultural differences affecting basic perceptions. The author called for further research into the nature of children's everyday ideas from even more countries, as well as an analysis that includes the effects of demographic data.

THE BOTTOM LINE: Children's everyday ideas are greatly influenced by the culture that they experience and in which they are acting and interacting. As environmental education is a collaborative and holistic endeavor—and

as learning itself is a sociocultural enterprise—educators need to be aware of cultural impacts on children’s views of nature or the environment. Those who design curricula must be cognizant of culture, perceptions, and the prior knowledge of the children who are the intended learners.

Wee, B. (2012). A cross-cultural exploration of children’s everyday ideas: Implications for science teaching and learning. *International Journal of Science Education*, 34(4), 609-627.

INTERDISCIPLINARY TEACHING POSES CHALLENGES

Historically, educators have considered an interdisciplinary approach necessary when teaching about sustainability, but very little research has been done about how teachers and learners respond to the interdisciplinary aspect of sustainability education. This study looked at two interdisciplinary teaching programs and asked how successful they were at implementing an interdisciplinary approach.

Interdisciplinarity is considered valuable in sustainability education because the topic of sustainability is so complex and multifaceted that it requires an integrated approach to understand the many different perspectives that surround related issues. The researchers distinguished between *interdisciplinary* and *multidisciplinary* approaches, suggesting that interdisciplinary programs are distinguished by “their deliberate choice to study issues from a variety of perspectives and to integrate insights from a range of academic disciplines.” A multidisciplinary approach, by contrast, describes a learning environment in which more than one subject is taught at the same time or in sequence, but that fails to make connections between the disciplines.

The two case studies examined in this article are two master’s courses in sustainability education, one in England and one in China. The researcher conducted semi-structured interviews with 16 students and eight staff of the English program and 14 students and six

staff of the Chinese program to “find out [about] their experiences of and perspectives on their courses.” The researcher also conducted document analysis to develop an understanding of the course content.

The English case study examined a course that emphasized and made explicit its interdisciplinary goals. The most explicitly interdisciplinary unit in the course was a unit entitled “Science and Culture in Education for Sustainability.” The unit’s goal was “to help develop awareness and understanding of how scientific and cultural thinking are inextricably linked, interrelated and complementary rather than conflicting.” The researcher found that students had differing reactions to the interdisciplinary nature of the topic, with some welcoming the differing perspectives and finding them enlightening, while others found them confusing and frustrating. The professors interviewed by the researcher observed that the scientifically oriented students responded more positively to the interdisciplinary inclusion of cultural and social sciences than the humanities students did to the inclusion of science in the curriculum. One teacher attributed this to the fact that science students seemed to passionately care about and want to solve the problems that they have seen in the environment.

The Chinese program faced different barriers to implementing an interdisciplinary approach. One barrier related to achieving cooperation between teachers of different disciplines and addressing political power dynamics among teachers within the university. The researcher observed that the large number of teachers involved in teaching the course tended toward a more multidisciplinary approach (adding up several areas of knowledge without linking them together) than an interdisciplinary approach. Some teachers were able to make their own lessons interdisciplinary, including a chemistry professor who provided “very clear examples of the way in which science could be integrated into practical educational projects that had a strong social purpose.” In this case study, the hierarchies and power dynamics between the different disciplines discouraged one professor from expanding the number of teachers collaborating in her program.

The researcher's examination of these two case studies suggests that, despite the recognition of the importance of interdisciplinarity in sustainability education, the current structure and culture of higher education organizations do not make it easy to implement interdisciplinary curricula. In addition, to achieve interdisciplinarity, teachers need to be able to make their own curricula interdisciplinary and not solely rely on the involvement of teachers from many different backgrounds. It is also important to note that students who are accustomed to more traditional teaching styles tied to just one discipline may find interdisciplinary learning difficult. Interdisciplinarity is important in sustainability education, but it must be implemented with planning and care to ensure *interdisciplinarity* rather than *multidisciplinarity*.

THE BOTTOM LINE: Environmental educators often tout the interdisciplinary nature of the environmental field. This research demonstrates that, while interdisciplinary thinking may be important, both practical and cultural barriers can prevent true interdisciplinary cooperation. These findings serve as a reminder that presenting information to students with an interdisciplinary approach is not as simple as inviting experts from a variety of fields to offer their perspective. Cutting across disciplinary lines requires an openness and willingness among both teachers and students that may need to be cultivated.

Feng, L. (2012). Teacher and student responses to interdisciplinary aspects of sustainability education: What do we really know? *Environmental Education Research*, 18(1), 31-43.

INTERPRETIVE PROGRAM ACHIEVES SOME GOALS BETTER THAN OTHERS

At one time, interpretive programs served to help connect people to a resource, whether to introduce them to a park's flora, describe a historical event, or introduce visitors to an ancient culture. Today, that is still a key goal of most interpretive programs. But other goals exist, too. According to the Four Conceptions of Interpretation model, modern interpretation exists to fulfill four key goals:

1. Connecting visitors to resources
2. Conveying agency mission and influencing behavior
3. Encouraging environmental literacy
4. Promoting tourism

According to this model, interpreters are often called upon to help visitors understand and explore a resource (goal one), understand the need for the resource and how to act in order to protect it (goal two), learn information and develop skills to act responsibly in other situations (goal three), and promote the resource as a means of generating economic benefits to support the resource and surrounding communities (goal four).

The author of this study investigated whether an interpretive program at Arkansas' Lake Fort Smith State Park fulfilled all of these goals successfully. The park had been closed for six years as managers merged the park's two lakes into one to improve water management. The author used the park's reopening as an opportunity to analyze the park's interpretive goals and to find out how well they were being met.

The research involved analyzing the content of the park's mission, official speeches, interviews with park staff, and a two-hour interpretive boat tour on the new lake. The researcher attended and transcribed the content of the boat tour, which was the centerpiece of the interpretive offerings at the park. Visitors from seven boat tours were asked for their contact information in order to conduct interviews one week after they attended the tour. In all, 52 visitors agreed to a post-visit phone interview.

The analysis revealed that, indeed, the park set out to meet all four goals laid out in the Four Conceptions model. The park mission, speeches, staff interviews, and interpretive program all indicated that the park hoped to achieve all four goals. Visitors, however, appeared to walk away mostly with messages related to goals one and two. Visitors showed strong evidence, through their recall and descriptions of the program, that they connected with the resource and understood the behavioral requirements of using the resource responsibly (namely, the need for the

“no swimming” rule in order to protect water quality). The program did not show strong evidence of helping people understand water conservation themes beyond the park, or to support tourism activities around the park.

THE BOTTOM LINE: Resource managers often rely on interpretive programs to achieve a variety of goals beyond the traditional ideas of connecting people to a resource. In particular, interpreters are often expected to encourage visitors to change their behavior in order to protect the resource and to extend what they’ve learned beyond the visit to new situations. But achieving those goals, particularly goals related to changing people’s behavior, and after they leave an interpretive program, can be challenging. This paper described a seemingly effective program that met only two of four interpretive goals. It serves as an important reminder that if a program truly does aim to fulfill multiple goals, progress toward those goals must be continuously monitored. If the program isn’t meeting the expectations, it should be reworked, or the goals should be reevaluated.

Benton, G. M. (2011). Multiple goal conveyance in a state park interpretive boat cruise. *Journal of Interpretation Research*, 16(2), 7-21.

VIDEO PRESENTATION BOOSTS STAYING TIME AND KNOWLEDGE IN AN EXHIBIT

As zoos have expanded their missions to include educational goals, they have also had to stretch their resources to provide the staff needed to deliver their conservation messages. And research suggests that the investment pays off, as live presentations have proven to be effective educational tools. But, as the authors of this paper acknowledged, “This requires zoo staff or volunteer docents to be present to give interpretive presentations, which can be costly and may not always be feasible.”

The authors of this study investigated whether a video presentation also can serve as a useful educational tool when a live presenter is not available. To find out, the researchers

analyzed visitors to Zoo Atlanta’s Orangutan Learning Tree exhibit. The exhibit showcases some of the zoo’s orangutan research, and the interpretive information—delivered in live presentations, video presentations, and signage—includes conservation information and specific behaviors that visitors can adopt to help conserve orangutan habitat.

The researchers measured visitors’ stay time in the exhibit and also administered a short survey to visitors to gauge their knowledge of key concepts delivered in the exhibit. The researchers noted whether a visitor experienced the exhibit with a live presentation, video presentation, or only signage. Visitors who stayed in the exhibit at least 90 seconds (the length of the presentation) were asked to complete the five-question survey. The survey consisted of three multiple choice questions and two free recall questions. In total, the researchers recorded the stay time of 582 visitors and administered the survey to 180 adult visitors.

The researchers found that visitors stayed in the exhibit longer during the live and video presentations than when there was no presentation. There was no difference in the amount of time visitors stayed if they experienced the live or video presentation.

In terms of what visitors learned, overall knowledge scores indicated that the live presentation generated the best results, followed by the video presentation. The no-presentation condition, in which the information was provided through signage only, yielded the lowest overall knowledge scores.

Interestingly, the knowledge results varied based on the type of question. Visitors who experienced the live and video presentations were equally skilled at answering the multiple choice questions, in which the visitor selected one correct answer among several choices. The researchers noted that this type of question tests “recognition memory.” In contrast, visitors who experienced the live presentation were better at answering the open-ended questions, which require “recall memory.” The researchers surmised that “videos may be effective for conveying fairly simple information or information that people might

come across and be able to recognize in the future.” On the other hand, the live presentations better support recall memory that “would be relevant if a visitor wanted to remember something that they weren’t likely to come across after leaving the zoo.”

Although the authors suggested that future research should focus on ways to improve video presentations so that they better support recall memory, nevertheless, “in the absence of a live presentation, a video recording of a person giving a presentation is an effective education technique.” The researchers also acknowledged that, while this research tested visitors’ knowledge of the exhibit’s key themes and suggested conservation behaviors, they did not measure whether visitors actually followed through with those behaviors, which is the zoo’s ultimate goal.

THE BOTTOM LINE: Real people make a real difference when it comes to delivering educational content. In this study, live presentations generated the best results in terms of visitors’ knowledge after viewing an exhibit. But when a real person isn’t available, video presentations can serve as an acceptable substitute. Visitors to the same exhibit who viewed a video presentation knew more about the exhibit content than visitors who were exposed to the same information through signage. This study did not investigate whether different approaches to video presentations could make them more effective, but based on the results of this research, it seems that it would be a fruitful area of research.

Perdue, B. M., Stoinski, T. S., & Maple, T. L. (2012). Using technology to educate zoo visitors about conservation. *Visitor Studies*, 15(1), 16-27.

STUDENTS WITH DIFFERENT BACKGROUNDS REASON DIFFERENTLY

The exploration of socio-scientific issues (SSIs) is becoming an important part of science education. With the discussion of SSIs, students merge moral and scientific reasoning, using scientific information to support their

moral judgments on controversial topics. The approach is often promoted for its ability to help students learn science concepts, connect science concepts to everyday life, think critically, develop citizenship skills, and build their scientific literacy.

Science education researchers have been investigating the ways that students engage in discussions around SSIs, but most of the research to date has focused on students in high school or college and has not dealt much with the ways that different students approach the same issue. The authors of this study explain, “A problem that is still unexplored in our field is how different students (e.g. from different cultural backgrounds, with different experiences, different levels of familiarity with the subject, different levels of achievement in the class) decide about the same SSI, how they justify their decisions, and how they use (or not) the evidence provided.”

To begin to address this gap, the researchers administered the same SSI learning activity in two different classrooms to compare how students made judgments and used evidence. The SSI program consisted of four 50-minute lessons related to a controversy surrounding red and grey squirrels in the United Kingdom. The program explained that grey squirrels were introduced to the U.K. in the 19th century. The grey squirrels have adapted well to their new home and flourished, while the native red squirrel is on the decline due to habitat loss and susceptibility to disease.

The students were asked to offer their opinion of the government’s position, which was that the grey squirrels should be trapped and killed in areas where red squirrels live. The students were asked to give their opinion, along with justification, at the beginning of the program and then again after the program.

The program was administered in two different classes in different parts of the U.K. Class A included 28 students, 12 to 13 years old, in a private school in the south of England. Test scores revealed that these students were high achievers. In addition, the students were white Anglo-Saxon and lived in an area of high socioeconomic status.

In contrast, Class B included 29 students of the same age in a public school in London. The students were average achievers, as measured by their test scores, and included a majority of students from an Indian background, with three quarters speaking English as a second language. Teachers in the two classes also differed in the way they administered the curriculum. Class A's teacher placed more emphasis on facilitating class discussion and helping the students structure arguments. On the other hand, Class B's teacher focused more on presenting the evidence, and spent almost no time modeling argumentation. In addition, the students in Class A spent far more time working in groups to write their arguments than the students in Class B.

The researchers found that “Class A and Class B, two different classes in terms of students’ characteristics, have very different patterns of decisions even though they are using the same learning environment.” In the end, students in Class A were more likely to support killing grey squirrels because, the students stated, they are a pest or because they are causing red squirrels to decline. Students in Class B, however, were more likely to protect both types of squirrels because, according to them, it’s inhumane to kill an animal. In both classes, students used evidence that supported their position and ignored evidence to the contrary.

The authors theorized that “the differences between the students in the two classes (either cultural differences, different experiences, or differences in achievement) were responsible for the differences in the decisions and justifications.” Unfortunately, because of the wide variety of variables in this study, the use of different teachers to administer the program, and the very small sample size, it is impossible to draw any conclusions about which factors in particular account for the differences.

THE BOTTOM LINE: In this small exploratory study, researchers asked teachers in two very different classrooms to administer the same online curriculum about a socio-scientific issue. Although they received the same information, students in the two classes arrived at

different conclusions with different justifications. But because of the nature of this research, it’s not clear if the differences were caused by the way the teachers led the classes, the students’ achievement levels, language differences, cultural differences, socioeconomic factors, or possibly other factors. Teasing out the effects of these different variables would require more controlled studies with larger samples. In the meantime, this study serves as a reminder that when it comes to controversial issues, students with different backgrounds can come to different conclusions based on the same information. Educators have to respect individual differences and work to help students focus on relevant information in order to develop informed opinions and form cogent arguments.

Evagorou, M., Jimenez-Aleixandre, M. P., & Osborne, J. (2012). ‘Should we kill the grey squirrels?’ A study exploring students’ justifications and decision-making. *International Journal of Science Education*, 34(3), 401-428.

TECHNOLOGY-SUPPORTED PROGRAM ENCOUNTERS UNEXPECTED HURDLES

It has become well accepted in the science education community (and the EE community, too) that inquiry-based approaches are good educational practice. But the approach is not without its challenges. Finding effective ways to train teachers, making connections to educational standards, providing sufficient guidance to students, and many other topics related to inquiry learning are routinely explored by education researchers.

The authors of this paper, who presented an inquiry-based learning program to ninth grade students in the United Kingdom, uncovered some additional challenges that they hadn’t expected. The researchers supplied the class with laptop computers loaded with nQuire software, designed to guide students through a research project. Although the software can be customized to address a variety of research questions, in this case, the authors selected a topic that they thought would interest the students: personal nutrition.

In the article, the authors explained that most science instruction is highly impersonal and suggested that “students will both engage with and take a committed stance towards the scientific process by forming questions for which they genuinely want to know the answer, by carrying out investigations that relate to their own needs and concerns, and by discussing emerging findings with peers and experts.” Because of various constraints, the researchers were not able to let the students select their own question to investigate, but they selected a topic that they thought would relate directly to the students’ everyday lives in a personal way. The software guided the students through an investigation designed to answer the following research questions: “What nutrients do I eat?” and “Do I eat enough nutrients to be healthy?”

To answer the questions, the students were asked to photograph each of their meals, and then the software helped them analyze the content of their meals and their nutritional value. The researchers provided the students with digital cameras and laptops to take home with them every day so they could collect their data. The students photographed their meals, analyzed their nutritional content, and shared their results in groups.

The students who participated in the study attend an inner-city school where more than half of the students have special educational needs. The researchers also selected another ninth grade class at the school to serve as a control group. Ideally, this class would also have received instruction on proper nutrition, without the inquiry approach, so they could compare the effect of the software. Unfortunately, this was not possible, and the other class received its normal instruction, unrelated to nutrition.

Nevertheless, the researchers administered pre- and post-tests of nutrition content knowledge and attitudes toward science to both groups. Because the researchers could only use the scores of students who completed the both the pre-test and the post-test for their analysis, student absences made their sample size considerably smaller than the full class size. Only 14 of 28 students in the inquiry class took

both tests, while 13 of 29 students in the control class took both tests. Not surprisingly, the control class, which received no instruction related to nutrition, showed no improvement in their content knowledge related to nutrition. But the class who participated in the program showed a 20 percent increase in their average score.

The students in the inquiry group did not show any change in their attitudes toward science, nor did the control group, except in the “Enjoyment of Science Lessons” subscale, where they showed a decrease. So, while the students in the inquiry group did not show an increase in their enjoyment of science lessons, they also did not experience a decline in interest as the control group did.

Interviews with the students and teacher revealed an unforeseen challenge with the topic and data collection method: The students were embarrassed to photograph and discuss their meals. The authors conceded, “In retrospect, this might have been obvious.” The authors explained that “neither the researchers nor the teacher identified this as a problem in advance of the study and we are not aware of the consequences of ‘too personal’ investigations being identified in the literature on inquiry learning.”

Another challenge that surprised the researchers surrounded the use of technology. Although the students were initially enthusiastic about the use of the laptop and camera, many eventually came to regard them as burdens. They had to be carried back and forth daily, many received constant reminders from parents not to break them, and many students’ families were eager to use them for their own purposes, complicating the students’ work.

The research conducted here underscores the challenges of both leading effective inquiry-based projects and working in challenging educational settings such as this school. Upon reflecting on the failure of the program to generate an improvement in attitudes toward science, the authors conclude that “this acts as a timely reminder that students’ attitudes to science can be resistant to change and that research teams should not be over-optimistic in their predictions for the likely impact of short-term interventions.”

THE BOTTOM LINE: Leading inquiry-based science projects is not easy. And while using technology such as digital cameras and laptops may create initial excitement, technology also can burden students. This research also serves as a reminder that while science can often be impersonal, some projects can also be too personal. Involving students in developing research questions can help identify topics that will generate interest and excitement. And teachers should also stay vigilant to potential problems as projects proceed, making adjustments as needed to keep students engaged.

Anastopoulou, S., Sharples, M., Ainsworth, S., Crook, C., O'Malley, C., & Wright, M. (2012). Creating personal meaning through technology-supported science inquiry learning across formal and informal settings. *International Journal of Science Education*, 34(2), 251-273.

INSTRUCTION IN THE NATURE OF SCIENCE AFFECTS STUDENTS' DECISION MAKING

Although educators agree that exploring and forming opinions about socio-scientific issues can be an effective way for students to build scientific literacy, some approaches are more beneficial than others. As the author of this paper explains, “[Decision making] is a learned process.” Offering scientifically sound arguments supported by relevant evidence to defend a position does not come naturally to many students.

In this study, the author explores whether explicitly instructing students in the nature of science (NOS) affects their decision making around a socio-scientific issue. The researcher used an experimental design, comparing the performance of two science classes that received instruction in NOS with two similar science classes at the same school that received no instruction in NOS. All the classes received a four-week unit on genetic engineering taught by the same teacher. The unit included a variety of activities related to genetic engineering and culminated with a debate about genetically modified food.

All the students received instruction in effective argumentation, but only the treatment groups also received instruction in NOS. Five key aspects of NOS were emphasized, namely that scientific knowledge is (1) tentative, (2) empirical, (3) inferential, (4) creative and imaginative, and (5) subjective. These themes were introduced explicitly with two activities and then incorporated throughout the unit through discussion, guided questions, and written reflections designed to help the students relate the NOS aspects to the lesson.

The researcher administered pre- and post-tests of student knowledge about the five NOS aspects, presented the students with a socio-scientific scenario and asked students to provide a written response indicating their decision on the issue and their reasoning, and interviewed a subset of the students. In analyzing the results, the researchers were blind to whether they were analyzing responses from the treatment or control group.

The results indicated that explicitly teaching students about NOS improves their understanding of NOS: Scores on the NOS test for the treatment group improved after they received NOS instruction, while scores in the control group didn't show any significant improvement.

An analysis of the students' decisions about the socio-scientific issue related to genetically modified foods revealed that while the students' NOS understanding didn't affect their decision to support or oppose the practice in question, it did affect their reasoning. Students in the treatment and control groups were not different in their decisions on the issue, but their decision factors were different. About 37 percent of the students in the treatment group included references to NOS aspects in their explanations of their decisions, especially related to the empirical, tentative, and subjective aspects.

While the author considered these “modest promising results,” the results are not unambiguous. For example, the author noted that although 44 percent of the students in the treatment group improved their understanding of

the subjective aspect of NOS, only about half of those students applied that understanding in their decision about the socio-scientific issue. The author concluded that “these participants might need more time and opportunities to help them assimilate and internalize the application of their acquired NOS understandings in their [decision making].” The author also noted that only three of the five NOS aspects emphasized in the program were represented in the students’ decision making.

THE BOTTOM LINE: Socio-scientific issues hold promise for engaging students and helping them apply scientific knowledge in real-world situations. But students need help in developing informed opinions based in science, and in defending their positions with well formed, science-based arguments. This study demonstrated that when students receive explicit instruction in the nature of science, those themes emerge in their decision making. Students who have a better understanding of how science works may come to the same conclusion on controversial issues as other students without the same understanding, but their opinions are more informed by science. Teachers should work to make instruction on the nature of science more explicit, clearly linking the abstract ideas of how science works to real-world situations.

Khishfe, R. (2012). Nature of science and decision-making. *International Journal of Science Education*, 34(1), 67-100.

SENSE OF PLACE

SENSE OF PLACE RESEARCH CAN INFORM ENVIRONMENTAL EDUCATION

What is “sense of place,” and how does it relate to environmental education? The authors of this study reviewed the literature to explain common terminology in the place literature and draw connections between that robust literature and the field of environmental education. Because the place literature is broad, the authors focused on research from the areas of social and environmental psychology.

Researchers studying sense of place use specific terminology to describe several important concepts. For example, they highlight two important sense of place subcategories—place attachment and place meaning. *Place attachment* typically refers to the bond people feel to a place, which can be positive, negative, or ambivalent. *Place meaning* refers to more symbolic affiliations with a place that may be influenced by social, economic, or aesthetic considerations. The authors summarized their discussion of place attachment and meaning by describing how these concepts come together to influence a sense of place: “Place attachment reflects how strongly people are attracted towards places, while place meaning describes the reasons for this attraction.” Because of the variety of emotional experiences and intellectual interpretations people may have as they interact with any given place, the sense of place different people experience can vary widely.

So how does this relate to environmental education? By examining and applying relevant research from the place attachment and place meaning literature, the authors hope to expand the framework of sense of place to environmental education. For example, several studies cited by the authors suggest that there is a positive correlation between strong sense of place and pro-environmental behaviors. Furthermore, the authors cited studies that suggest “a cause-and-effect relationship between place attachment and pro-environmental behavior.” In these studies, place attachment could predict positive environmental behavior. Similarly, studies of place meaning showed positive relationships to behavior: “These studies suggest that what we call ‘ecological place meaning’—one of the dimensions of place meanings reflecting natural elements or ecological features of places—may be related to behaviors that protect these elements.” The authors posited that the strongest influence on pro-environmental behavior via a place-related connection may be through a combination of place attachment and ecological place meaning.



If place attachment and ecological place meaning contribute to pro-environmental behavior, then how can we nurture these particular aspects of place connections to encourage environmental behavior? The authors identified two possible methods. First, the literature shows evidence that experience in a particular place that is long, frequent, and positive can predict both increased place attachment and place meaning. Second, it may be possible to develop place meaning through indirect means, with people forming connections to places they have never visited. For example, some people may express some level of attachment to the Grand Canyon, even if they have never visited it. Their feelings might be based on what they have learned about the canyon indirectly through photographs, stories, films, paintings, or other means. That is, both direct experience and interpretive learning can enhance place meaning which, in turn, may lead to positive environmental behaviors.

Having identified some methods for nurturing and enhancing a sense of place, how can we use these strategies to inform environmental education? The authors examined two specific approaches frequently used in environmental education—experiential and instructional. In the experiential approach, students are taken to places where they can physically explore the outdoors. With the instructional approach, students are familiarized with places through methods such as explanation, storytelling, and conversation. The authors suggested that a combination of experiential and instructional approaches is “an effective strategy to nurture place meaning and strengthen place attachment.”

These environmental education techniques are very similar to experiential and interpretive strategies that have been cited by environmental psychologists in the sense of place literature. Because sense of place has been extensively studied by environmental psychologists, the authors suggested that “it is possible to apply the sense of place literature—including terminology and relationships among various constructs—to environmental education practice and research,” and that doing so “may enrich an already vibrant place-informed scholarship in environmental education.” The two fields have similar missions and similar approaches, so the authors encourage environmental educators to take

advantage of the vast research available in environmental psychology to enhance their instruction around sense of place and pro-environmental behaviors.

THE BOTTOM LINE: Research suggests that, among other important benefits, people with a strong sense of place may be more likely to engage in environmental behaviors, which often is an ultimate goal of environmental education programs. The authors of this paper believe that a combination of experiential and instructional approaches in education programs may be the most effective way for environmental educators to boost sense of place. Experiential approaches involve educational experiences in the field, while instructional approaches are more intellectual exercises, such as writing or discussion that takes place in other locations. The authors hope that further research will connect research from environmental psychology, anthropology, cultural geography, and other disciplines to link sense of place theories to environmental education practice.

Kudryavtsev, A., Stedman, R. C., & Krasny, M. E. (2012). Sense of place in environmental education. *Environmental Education Research*, 18(2), 229-250.

TIME IN NATURAL PLACES LINKED WITH PLACE IDENTITY AND ENVIRONMENTALLY RESPONSIBLE BEHAVIOR

What types of students are likely to visit natural environments on campus, and how might these visits affect their behavior? The author of this paper approached these questions, among others, by surveying students at Guilford College in Greensboro, North Carolina.

A range of research supports the connection between time spent in nature and an increased concern for environmental issues, especially when the type of activity is appreciative (that is, activities such as hiking or camping, where appreciating nature is a key part of the activity) as opposed to consumptive (such as hunting or

fishing) or mechanized (such as snowmobiling or ATV riding). Although the link between time spent in nature and concern for the environment is fairly well established, the specific chain of mechanisms linking time in nature to environmental concern is more difficult to isolate. One proposed mechanism is that increased time spent engaging in appreciative nature activities leads to the formation of place identity. In turn, this stronger connection to a place may lead to increased care for and protection of that place.

This study investigated this idea by analyzing student use of natural areas on a college campus. Through online surveys with 115 undergraduate students, the author examined students' interactions with the natural areas on campus and the associated outcomes in terms of students' identification with natural areas and reported environmental behaviors (the author relied on the students' reports of their behaviors, not measures of their actual behaviors).

The author first examined who visits these natural areas on campus and for what purposes. The results suggest that most respondents primarily visited for recreational purposes, and most indicated they visited in order to enjoy nature. Students who were younger visited more frequently than older students, and students who lived on campus visited more often than commuters. Students who majored in humanities, environmental studies, or art reported higher visitation frequencies than those who majored in business, natural science, or social science.

The author found correlations between self-reported environmentally responsible behavior and the students' frequency of visits, whether they were visiting as part of a course, and their place identity. In other words, students who visited more frequently, visited natural areas as part of a course requirement, or expressed stronger place identity were more likely to report environmentally responsible behavior. Interestingly, time spent in outdoor leisure activities was not significantly related to environmentally responsible behavior. Place identity was associated with both frequency of visits and visiting as part of a course. Further analyses showed that majoring in humanities,

environmental studies, or art was significantly correlated with both place identity and environmentally responsible behaviors. In addition, students who frequently visited the natural places on campus demonstrated significantly greater place identity and more frequent environmentally responsible behaviors. Finally, students who visited natural areas as part of a course had significantly stronger place identity than students who visited only recreationally.

The results of this research demonstrate that the more frequently students visit natural areas on campus, the stronger their identification with these areas will be and the more environmentally responsible behaviors they will report. The author believes that "these results support previous literature touting the importance of outdoor experiences on place identification." But the author also cautions that "at the same time, it is important to note that these results do not provide evidence for a causal link between outdoor experiences and environmental outcomes."

THE BOTTOM LINE: This study supports previous research demonstrating the positive correlations between time spent in natural areas as part of a course and both increased place identity (an emotional connection to a place) and environmentally responsible behaviors. Although this research does not suggest that all time spent outdoors affects place identity, it does suggest that spending time outdoors as part of a course is associated with increased place identity, which in turn is associated with environmentally responsible behavior. More research with a larger sample could help clarify these results, but, for now, they suggest that structured outdoor experiences like those offered in environmental education can help build place identity, which often is associated with positive environmental behaviors.

Lawrence, E. K. (2012). Visitation to natural areas on campus and its relation to place identity and environmentally responsible behaviors. *The Journal of Environmental Education*, 43(2), 93-106.

SENSE OF PLACE USED AS STRATEGY FOR EARLY CHILDHOOD TEACHING

In Western culture, childhood is often understood as a time of innocence, when children should be sheltered from harsh realities of the world. Topics such as climate change—which emphasize the urgency for behavior change and engagement—can be difficult for early childhood education (ECE) teachers to introduce, because they can bring “reality” into the protected space of childhood. In the first section of this paper, the author explored dominant perspectives about what ECE is and how those perspectives can be detrimental to teaching sustainability. In the second section, she reported on findings from a study where local, place-based teaching strategies were used as a means of teaching about global sustainability issues. She argued that “place” can provide a helpful starting point for teachers to expand from local to regional to global issues, including sustainability.

The author described two dominant perspectives on the role of ECE, which she dubbed *technicist* and *consumerist*. Technicist approaches see ECE as a place where young people are prepared for later years of schooling and tend to focus on measurable outcomes. For technicists, watering the garden may appear as wasted time that could be better used to learn the alphabet, for example. Consumerist approaches view ECE as a service that is provided to parents for taking care of their children. For those with this view, minimizing inconvenience for parents is important. For consumerists, a teacher who suggests that students walk to school may be met with hostility, because such an action would require more time of busy parents. The author argued that both the technicist and consumerist ideas about the role of ECE pose significant challenges for teachers. She added that rethinking concepts about childhood and ECE needs to be a critical focus for those researching and implementing environmentally focused teaching strategies.

The findings reported in this paper examined the use of place-based learning strategies as a means of teaching

about both local and global environmental issues. This research was part of a two-year qualitative study of 10 ECE centers across New Zealand, all of which were making efforts to teach from a bicultural—Maori and Western—perspective. The author decided to write about place-based teaching strategies after noticing that these were practices that the teachers were already frequently using. The author used the term *place* to describe the local physical area, as well as the cultural and political aspects of the region, specifically regarding indigenous knowledge.

One example of a place-based learning strategy the author described was going to a tree-planting event at a local tribal meeting place. This event had multiple learning outcomes, including learning specific knowledge about the local ecology, as well as learning about the indigenous culture through activities such as reading books and eating a traditional feast. The author also described how an activity such as planting trees can be used as a means of connecting local environmental issues (deforestation) with broader environmental issues such as climate change.

The author also described a project in which the teachers focused on recycling as a means of talking about consumption in a broader sense. The teachers did this by asking the children to collect their yogurt containers in the classroom, which they used to make a “yogurt curtain.” The teachers then used this tangible display of their own consumption as a way of talking about plastic as it relates to landfills, pollution of the oceans, use of fossil fuels, and production and recycling in other places, such as Bangladesh.

THE BOTTOM LINE: Place-based learning strategies can be an effective way for ECE teachers to introduce global environmental issues such as climate change. These issues can otherwise be difficult for teachers to bring up because of common conceptions of young children needing to be protected from the “harsh reality” of the world, including global environmental problems.

Duhn, I. (2012). Making ‘place’ for ecological sustainability in early childhood education. *Environmental Education Research*, 18(1), 19-29.

PROFESSIONAL DEVELOPMENT

TEACHERS' BELIEFS TIED TO STUDENT ACHIEVEMENT

Teachers are gaining more and more attention in discussions about student achievement. The authors of this study explain, "It is becoming increasingly clear that teachers are critically important to the success of education reforms since they play such a key role in directly impacting student learning." Accordingly, researchers have been working to better understand what makes an effective teacher, and research has particularly focused on professional development programs, hoping to understand what is most effective in teacher training.

That research has yielded important results that point to several key features of effective teacher training, including:

- Focusing on the content that students will learn
- Providing active learning experiences for the teachers
- Meeting the teachers' professional needs
- Offering training over the long term
- Creating opportunities for teachers to work together

According to this model of teacher training, these approaches improve not just teachers' knowledge and skills, but also their beliefs about teaching. And an improvement in teachers' knowledge, skills, and beliefs should translate into higher achievement for students. The authors of this paper investigated whether a well-designed training program for elementary science teachers affected the teachers' beliefs about teaching, and whether those beliefs in turn affected student achievement.

The training program focused on training K-6 teachers in science and involved collaboration between two Ohio universities, a large urban school district, and a smaller nearby suburban school district. Both of the school districts were struggling to improve their students' performance in science.

The training program was extensive and included many of the key features past research identified as important for successful programs. Teachers participated in a two-week summer program for a total of about 80 hours, focusing on inquiry-based instruction and science content knowledge. During the school year, trained support teachers assisted the teachers in a variety of ways, including helping the



teachers execute their teaching plans, modeling science inquiry, supplying background information on science content, helping administer assessments, and more. Training programs during the academic year added about 24 hours of additional professional development. And the program went further still, also involving school principals in training programs and reaching out to the community through family science days, parent-teacher organization meetings, and other methods.

To gauge the impact of the program, the authors measured teachers' beliefs before and after their participation in the one-year program. In particular, the researchers measured the teachers' self-efficacy beliefs (whether teachers felt that they are effective teachers), outcome expectancy (whether teachers felt that if they teach well, their students will learn science), and context beliefs (whether teachers felt that their professional environment was supportive). They then compared the teachers' beliefs with their students' performance on the state achievement test for science (the Ohio Proficiency Test).

The researchers found that, after participating in more than 100 hours of the research-based professional development program, science teachers had more positive beliefs about their own teaching effectiveness (self-efficacy). The research did not uncover an increase in outcome expectancy among the teachers (the teachers were no more likely to believe that their teaching was responsible for student performance). Interestingly, the researchers detected a small, but significant, drop in context beliefs (in essence, the teachers were less likely to feel professionally supported). They suggested that one possible explanation for this drop in context beliefs was the increase in expectations for the teachers' performance that this program brought. Before the program, most of the teachers were not required to teach science, but the program required many hours of new science instruction. The authors conjectured that "such added stress may only serve to decrease beliefs in the context."

And perhaps most importantly, the researchers found that teachers' beliefs about their effectiveness and the number of hours they spent in professional development

predicted student achievement, though the effect was small. "Obviously, other factors are involved and should be investigated," the authors concluded. They continued, "These [other] factors may include actual classroom practices, curriculum materials, support systems, and student background variables." Although other factors may play a larger role in student achievement, nevertheless, this research demonstrates that teachers' beliefs about their effectiveness and their participation in a high-quality, research-based training program nevertheless play a role in student success.

THE BOTTOM LINE: This study demonstrates that students of confident teachers who believe in their own effectiveness perform better in science. In this study, teachers' self-efficacy beliefs increased after they participated in a long-term professional development program that included more than 100 hours of training, teacher support during the school year, and training for principals and community members. These findings emphasize the importance of designing teacher training programs that improve teacher knowledge, skills, and confidence by following proven principles of program development. Future research could help clarify just how much time in training is needed to achieve similar positive results.

Lumpe, A., Czerniak, C., Haney, J., & Beltyukova, S. (2012). Beliefs about teaching science: The relationship between elementary teachers' participation in professional development and student achievement. *International Journal of Science Education*, 34(2), 153-166.

INTENSIVE TRAINING IN INQUIRY-BASED TEACHING PAYS OFF FOR URBAN TEACHERS

Leading voices in education, including the National Research Council and the American Association for the Advancement of Science, have stepped up recommendations for teachers to adopt inquiry-based science teaching methods. At the same time, however, teachers also face increasing pressure to focus their

teaching on the standardized tests that will evaluate their students and themselves. Many teachers understandably fear that student inquiry might lead students away from mandated material toward subjects not covered by standards and tests.

Add to this nervousness about the unpredictability of inquiry-based teaching and the additional challenge that most elementary school teachers feel less qualified to teach science than any other subject, and it's not surprising that 30 percent of elementary school students receive no science instruction *at all* on a typical school day. In urban settings, teachers face yet another hurdle: Students often perform below their grade level in basic skills. As a result, teachers and students in urban schools often lack the knowledge and confidence to effectively use an inquiry-based approach to science.

The study described in this paper set out to address some of these considerable barriers with an intensive, multi-year teacher training program called the Rice Elementary Model Science Lab (REMSL). The REMSL program aimed to increase urban elementary teachers' ability to use constructivist teaching methods by adopting the 5E Model, in which teachers and students move through the stages of engagement, exploration, explanation, elaboration, and evaluation. Over the course of a year, teachers met once a week, working within professional learning communities to test out science content activities, receive training in the theories of constructivism, and participate in leadership training. The teachers also kept reflective journals and created digital portfolios of their development through the year. This frequent, intensive model amounted to 200 direct hours of training.

To test the effectiveness of the model, the researchers randomly assigned teachers in the participating schools to either a treatment group (which received the training) or a control group (which did not receive the training, but was guaranteed participation in the following year). Specifically, the researchers investigated whether the program (1) increased teachers' content knowledge, (2) improved their inquiry-based teaching methods, and (3)

improved their leadership skills. The evaluation research focused on the program's third and fourth years, in 2008-2009 and 2009-2010, respectively. The 2008-2009 year saw 64 teachers in the treatment group and 30 in the control group, while the 2009-2010 group included 61 in the treatment group and 38 in the control group.

Based on the results of pre- and post-tests of science content knowledge, the researchers reported that "teachers who received training showed a significant increase in their science content knowledge between pre- and post-tests on all science topics tested." In both 2008-2009 and 2009-2010, both the treatment and control groups showed increases in science content knowledge, but the treatment groups' scores were significantly higher than the control groups' scores.

Although the teachers in the treatment group scored higher on a test measuring their knowledge of constructivist teaching practice (the teachers that participated in the training demonstrated a significant gain from the pre-test to the post-test, while the teachers in the control group didn't show a significant gain), classroom observations did not reveal significant differences in the teaching practices of teachers in the control and treatment groups. Based on the classroom rating protocol the researchers used, both groups increased their rating scores from before training to after training. But there was not a significant difference between the scores of the teachers who received the training and those who did not.

Finally, the results of a survey of the teachers' participation in leadership activities revealed that the training helped the teachers develop their leadership skills. For both years studied, teachers who participated in the REMSL training presented at more professional development programs, attended and presented at more conferences, and applied for and received more science grants than teachers in the control group.

The researchers also noted that interview data confirmed that teachers have significant reservations about the feasibility of inquiry-based science teaching, but that

this kind of intensive training is valuable in developing their science teaching skills. The authors explained, “What remained important for the urban participants interviewed was to have a year-long opportunity to participate in science training every week, to have materials to take the training into the classroom and to return the following week to discuss the results of the new teaching and learning.”

The authors concluded that, overall, this approach was successful because teachers demonstrated increases in content knowledge, reported significant positive changes in their teaching styles, and took on more roles of leadership in their schools. As for the results of the classroom observations, the researchers wondered if the teachers were nervous in the presence of an observer, or if the observers were not picking up on the nuances of the teachers’ approaches. They also suggested the possibility that the observation protocol may not be appropriate for evaluating elementary school science, as it was first developed for assessing college teaching.

THE BOTTOM LINE: Teacher training can make a difference, even in tough teaching conditions like urban schools. The high-intensity approach to teacher training studied here helped teachers improve their science content knowledge and leadership skills, and improved their knowledge of inquiry-based, constructivist teaching practice. The research was not able to demonstrate that teachers who received training were better able to translate that knowledge to classroom practice than teachers who didn’t participate in the training. Future research will need to focus on whether that’s because of a teacher’s actual practice or the way the teachers are assessed. In any case, it appears that this is largely an effective approach, but it is intensive. The program included 200 hours of training, with teachers participating in weekly training, journaling, the development of a digital portfolio, and the support of a professional learning community over the course of a year.

Diaconu, D. V., Radigan, J., Suskavcevic, M., & Nichol, C. (2012). A multi-year study of the impact of the Rice Model Teacher Professional Development on elementary science teachers. *International Journal of Science Education, 34*(6), 855-877.

OTHER RESEARCH

CHILDREN'S RELATIONSHIPS WITH NATURE CHANGE OVER TIME

As humans, our relationship with nature is an important part of our lives, past, present, and future. A connection with the natural world, or lack thereof, is also an essential part of environmental education as practitioners in the field often strive to foster positive relationships with nature. Children are frequently the focus of environmental education programming, and therefore it becomes important to understand specifically how young children relate to and interact with the natural world. This study aimed to better understand children's relationships with nature in order to inform as well as improve practices within the field of environmental education.

The researchers in this study focused on two primary questions: What are children's relationships with nature, and how do these connections change as children grow from ages six to 11? To answer these questions, the researchers instructed 176 children, ages six to 11, to "draw a picture of yourself in nature doing something" and "write about your picture and your relationship with nature." The authors then analyzed the children's drawings and written narratives in three phases.

In phase I, the researchers first identified all of the items or elements that were featured in the children's drawings, from trees to insects to other people. Based on this list of elements, the researchers indicated which of the features were present in each drawing and then organized the list of features a drawing had into larger categories of "setting," "emotional tone," "style," and so on. In phase II, the researchers investigated developmental differences illuminated in the distribution of phase I responses and determined which of these trends were statistically significant. Finally, in phase III, the researchers performed a word frequency analysis of the written narratives to assess trends in the entire sample as well as developmental differences across grade levels.

Despite the fact that the participants portrayed their relationship with nature in unique and varying ways, the authors garnered several results from the drawings and written narratives that demonstrated similarity among the sample. Across all age groups, this study indicated that, by and large, children have a positive relationship with nature and frequently used "like" or "love" to describe their experience. Another element that did not change with grade level was the inclusion of "play



or playing” in children’s drawings and narratives. Finally, the children participating in the study did not describe themselves as separate from nature, but instead described their relationship to nature in terms of family or friendship.

In contrast to these similarities across ages, the authors found several significant developmental differences present in the participating children. One such trend they reported was that younger children were more likely to include friends and family in their narratives. Younger children also included more insects and animals in their responses. By contrast, older children portrayed their nature relationship in more solitary situations and included elements such as chores, hiking, and natural areas.

In conclusion, the authors presented several implications for their work as well as mentioned the need for future research. The authors suggested that, by recognizing these developmental trends, environmental educators working with young children could capitalize on particular age-based interests. They believe that research into children’s developing relationships with nature could have important implications for curriculum, programming, and policy in environmental education. That said, the researchers cautioned that “these findings should only be contextualized to the study participants,” and that further research must be undertaken to understand how children’s connections to the natural world vary by location, culture, and socioeconomic status, among other factors.

THE BOTTOM LINE: This study used children’s drawings and written narratives to examine how young children portray and describe their relationships with nature, as well as how these relationships differ by age. Researchers found that participating children had an overwhelmingly positive relationship with nature, yet they found developmental differences among various ages: Younger children were more likely to include family and friends in their narratives, while older children were more likely to portray solitary situations. Although their results cannot be widely generalized, this research suggests opportunities for informing and improving environmental education practices based on how children connect to the natural world.

Kalvaitis, D., & Monhardt, R. M. (2012). The architecture of children’s relationships with nature: A phenomenographic investigation seen through drawings and written narratives of elementary students. *Environmental Education Research*, 18(2), 209-227.

ADMINISTRATORS’ ATTITUDES INFLUENCE THEIR SUPPORT FOR EE

This study used the term *environment-based education* (EBE) to describe a type of environmental education in which “the environment is used as a context for integrating core subject areas and a source of real world learning experiences.” In EBE, students often work on community-based projects in which they learn firsthand about issues and develop skills to take action. Previous research has suggested that administrators play a key role in the success and extent of any pedagogical reform, including the use of EBE in schools. In particular, how administrators support teachers’ use of EBE has been shown to be critical for teachers to successfully implement EBE. In this study, the author analyzed what influences and impedes K-12 administrators’ support for EBE.

K-12 administrators who already support the use of EBE in their school or district were the first focus of this study. The author wanted to know what these administrators perceived to be the greatest influences and obstacles to their support for EBE implementation. Second, the author wanted to know if the perceived influences on and obstacles to their support for EBE differed among K-12 administrators who (1) supported EBE as a comprehensive school reform model (*school-wide* EBE); (2) supported EBE as an instructional method by one or several teachers (*partial-school* EBE); and (3) supported other more traditional forms of school-based EE (*other* EE).

To address these questions, the author surveyed 98 administrators using a questionnaire modified from earlier studies of teachers and EBE. The sample varied fairly evenly across administrators who supported school-wide EBE, partial-school EBE, and other EE.

In the first round of analysis, the response data was organized using conceptual clustering. This resulted in 11 clusters that described influences to support EBE, which the author described as influence-composites. For example, the “environmental sensitivity” influence-composite included items such as “high level of comfort with the outdoors” and “frequent contact with nature as a child.” It also resulted in six clusters that described obstacle-composites such as “logistical obstacles” and “standards-based education obstacles.”

The second-level analysis looked at administrators who already support school-wide or partial-school EBE. The author found that the strongest influences on these administrators’ support were positive environmental attitudes, environmental sensitivity, and receptiveness to the EBE approach. Concerns about safety and liability were reported as the most significant obstacles. Those with such concerns reported significantly less support for EBE.

The third analysis looked at differences between the groups of administrators who support school-wide EBE, partial-school EBE, or other EE. The influence-composites that varied the most across these three groups were receptiveness to EBE and access to other forms of professional development in EE (such as attendance at a professional conference where an EE/EBE approach was presented). In particular, school-wide EBE administrators perceived receptiveness and access to other forms of professional development as having a stronger influence on their support for EBE than did other EE administrators. The obstacle-composites that varied across the three groups were administrator obstacles (such as “my own lack of training in this approach”) and safety/liability obstacles. In general, school-wide EBE administrators perceived their own lack of training, knowledge, and so on as less of an obstacle than partial-school EBE or other EE administrators did. Similarly, school-wide EBE administrators viewed safety and liability concerns as less of a problem.

Another significant difference between the groups of administrators was their level of support and the level of effort, time, and financial commitment they reported devoting to EBE or EE. Those who supported school-wide

EBE or partial-school EBE implementation characterized their support and the level of effort, time, and financial commitment they devoted to EBE/EE as significantly greater than the administrators who supported other forms of school-based EE. The author noted that this finding may be strongly linked to why EBE is not more widely practiced, in spite of the demonstrated positive educational outcomes.

One of the implications of this study is that although environmental literacy plays a large role in influencing teacher support for EBE, it appears to be less important for administrator support. Rather, efforts to increase professional development around EBE overall may be the most fruitful in influencing more administrators to support school-wide EBE. One example of this would be providing administrators with opportunities to participate in environmental projects where they see the need for their involvement and they see that their actions make a difference. Such professional development could concurrently help administrators develop positive environmental attitudes, environmental sensitivity, and receptiveness to EBE, which are all critical factors in administrator support of EBE. Professional development could also be directed at addressing the major obstacle of concerns related to safety and liability in EBE programs. This professional development could occur in multiple forms, including mentoring, professional conference attendance, and observations at schools with school-wide EBE.

THE BOTTOM LINE: Although this study focused on K-12 school administrators, this research can be applied to just about any educational setting where administrators are key in supporting comprehensive environmental education (EE) or environment-based education (EBE). Positive environmental attitudes, environmental sensitivity, and receptiveness to EBE were found to be the strongest influences on administrators’ support for EBE. Safety/liability concerns were found to be the biggest obstacle to administrator support for EBE. In addition, administrators who support EBE reported a greater willingness to devote time, effort, and money to EE than administrators who support other forms of EE. Environmental education organizations could play an important role in providing varied support and professional development for school

administrators towards the goal of EBE. This support and professional development could target the key influences and obstacles identified in this exploratory study.

Ernst, J. (2012). Influences on and obstacles to K-12 administrators' support for environment-based education. *The Journal of Environmental Education*, 43(2), 73-92.

ACADEMICS AND FUN MOTIVATE TEACHERS TO ATTEND NATIONAL PARK PROGRAMS

At the Great Smoky Mountains National Park (GSMNP), students from elementary through high school are invited to attend curriculum-based education programs onsite or in their own classrooms. While participation levels are high at the elementary-school level, park staff are interested in building participation at the middle- and high-school levels. But they're not sure how to best attract teachers to their programs.

The authors of this paper set out to understand what motivates middle and high school teachers in surrounding schools to attend GSMNP programs with a mixed-methods study. An initial focus group helped the researchers understand the most important broad perceptions of teachers in the area. The researchers also interviewed administrators from the surrounding schools, and used the results of the focus group and interviews to help develop a survey for teachers. The surveys were administered in 14 middle and high schools near the park, and teachers of every subject area were invited to participate. In the end, the researchers received 387 valid surveys to analyze, with 136 from middle school teachers and 251 from high school teachers.

Although environmental educators often refer to financial constraints as a major barrier to field trips, the administrator interviews in this study suggested otherwise. The authors explained, "Although some administrators indicated that money for participation was a concern, most suggested it was not the primary issue in determining program attendance." The administrators indicated they were most likely to grant permission for a field trip if the teachers could demonstrate

how the trip fit with their curricula. Time constraints were another important issue to be addressed, especially related to the need for large amounts of classroom time devoted to test preparation.

The teacher surveys indicated that teachers perceived "finances" as the biggest barrier to participation in the park programs. Like the administrators, the teachers also often mentioned time constraints and connections to the curriculum as other concerns. In both the interviews and the surveys, science was perceived to be the subject area most closely linked to park programs, and science teachers were most likely to have participated in a program in the past. Middle school teachers were more likely than high school teachers to believe that the park programs could be easily incorporated into their courses, and that the programs would result in better academic achievement.

The researchers analyzed the survey results to determine which variables best predicted teachers' intentions to participate in park programs. The researchers found that they could predict which teachers would describe themselves as most likely to participate in a park program with 74 percent accuracy based on three variables: the teacher's perception of how easy it is to incorporate the program into their curriculum, how likely the program is to support students' academic achievement, and whether the program will provide a fun educational experience.

The researchers offered several suggestions for putting their results into action to better market park programs to teachers. First, they suggested that "the most effective messages for motivating greater participation in the park's educational offerings will emphasize that the programs are fun, relevant learning experiences that address academic requirements for multiple subjects and are relatively easy to incorporate into pre-existing curricula." The researchers also suggested communicating directly with teachers about park programs, as teachers have substantial control over the decision to participate, and most teachers learn about park offerings through other teachers. And because teachers believe that financial constraints are a barrier, emphasizing the affordability of park programs is likely to help, too.

THE BOTTOM LINE: This study suggested that while financial constraints are important, they may not be the most important factor in determining whether a class participates in a field trip. Administrators in this study were more likely to first evaluate how well a program aligns with a teacher's curriculum, with financial considerations being secondary. Teachers were most likely to participate in a field trip if they believed that (1) the program materials related to their course curriculum, (2) the program would enhance their students' performance, and (3) the experience would be fun and educational. These features should be emphasized in marketing field trip programs to teachers. But it's important to note that this research focused only on the schools surrounding one national park. More research would help test these results in other settings.

Stern, M. J., Wright, M. E., & Powell, R. B. (2012). Motivating participation in National Park Service curriculum-based education programs. *Visitor Studies*, 15(1), 28-47.

RANGERS' AND VISITORS' PERCEPTIONS NOT ALWAYS IN LINE

Research has demonstrated that live interpretive programs at national parks can help visitors create emotional connections to the land, educate visitors about a park's natural resources, and influence visitors' environmental attitudes and possibly even behaviors. However, these benefits are contingent on program attendance, which, according to recent estimates, includes between 12 and 30 percent of total park visitors, depending on the specific park. This research examined visitor incentives and motivations at Great Smoky Mountains National Park (GRSM), the most-visited national park in the United States, in order to improve understanding of interpretive program attendance. The authors addressed three specific questions: (1) What do GRSM *rangers* think are people's primary motivations for and barriers to program attendance?; (2) What do *visitors* report as their reasons for attending (or not attending) interpretive programs?; and (3) How can the answers to the previous questions increase program attendance and inform interpretive program management?

These research questions were addressed using surveys with three populations: GRSM interpretive rangers, park visitors, and interpretive program attendees. In the first survey, 13 GRSM interpretive rangers were asked to rank perceived motivations or barriers for visitors attending interpretive programs. The general visitor survey and the program attendee survey (with 617 and 276 respondents, respectively) also asked about motivations for visiting, but also collected information on attendance patterns, group characteristics, and reasons for visiting the park. Additionally, both the ranger survey and the program attendee survey inquired about the information sources visitors used to learn about park programming.

The survey results revealed that rangers perceive the strongest drivers for program attendance to be a specific interest in a place or topic, tangible rewards (e.g., Junior Ranger Badge), and a chance encounter with an interpretive program. In contrast to rangers' perceptions, visitors stated that entertainment, a better opportunity to see park attractions, and providing a good group experience (particularly for families) were the top factors influencing attendance, in addition to those the rangers named. Rangers and visitors agreed on prominent barriers to attendance: lack of awareness of the program, inconvenient time or location, and desire for a solitary experience. Finally, rangers believed that their personal invitations, followed by visitor center information boards, are the most effective sources of information about interpretive programs, while program attendees cited the GRSM visitor guide followed by visitor center information boards as their top sources.

Overall, this new research offers valuable insight into methods for increasing interpretive program attendance at Great Smoky Mountains National Park based on an analysis of ranger predictions, visitor motivations, and effective sources of information. By analyzing discrepancies between visitors' interest in programs and their actual attendance, together with the barriers to participation, the authors believe that parks can capture more visitors in their interpretive programs. They explained, "We might assume that up to one-third of those not attending interpretive programs might actually have been interested in doing so given better marketing, locations, or timing of programs."

They explained that one way to capture these visitors might be to “take advantage of the belief that ranger-led programs might expose the visitor to something he or she might otherwise not get to see and build off interests in scenery enjoyment, social experiences (particular for family groups), and wildlife by using words and phrases like ‘reveal,’ ‘glimpse,’ ‘behind the scenes,’ ‘secrets,’ ‘best views,’ ‘chance to see wildlife,’ ‘fun,’ ‘great for kids,’ and similar themes.” The authors also recommended continuing certain successful approaches, such as the use of the park’s visitor guide to advertise interpretive programs. They also suggested reaching out to visitors who stay in the park for the shortest amount of time, and are the group least likely to attend a program, with messages such as, “If you only have a few hours (or one day) in the park, don’t miss ...”

THE BOTTOM LINE: While rangers at Great Smoky Mountains National Park know what often keeps visitors from attending their interpretive programs, their visitors are motivated by a broader range of benefits than the rangers realized. The rangers correctly predicted some motivations, such as an interest in a specific topic, but they didn’t predict that people are most commonly motivated to attend a program for entertainment, a chance to see the park’s unique attractions, and the hope that an interpretive program will be something that everyone in their group can enjoy. This study serves as a reminder that educators’ perceptions don’t always match their audiences’ perceptions, and that knowing your audience can help you refine messages that will attract your audience’s attention.

Stern, M. J., Powell, R. B., & Hockett, K. S. (2011). Why do they come? Understanding attendance at ranger-led programs in Great Smoky Mountains National Park. *Journal of Interpretation Research*, 16(2), 35-52.

PRESCHOOL CHILDREN’S ENVIRONMENTAL ATTITUDES TEND TO BE SELF-CENTERED

The positive environmental behaviors that can be effected by simple lifestyle changes are often learned as very young children. Habits such as turning off the lights when leaving a

room may be formed at a young age, and may form the basis for positive environmental behavior throughout a person’s lifetime. The authors of this paper studied the formation of such behaviors in 40 preschoolers who ranged in age from five to six years old and who lived in Ankara, Turkey. The researchers interviewed the students about their motivations for acting in an environmentally conscious manner.

The authors classify motivations for environmental behaviors into two categories: ecocentric, or valuing the environment for its own sake and giving nature an intrinsic value; and anthropocentric, or valuing nature for human use. The researchers asked the children about four broad categories of environmental behavior: consumption patterns, environmental protection, recycling–reusing, and living habits. Male and female students showed both types of motivation for environmentally friendly behaviors, and the researchers found no significant variation for boys and girls in this age group between ecocentric and anthropocentric reasoning. (The authors do cite other studies in which teenage girls have been shown to be more ecocentric than their male peers.)

There was, however, a great deal of variation between the two classifications of motivation within the four behavior categories. Children tended to be anthropocentric in the consumption category, giving responses such as, “If we do not turn the water off while brushing teeth, we waste water and we have to pay a lot more for the water bill,” although some (about 16 percent) cited ecocentric motivations, such as the fact that saving paper saves trees and trees are food for animals. In the environmental protection category, researchers asked subjects about respecting wildlife, and not disturbing plants and animals. These responses tended to be much more ecocentric, with 62 percent of subjects reporting positive behaviors with ecocentric reasoning, such as, “I do not want to kill flowers, if I bring them home, they cannot live, they miss their home and they die.”

Students in this study showed a very low rate of recycling, with only 5 percent of them reporting regularly separating recyclable items, mainly due to lack of recycling bins. In the category of living habits, 75 percent of subjects reported a

preference for playing outside, and 95 percent wanted to live somewhere with a lot of plants and animals, although most of them showed anthropocentric reasoning as well (for example, they are able to play more roughly outside, or living in a less crowded place would give them more room to play). There were, however, a number of ecocentric responses to this question as well.

The authors cited Piaget's theory of egocentrism, which states that young children tend to focus on their own point of view more so than others, as a possible reason for the high level of anthropocentric motivations for environmental behavior. The researchers also postulated that the environmental protection category received more ecocentric responses because caring for plants and animals had a more tangible positive environmental impact than other actions. In addition, many of the schools which the children attended included classroom pets or gardens, giving them more experience with caring for nature.

THE BOTTOM LINE: Preschool children are at the age where they are generally self-centric/anthropocentric in their reasoning. However, they are capable of positive environmental behaviors and show signs of developing ecocentric motivations. At this age, there are no significant gender-based differences between ecocentric and anthropocentric motivations. Educators can always support young students in nurturing and developing an ecocentric view. As the authors explained, "Educators and others involved in child care can help young children feel part of nature, thus beginning the process of developing the child's ecocentric attitudes towards nature. For this reason, environmental issues should be integrated into the existing early childhood education programmes and should include both indoor and outdoor activities."

Kahrman-Ozturk, D., Olgan, R., Tuncer, G. (2012). A qualitative study on Turkish preschool children's environmental attitudes through ecocentrism and anthropocentrism. *International Journal of Science Education*, 34(4), 629-650.