

ENVIRONMENTAL EDUCATION

# RESEARCH BULLETIN

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## ABOUT THE RESEARCH BULLETIN

The *Environmental Education Research Bulletin* is a project of ChangeScale and the North American Association for Environmental Education (NAAEE) in partnership with Dr. Nicole Ardoin at Stanford University. The bulletin is designed to inform environmental and sustainability educators about recent relevant research, with a primary emphasis on informal, field, and residential settings, as well as stewardship behavior, conservation, and related topics. Although other environmental educators and those in related fields might also find this bulletin useful, it does not—nor is it intended to—cover all aspects of environmental education. This bulletin, as well as past issues, is available online through the ChangeScale website: [www.changescale.org/resources](http://www.changescale.org/resources), and through NAAEE’s eePRO website: <https://naee.org/eeopro/resources>. Please send questions and feedback to [eereseearchbulletins@changescale.org](mailto:eereseearchbulletins@changescale.org).

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# TABLE OF CONTENTS

## ENVIRONMENTAL BEHAVIOR

Motivating Pro-Environmental Behavior Through Emotions	Page 5
Using Communication Theory to Unpack Environmental Behavior	Page 6
Climate Change: Hope's Role in Pro-Environmental Behavior	Page 7
Fostering Specific Attitudes and Beliefs for Pro-Environmental Behavior	Page 9

## EVALUATION

Enhancing Science Knowledge Through School Gardens	Page 11
Assessing Outcomes Through an Interactive Art-Based Evaluation Tool	Page 12

## TEACHING METHODS

Successful Sustainability Education Practices	Page 14
Integrating "Icky" Insects into Science Education Curriculum	Page 16
Service Learning for Pre-Service Teachers: Community Partner Responses	Page 17
Making Early Science Education Hands-on, Heads-on, and Hearts-on	Page 18
Developing Leadership Skills Through Service-Learning Courses	Page 20

## SENSE OF PLACE AND NATURE CONNECTION

- Place- and Community-Based Education in China Contribute to Learning Outcomes and Personal Growth Page 22
- Expanding Our Understanding of the Benefits of School Gardens Page 24

## PROFESSIONAL DEVELOPMENT

- Improving Professional Development for Science Educators Page 26
- Learning to Be Leaders for Change Page 28

## OTHER RESEARCH

- Understanding Expectations of Zoo Visitors Page 31
- Increasing Diversity in the Natural-Resource Field Page 33
- Supporting Diverse Students' Environmental Science Identities Page 34
- Joint Attention: Family Learning Talk in Museums Page 36

# INTRODUCTION

Dear Colleagues,

ChangeScale and the North American Association for Environmental Education (NAAEE) have collaborated with researchers at Stanford University to create this tenth issue of the *Environmental Education Research Bulletin*. Talented environmental educators are conducting fantastic programs, collaborating with communities, using hands-on strategies, and making critical links that help enhance environmental awareness, build skills, and support informed action. Yet many of these committed professionals lack the time to keep up on the latest research, which may provide insight into how to improve the effectiveness of their work. We hope these Research Bulletins can help bridge the research-and-practice gap by summarizing recently reported research and help practitioners use the results to enhance their programs.

This issue includes synopses of peer-reviewed journal articles that are particularly relevant for frontline environmental education practitioners. We reviewed issues (published between July and December 2015) of a number of environmental education-related journals, including *Journal of Environmental Education*, *Environmental Education Research*, *Applied Environmental Education & Communication*, *Australian Journal of Environmental Education*, *Journal of Experiential Education*, *International Journal of Science Education*, and *Visitor Studies*.

We want these bulletins to be as useful as possible, so please send your feedback on additional topics or journals you would like us to cover as well as alternative formats that may be helpful. Send suggestions to: [eereseearchbulletins@changescale.org](mailto:eereseearchbulletins@changescale.org).

We also encourage you to check out the research blog on eePRO, NAAEE's professional development community. The community has a section devoted to research and evaluation; you can join here: <https://naaee.org/eeepro/groups/research-and-evaluation>. You may also be interested in the NSF-funded Relating Research to Practice effort of CILS and the Exploratorium, available here: <http://relatingresearchtopractice.org>.

Thanks for all you do, and we look forward to hearing from you!



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# ENVIRONMENTAL BEHAVIOR

## MOTIVATING PRO-ENVIRONMENTAL BEHAVIOR THROUGH EMOTIONS

Environmental activist Jane Goodall once said, “Only if we understand can we care. Only if we care will we help. Only if we help shall we be saved.” This perspective suggests the importance of coupling a range of variables—such as emotion, skills development, or self-efficacy—in order to influence environmental behavior. This study explored the relationship of knowledge and emotion with environmentally related behaviors. Specifically, the researchers asked: What role do emotions play in bringing about pro-environmental behaviors?

A representative sample of more than 1,000 undergraduates at Israel’s Tel Hai Academic College participated in this study. Researchers asked the undergraduate students to complete an extensive survey, which began with items assessing the students’ objective knowledge of environmental science, as well as how well the students felt they understood the causes of and solutions to environmental problems (or, their subjective knowledge). The survey’s second section assessed the students’ environmental emotions based on their self-reported connectedness to nature, concern for the biosphere, and commitment to the natural world. Finally, the survey asked about the students’ pro-environmental behaviors, which the authors considered to be the study’s dependent variable, or the desired outcome. Specifically, the authors asked the students to report their habits related to energy and water use, littering, green consumption, and recycling. The authors controlled for certain related variables—such as the students’ gender, the social desirability of the behaviors, and social norms—to take into account the ways in which those variables might influence responses.

The authors found that neither objective nor subjective knowledge had statistically significant direct effects on environmental behavior. Subjective knowledge, however, did have a statistically significant indirect (or mediated) effect on behavior through its relationship with environmental emotions. These findings suggest that, while environmentally related knowledge might not influence environmental behavior on its own, it can be powerful when coupled with emotion. Importantly, the results also showed that not all knowledge has the same effect: subjective knowledge,



or understanding the causes and consequences of environmental issues, has a greater effect on emotion and behavior than objective knowledge, or knowledge characterized by facts and terminology.

Overall, the findings supported the hypothesis that emotion is one of the factors that mediates environmental behavior. The results indicated that emotions were a significant and strong predictor of environmental behavior. This suggests that environmental programs might be more effective in influencing environmental behavior if, rather than focusing solely on environmental facts, they also emphasize an emotional connection to nature. This implies, further, that informal educational settings may play a valuable role as they may provide more opportunities for emotional connection. Moreover, these findings suggest the need for a possible paradigm shift in formal education toward a greater consideration of the affective, or emotional, realm.

To put this research into action, the authors suggested that practitioners and researchers carefully consider how best to engage emotions when framing and teaching about environmental issues. Knowing how students personalize environmental issues, as well as the factors that influence environmental emotions, is important for environmental educators, particularly if the educators wish to affect environmental behavior.

### **THE BOTTOM LINE:**

Ultimately, addressing environmental issues does not depend simply on what we know, but rather on what actions we do or do not take. To that end, this study offers one way of motivating pro-environmental behavior: through focusing on the role of environmentally related emotions. The results suggest that knowledge, particularly subjective knowledge, can contribute to building, clarifying, and amplifying students' environmental emotions. In turn, emotional connection to nature can have a strong, positive effect on environmental behavior. By providing educational opportunities that engage students in environmental issues through emotional pathways, environmental education experiences can help move students from knowledge to action.

Carmi, N., Arnon, S., & Orion, N. (2015). Transforming environmental knowledge into behavior: The mediating role of environmental emotions. *Journal of Environmental Education*, 46(3), 183–201.

## **USING COMMUNICATION THEORY TO UNPACK ENVIRONMENTAL BEHAVIOR**

One of the biggest challenges of environmental education is figuring out how and why people decide to engage in environmental behavior. Borrowing from the fields of communication and marketing research, this study's researchers used a case study in Nevada to shed light on people's decision-making processes related to environmentally sustainable behaviors. The findings could help inform the way that environmental educators address environmental behaviors, more generally, and energy-related behaviors, more specifically.

The researchers used diffusion theory—an applied communication theory developed by scholar Everett Rogers—to consider peoples' decisions to retrofit their homes with energy-efficient appliances and infrastructures. Diffusion theory considers the various stages that innovations, such as the adoption of solar panels, reach as they work their way through a population. Rogers uses the following terms to describe people in the five stages of adopting and diffusing innovations: innovators, early adopters, early majority, late majority, and laggards. He further theorized that each individual who will eventually adopt usage of a product or idea will go through the stages of initial awareness, interest, product evaluation, trial, and, finally, adoption.

Just as researchers and practitioners have used diffusion theory for targeted sales marketing, this study's researchers found it to be helpful in examining how and why certain people retrofitted their homes in an energy-efficient manner. In an effort to target early adopters, the researchers used a purposive sample of owner-occupied single-family homes in four Nevada neighborhoods in an area serviced by EnergyFit, a nonprofit organization that oversees a home-energy conservation program. Out

of 3,939 surveys mailed to households, the researchers received 288 responses, equaling a 7.3% return rate, which the authors indicate is about average for a mail survey.

The researchers asked consumers whether they had made, and subsequently liked (or did not like), various energy-efficient retrofit changes in their homes. The researchers asked a series of hypothetical questions, based on scenarios such as imagining they had \$1,000 to invest in a water- or energy-saving device. On a scale of 1 (very unlikely) to 5 (very likely), researchers asked respondents to indicate the likelihood that they would, for example, purchase better insulated windows or doors, purchase more efficient appliances, replace current heating/cooling systems, or install solar panels. The researchers also measured values and attitudes toward energy-efficiency and retrofit changes using questions inquiring about topics, such as the consumers' likelihood to invest in their homes, access to information, and attitudes toward the environment and finances. At the end of the survey, the researchers asked about the consumers' intentions to take the actions described in the survey in the next two to four months.

Using diffusion theory, the researchers analyzed the results by what values or attitudes might cause the participants to undertake, or adopt, an energy-efficient retrofitting process. The authors defined the dependent variable as a participant's intention to take action, and they defined the independent variable as a participant's likelihood to spend \$1,000 on various retrofits. The researchers then tested each independent variable against the dependent variable and participants' values and attitudes.

The results revealed that participants' motivations to adopt an innovation—in this case, an energy-efficient retrofit—are complicated. The researchers found that a variety of factors could explain the adoption of the innovative action, including: participants' likelihood to invest in their homes (9.5% of the time); the amount of information provided (9%); participants' attitudes (8.6%); participants' environmental orientations (8.6%); and participants' financial attitudes (8.2%).

This complex picture of motivations suggests that a variety of factors influence participants' decisions about their homes. If program designers understand what those factors might be, they could then design programs, such as EnergyFit, to address peoples' multifaceted motivations. More broadly, knowing that multiple factors influence environmental decision-making may help environmental educators layer their messaging to speak more effectively to participants' differing motivations for environmental behavior.

### THE BOTTOM LINE:

Many factors—including access to information as well as the likelihood to invest—influence peoples' motivations to undertake environmental behaviors. Approaches that target such behaviors must consider these factors, along with others, such as attitudes and value systems, environmental orientations, and financial attitudes, when tailoring messaging about environmental action and behavior. Environmental educators can identify such factors and target motivations to more effectively reach participants. A multilayered message will help enhance the effectiveness of conservation messaging for a diversity of participants and, therefore, increase the likelihood that the message will influence conservation behavior.

Priest, S. H., Greenhalgh, T., Neill, H. R., & Young, G. R. (2015). Rethinking diffusion theory in an applied context: Role of environmental values in adoption of home energy conservation. *Applied Environmental Education & Communication*, 14(4), 213–222.

## CLIMATE CHANGE: HOPE'S ROLE IN PRO-ENVIRONMENTAL BEHAVIOR

As climate change becomes more serious, the need for environmental education (EE) and education for sustainable development (ESD) for young people and in schools is increasingly relevant. Traditionally, EE has aimed to help students better understand causes, impacts, and solutions to environmental issues and inspire critical thinking around ethical issues, conflicts, and uncertainties.

Recent research has identified that such education also involves consideration of emotions because of the gravity of the topics involved. Hope is one of these important emotional aspects, yet research on hope has revealed mixed views about its role and influence on environmental engagement and actions. This study aimed to examine different sources of hope related to climate change through surveys of high-school students in Sweden. The author suggests that there are two types of hope: one associated with engagement and the other associated with less pro-environmental behavior.

To address mixed views about hope and its role in environmental behavior, the author identified two subscales of hope concerning climate change: constructive hope and hope based on denial. The author defined constructive hope as relating positively to pro-environmental behavior, and hope based on denial (such as the gravity of climate change) as relating negatively to pro-environmental behavior. In this study, the author aimed to construct a reliable scale for understanding hope based on denial to replicate her previous study on hope and environmental engagement. She also sought to understand the relationship between the hope subscales and how students perceive EE and ESD in their schools, whether gender plays a role in the hope subscales, and any relationship that might exist between hope and self-efficacy.

The study consisted of a convenience sample of 624 high-school students (59% girls) from 22 communities. The students completed an online survey that addressed topics related to the environment as well as science, technology, engineering, and mathematics (STEM). Specific survey areas included environmental engagement (for example: “If I had extra money, I would give some to protect the environment.”), political engagement (“The political party I will vote for should work for sustainable development.”), self-efficacy (“I have good opportunities to influence my own life-situation.”), teachers’ acceptance or dismissal of attitudes toward negative emotions (“Think about how your teachers talk about societal issues and environmental issues in the classroom.”), future orientation in school

(“What can I do to influence our common future?”), and pathways to sustainable development (“What can I do to contribute to sustainable development?”).

The author used factor analysis to create the two hope subscales (constructive hope and hope based on denial). In this way, the author confirmed that the hope questions indeed measured a construct of hope within the two subscales. Next, the author used correlation analyses to examine how the hope subscales related to environmental engagement. The results confirmed that the more constructive one’s hope, the more likely one is to engage in pro-environmental behavior and vote for a sustainability-focused political party. Conversely, the author found a significant correlation between hope based on denial and lower levels of engagement in pro-environmental behavior. The correlations showed that students with more constructive hope had more self-efficacy, viewed teachers as being more accepting of their negative emotions in relation to climate change issues, and had more “solution-oriented styles.” Students with hope based on denial were associated with opposite results: less self-efficacy, feelings of dismissal by teachers, and a negative outlook.

The results of the statistical analysis also showed that boys were more likely to base their hope on denial than were girls, and that self-efficacy is an important predictor of boys’ hope base. This effect only occurred, however, when students perceived their teachers as being dismissive toward negative emotions. Boys, more than girls, viewed their teachers as being more dismissive and, therefore, experienced hope based on denial to a higher degree.

This study clarifies the mixed views around hope: hope can be positively or negatively related to environmental engagement, depending on the base or source of hope. It is the first study to elucidate the relationship between EE/ESD in school and the hope subscales, illustrating the importance of promoting constructive hope through discussing a common future and pathways for sustainable development in schools. Most importantly, the study shows the potential impact of teachers’ responses to their students’ negative emotions while discussing climate change.

### THE BOTTOM LINE:

To address the sources and feelings of hope that students might bring to discussions of climate change, and also to encourage pro-environmental behaviors and positive environmental engagement, educators should be aware of their own reactions to students' negative emotions. This study's findings emphasize the importance of considering students' emotions seriously, using opportunities around feelings of hope—and lack thereof—as teachable moments, and communicating about such issues in a solutions-oriented way to promote constructive hope among students. Additionally, the study highlights the importance of supporting educators to address climate change, and similarly challenging, large-scale issues, in an emotionally aware, sensitive, empowering way within the classroom.

Ojala, M. (2015). Hope in the face of climate change: Associations with environmental engagement and student perceptions of teachers' emotion communication style and future orientation. *Journal of Environmental Education*, 46(3), 133–148.

## FOSTERING SPECIFIC ATTITUDES AND BELIEFS FOR PRO-ENVIRONMENTAL BEHAVIOR

Motivating pro-environmental behavior through environmental education and outreach requires understanding the attitudes and perceptions that predict engagement in pro-environmental behaviors. In this study, researchers considered two elements of attitudes and perceptions they have explored and connected with environmental behaviors: (1) attitudes and beliefs specific to the environmental behavior that is being promoted, such as attitudes specifically toward energy conservation; and (2) more general environmental attitudes and beliefs.

Although both behavior-specific and general environmental attitudes have been found to predict environmental behavior, few studies have examined which is a better predictor, even though investigating this is crucial for designing environmental education

and outreach programs with the goal of motivating behavior change. If behavior-specific attitudes are more predictive of behavior, for example, then programs may be more effective if they seek to foster supportive attitudes and beliefs specific to each individual environmental behavior, rather than focusing on generating support for environmental causes in general.

This study's authors surveyed 1,160 Israeli undergraduate students to examine whether students' behavior-specific or general environmental attitudes were better predictors of various self-reported pro-environmental behaviors. In designing the survey, the authors drew from Ajzen and Fishbein's Theory of Planned Behavior, which suggests that behavior is influenced by four primary attitudes and beliefs: (1) attitudes toward an environmental behavior; (2) subjective norms, or beliefs about social expectations around engaging in an environmental behavior; (3) perceived behavioral control, or beliefs about the difficulty of engaging in an environmental behavior; and (4) behavioral intention, or plans to engage in an environmental behavior. For each of the four attitudes and beliefs outlined in this theory, the authors developed questions that were specific to each environmental behavior. They also developed questions focused more generally on environmental conservation. For attitudes toward behaviors, for example, the authors asked about students' like or dislike of saving water, as well as environmental conservation in general. The authors then examined the extent to which those specific as well as general attitudes and beliefs predicted five types of self-reported environmental behaviors: water conservation, energy conservation, littering, recycling, and consumption.

The authors found that, for every type of environmental behavior, the behavior-specific attitudes and beliefs predicted environmental behavior better than the general environmental attitudes and beliefs. However, the extent to which behavior-specific elements of the Theory of Planned Behavior improved prediction varied by the type of behavior as well as the attitude and belief measured. Behavior-specific measurements of perceived behavioral

control were particularly effective when compared with more general measures of the same constructs. This may be because the more specific measures better accounted for the concrete details and constraints of how a person's life may influence participation in the desired behavior. In addition, the authors found that more specific measures of subjective norms were especially important for the recycling and consumption domains, possibly because the greater sacrifice demanded by these behaviors meant that social motivations could have a greater impact. Based on these findings, the authors suggest that environmental outreach and educational programs may benefit from addressing attitudes and beliefs about specific environmental behaviors in addition to fostering general environmental awareness.

#### **THE BOTTOM LINE:**

Rather than general attitudes and beliefs, this study finds that specific attitudes and beliefs related to a desired environmental behavior are better predictors of pro-environmental behaviors. Therefore, environmental education programs are likely to be more effective in motivating conservation behavior if they focus on fostering specific attitudes and beliefs associated with a desired pro-environmental behavior, rather than focusing on more general environmental attitudes overall. To target behaviors with this level of specificity, practitioners should focus on one or two key behaviors, as well as the barriers and motivations that influence those behaviors, rather than solely on environmental attitudes more generally.

Carmi, N., Arnon, S., & Orion, N. (2015). Seeing the forest as well as the trees: General vs. specific predictors of environmental behavior. *Environmental Education Research*, 21(7), 1011–1028.

# EVALUATION

## ENHANCING SCIENCE KNOWLEDGE THROUGH SCHOOL GARDENS

Researchers and practitioners have documented gardens as part of schoolyards and pedagogical practices since at least the early 1900s, although they may have been part of educational practices, and certainly daily life, even earlier than that. Some of the many touted benefits of schoolyard gardens include providing active, engaging, real-world experiences; enhancing students' connection to nature; offering a setting for integrated, holistic learning; and fostering nature-related values. Yet one may ask what impact school gardens actually have on student learning. This paper's authors undertook a randomized controlled trial study in low-income schools to address that question. They set out to measure the effect of school gardens on student learning using the Garden Intervention Fidelity (GIF), a scale that the researchers developed to determine whether the intensity and rigor of a garden-based education experience influences student learning.

The authors implemented the study in 47 low-income elementary schools, and 151 classrooms, in Arkansas, Iowa, New York, and Washington. All schools included in the study had a student population where at least 50% of their students qualified to participate in free or reduced-price lunch programs. Cooperative Extension educators taught lessons for some classrooms. The study compared students who received a garden-related intervention with those in a control group that did not receive the intervention during the study period. (The control group received the intervention after completion of the study.) Researchers gave each participating classroom raised-bed garden kits, including a toolkit of garden-based lessons focused on nutrition, plant science, horticulture, and youth development. The toolkit contained 20 lessons for second- and third-grade students, and 20 lessons for fourth- and fifth-grade students. The intervention also included online training for educators, a garden-implementation guide, and generic resources for the school. The components of the GIF metric included the number of lessons implemented, the number of fruits and vegetables planted, the number of fruits and vegetables harvested, and the number of different methods of fruit and vegetable distribution.



Overall, students in the schools with the school garden treatment had modest, but statistically significant, gains in science knowledge as measured by a seven-question multiple-choice survey. However, when the authors controlled for GIF, they found a higher increase in science knowledge for classrooms with a higher GIF score; this means that the students with more lessons and interactions in the garden had higher increases in their science knowledge scores.

Although the study found only modest benefits in the science knowledge metric, the findings indicated other positive school-garden outcomes that the researchers did not measure in this study, such as cognitive functioning, physical activity, and collaboration. The authors note, however, that there are myriad reasons why this specific intervention may have yielded these knowledge-related results; they emphasize that further research should be conducted on the types of science knowledge impacted by school gardens as well as other factors that may affect the implementation of a garden project. In this way, researchers may shed more light on the connection between gardens and the range of related positive outcomes.

### **THE BOTTOM LINE:**

In addition to benefits such as cognitive functioning, physical activity, and improved cooperation among youth, school gardens may also provide an opportunity for enhanced science learning, particularly among elementary-aged children from low-income communities. Researchers found that these benefits accrue when supplementary materials—such as complementary lessons related to nutrition, plant science, horticulture, and youth development—accompany garden visits and youth development, online teacher professional development, and other school resources. Therefore, to achieve similar positive effects in a school garden program, educators can incorporate hands-on gardening with group work, complementary lessons, and teacher development into their school gardening curriculum.

Wells, N. M., Myers, B. M., Todd, L. E., Barale, K., Gaolach, B., Ferenz, G., Aitken, M., Henderson, C. R., Jr., Tse, C., Pattison, K. O., Taylor, C., Connerly, L., Carson, J. B., Gensemer, A. Z., Franz, N. K., & Falk, E. (2015). The effects of school gardens on children's science knowledge: A randomized controlled trial of low-income elementary schools. *International Journal of Science Education*, 37(17), 2858–2878.

## **ASSESSING OUTCOMES THROUGH AN INTERACTIVE ART-BASED EVALUATION TOOL**

When it comes to environmental education, assessment is important: educators want to know whether, and in what ways, their programs are effective. Based on this information, educators have the ability to adapt programming to better meet participants' needs. Yet, it can be challenging to make traditional evaluation measures, such as surveys, engaging for participants, especially children, and design them in a way that does not detract from the overall program. In addition, the data can be cumbersome and time-intensive to analyze. Therefore, considering creative, embedded ways to assess an activity has been at the forefront of many researchers' minds. Researchers have found art, for example, to be an interactive evaluation tool that is age appropriate for young participants, as it requires no language fluency and additionally it can transcend linguistic, socio-economic, and/or cultural barriers. Some argue, alternatively, that using children's drawings to evaluate educational experiences is subjective and, therefore, invalid. To counter that notion, this study's authors used a quantitative scoring rubric to assess the drawings of children between the ages of 6 and 12. The authors investigated what the children's drawings expressed about their environmental awareness and attitudes.

The study sample included 285 children who attended a one-week summer camp in Athens, Georgia. The children ranged from 6- to 12-years old and were from diverse racial and ethnic backgrounds, including African-

American, Asian, Hispanic/Latino, and White. The authors instructed the students to “Draw (and label) a habitat or ecosystem that you see or play in almost every day.” The authors then created a scoring rubric with elements such as the presence or absence of humans, as well as nature-related elements (e.g., plants, animals, trees, mountains, and rivers). The authors also noted how the children’s drawings depicted interactions between human and nonhuman elements. The drawings received higher scores when they included explicit interactions between humans and nonhuman elements of nature.

After scoring the drawings, the researchers compared the results of the quantitative rubric with a traditional evaluation tool: a survey adapted for children. After several rounds of calibrating the scores, the authors were able to obtain reliability among evaluators; in other words, they reached a point where the various researchers independently scored drawings similarly.

The authors found that children more often drew pictures of the ecosystems’ biotic elements, such as plants and animals, than of abiotic elements, such as rocks, soil, and water systems. They also found that it was more common for the children to draw nature scenes without humans. The authors interpreted this to mean that the children were depicting a separation of humans and nature. The most common habitat that children drew was their own backyard; for animals, the children most frequently drew mammals.

When comparing the traditional assessment tool (in this case, the survey) with the art-based assessment tool, the authors found that the two tools measured somewhat different environmental concepts and skills. This finding suggests that using only one of the assessment tools (either the survey or the art-based tool) in isolation might result in an incomplete understanding of children’s environmental awareness and attitudes. The authors did find, however, that high correlations existed among certain constructs within each of the assessment tools. Eco-affinity (children’s attitudes toward and personal interest in “natural settings”) and eco-awareness (children’s understanding

of environmental aspects and relationships) scores, for example, were highly correlated within the survey; within the art assessment, art appreciation was correlated with eco-affinity and eco-awareness.

The study offers a possible alternative structure for environmental education assessment with young participants. In the art-appreciation section of the survey, moreover, the children expressed preference for the art-based evaluation measures. This suggests that the art assessment may offer children a low-stress, creative option for expressing their opinions.

The authors point out that although there were no statistically significant similarities between the drawing and the survey, using both tools might help educators develop a broader understanding of children’s learning. In future work, the authors suggest using a mixed-methods approach that employs traditional tools, such as surveys, with non-traditional tools, such as the arts-based practices implemented in this study. This combination might help in clarifying the exact concepts measured by the arts assessment, limiting misinterpretation, triangulating assessment results, and engaging students.

### **THE BOTTOM LINE:**

Although art-based assessments might not align perfectly with more traditional survey assessment measures, they can be enjoyable activities that assess certain environmental attitudes in nontraditional ways. When coupled with other more traditional and structured assessment methods, art-based assessments may provide a more holistic evaluation of learning. In this way, when measuring their students’ learning, environmental educators might consider combining an enjoyable, language-free activity—such as an art assessment—with other tools—such as a survey—to gain a more complete picture of student comprehension.

Flowers, A. A., Carroll, J. P., Green, G. T., & Larson, L. R. (2015). Using art to assess environmental education outcomes. *Environmental Education Research*, 21(6), 846–864.

# TEACHING METHODS

## SUCCESSFUL SUSTAINABILITY EDUCATION PRACTICES

As the concept of education for sustainability has grown in prominence, many schools and teachers are eager to implement sustainability education in the classroom. Teachers, however, may feel unsure of how to teach about sustainability: they may not have much opportunity to build their knowledge base in this area and, as such, may not have a great deal of experience in developing and implementing sustainability education programs. This study shares some of the ways that teachers are successfully implementing sustainability education in sites where sustainability is a shared goal among educators and community members. The authors looked at teacher practices in eight schools in Victoria, Australia, focusing on place-based sustainability education practices and the relationships between teachers, students, and community members.

The authors conducted this research as part of a longitudinal study examining teacher professional learning and teacher education for sustainability in Victorian primary schools. In a previous sustainability mapping survey in the Gippsland region of Victoria, researchers identified eight primary schools with active sustainability education programs and invited those schools to participate in this study by hosting pre-service teachers for a three-week practicum. Schools in the sample were a mix of large and small rural and regional schools, including one Catholic school and five government schools. None of the schools were located in close proximity to a large metropolitan area. Researchers used semi-structured focus groups with a total of five principals and 16 teachers to understand the ways in which school administrators and teachers thought about sustainability, as well as what practices they used to educate students about sustainability. The researchers also analyzed photographs of school grounds (including projects such as gardens and interpretive trails) to supplement their knowledge of sustainability practices at each site. The authors analyzed those data in terms of storylines, or the narratives people and groups use to explain and contextualize their actions.

The authors found that the schools' sustainability programs were grounded in typical discourses of sustainability, including projects such as edible gardens, energy and waste management, and,



occasionally, biodiversity and resource conservation. The particularities of each site, however, nurtured these standard visions of sustainability. Four storylines emerged from educators' reflections on their practices and from photographic analysis.

First, sustainability education involved physical and material engagement with the school grounds. One teacher's class, for example, conducted an experiment where the students buried items such as a leaf, a chip bag, and an apple core in the soil; two weeks later, they dug up the items and discussed what the state of the items indicated about decomposition processes and rates, as well as about soil microorganisms. This experiment extended into other lessons on waste and plastics in the ocean. The educators did not plan the sequence but, rather, the sequence grew from students' experiential encounters with their everyday physical environment.

Second, teachers helped students develop a sense of place through action-based learning. One class learned about a local wetlands site through a project about town planning; the class researched the history of the site, learning about its Aboriginal inhabitants and later settlers, as well as biological characteristics of the site's nonhuman mammal and insect populations. Another class visited a community garden to learn about the indigenous inhabitants of the place, focusing on what it meant to grow a community and work on a shared project in a community place. The researchers argue that these place-based pedagogies connect students to a network of relationships across time; in this way, the pedagogies help the students develop meaningful connections to the local environment.

Third, teachers formed community partnerships to enhance both their students' and their own understanding of sustainability. They brought students into contact with other schools, parents, tradespeople, conservation groups, volunteers, and community organizations, thus deepening students' engagement with their communities and exposing them to a wider base of skills and expert knowledge. At one school, for example, a group of local woodcutters worked to build nest boxes with boys who had

been somewhat disengaged in the school setting. Nearby schools then installed the nest boxes during a community field day. At another school, students prepared dishes using produce from the school garden and sold them at a local farmers' market. The researchers found these community partnerships help create a social ecology of place that involves whole communities in sustainability education.

As the researchers point out, these creative, experiential, and experimental activities involve uncertainty and unpredictability, as opposed to traditional pedagogies, which often are based on teacher knowledge and control. The authors conclude, as the fourth storyline supports, that emergent, creative pedagogies encourage students to take risks and explore new ideas, driving their own exploration of sustainability.

#### **THE BOTTOM LINE:**

Successful sustainability education programs integrate and situate lessons within the local social and environmental setting, and their teaching methods encourage creativity and experiential learning. Strategies that sustainability educators can employ in their classes include: (1) engaging students with the physical environment that surrounds schools, (2) working across disciplines to help students understand the historical and ecological relationships that constitute local places, (3) forming partnerships with community members and groups, and (4) pursuing creative and inquiry-based projects. No standardized formula exists for sustainability education; rather, it should grow from local conditions, students' interests, and the conceptual connections that emerge from each learning encounter.

Green, M., & Somerville, M. (2015). Sustainability education: Researching practice in primary schools. *Environmental Education Research*, 21(6), 832–845.

## INTEGRATING “ICKY” INSECTS INTO SCIENCE EDUCATION CURRICULUM

More than 97% of all animal species in the world are invertebrates and, of those, most are insects. This abundant, diverse class of animals—populated by more than one million species and comprising more than half of the world’s known species—plays a vital role in keeping Earth’s ecosystems functioning. Yet, despite their critical importance, these creatures have, perhaps unfairly, earned a negative reputation. With their fast movements and foreign body shapes, humans have historically viewed insects as disgusting or abhorrent. This study sought insight into children’s attitudes toward insects and invertebrates. The researchers hoped the insights could help educators better integrate the ecological role of insects and invertebrates into science education.

Although many studies have used quantitative metrics to assess children’s perspectives on insects, this study is quite unique in combining qualitative responses with quantitative data related to this topic. The study’s goals were threefold. First, determine statement categories that arise when children comment on pictures of invertebrate species in order to create a framework for use in future qualitative studies. Next, identify insect and invertebrate groupings that emerged from the qualitative data. Last, test potential correlations among emotions of fear and disgust in response to stimuli.

To address these goals, the authors administered a questionnaire to 246 fifth- and sixth-grade students (ages 9 to 13) in Switzerland. The authors presented each child with color pictures of 18 native insects and invertebrates. The authors gave the children no background information related to the organisms; they then asked the children to use a questionnaire to give an “attitude score” to each insect or invertebrate. In addition to the attitude score, the authors asked the children to describe why they had given that attitude score.

In analysis, the authors identified seven positive and nine negative statement categories that encompassed themes

emerging from student comments. Positive statement categories included “pretty,” “positive entertainment value,” and “useful.” Corresponding negative categories included “ugly,” “negative entertainment value,” and “harmful.” Based on cluster analysis, authors identified four categorical divisions in the insects, each of which were associated with a dominant emotion. These divisions included: (1) fear-conjuring stinging species, (2) appealing and colorful flying species, (3) peculiar species, and (4) disgust-inducing crawling species. The authors found that the emotions of fear and disgust had a weak, although not significant, correlation, indicating that these are separate emotional responses to insects.

This study’s findings have implications for science education related to insects and invertebrates. The authors advise the use of qualitative data and multiple methods in future studies to gain insight into emotions and attitudes toward nature-related topics. The statement categories developed in this study may serve as a sample framework for future qualitative studies on human attitudes toward insects. Further, the authors suggest science education should address prejudicial misunderstandings about insects and invertebrates, such as those that sting or crawl. Strategies to address these stigmas include improving lesson content, teaching accurate information, leading through example by demonstrating positive perceptions, and facilitating personal experiences with regard to insects and invertebrates. If implemented, these strategies may increase support for conservation and sustainable, environmentally related behavior.

### THE BOTTOM LINE:

Qualitative data on children’s attitudes toward insects and invertebrates suggest that children feel favorably about colorful flying insects, whereas stinging and crawling insects evoke fear and disgust. Science education can be instrumental in addressing prejudicial stigma against these diverse, ecologically important organisms by facilitating positive, firsthand experiences and leading by example. Such data may be useful when designing science curricula, as they offer insight that helps address prejudicial stigma against these diverse, ecologically important organisms.

Well-designed, engaging curricula may help improve children's attitudes toward invertebrates and support pro-environmental conservation behaviors.

Breuer, G. B., Schlegel, J., Kauf, P., & Rupf, R. (2015). The importance of being colorful and able to fly: Interpretation and implications of children's statements on selected insects and other invertebrates. *International Journal of Science Education*, 37(16), 2664–2687.

## **SERVICE LEARNING FOR PRE-SERVICE TEACHERS: COMMUNITY PARTNER RESPONSES**

Service learning as part of an educational experience provides an opportunity for students to learn about different life experiences and make positive contributions to their community. Although substantial research exists about the impact of service learning on students as well as on the educational institution that facilitates such courses, little research exists about the impact of service learning on community partners. In this study, the authors aimed to understand the benefits and drawbacks of the partnership for all stakeholders in a service-learning experience for pre-service teachers. A teacher-training program with an urban-community connection at a private university enrolled the pre-service teachers involved in the study; the papers' authors directed the program.

The authors used a Critical Action Research framework in their study to develop an understanding of various stakeholders' experiences with the service-learning initiative. Critical Action Research approach uses inquiry, reflection, and problem solving to improve practices. To that end, the authors analyzed pre- and post-experience questionnaires and reflection assignments of 140 teacher candidates, along with post-experience questionnaires from community partners. Each instructor tailored the reflection activities and individualized them to the pre-service teachers. The instructors used three types of reflection activity questions: content, theory, and application questions. The authors

also analyzed the pre- and post-experience questionnaires and reflection activities to examine patterns around the participants' beliefs. They then triangulated across the data sources. Survey questions included whether the students felt that the service-learning activities contributed to their studies, affected their civic engagement, and contributed to their professional skills. The questions also asked the students to reflect on their experience with the service-learning model.

In the article, the authors included their personal reflections on building the service-learning course. Based on their experience developing and directing the course, the authors suggest necessary preparations for establishing such a course; specifically, these should provide students (in this case, teacher candidates) with real problems in actual places. The researchers suggest that completing a Memorandum of Understanding (MOU) is helpful to clearly outline terms and expectations between the students and service-learning partners. Finally, it is emphasized that, before beginning the project, instructors clarify with students the difference between service learning and volunteering; this difference is that service learning involves collaboration with community partners. The authors also emphasize the importance of reflection in service learning: the reflection activities designed by the researchers included questions focused on content, theory, and application. The authors conducted the reflections in writing, as well as in small- and whole-group discussions.

Survey analysis showed that teacher candidates were, overall, positive about the service-learning projects. Many provided examples of learning about community relationships, working within groups, and developing a better understanding of different groups and cross-cultural awareness. Service learning, furthermore, provided the teacher candidates with ways to improve their understanding of the course concepts. Based on the analysis of their reflections, the authors found that—after the course—teacher candidates were more aware of stakeholder needs, had changed their opinions of their students and community partners, and were able to connect course content with their service-learning experiences.

Analysis of the post-experience questionnaires indicated that the community partners were satisfied with the services that the teacher candidates provided for their organizations. The community partners felt that the service-learning program benefited their organizations, families, and children, as well as the teacher candidates. The community partners also indicated that other benefits accrued, such as the teacher candidates leaving useful materials at the community sites, and gaining an increased understanding of students with disabilities as a result of building an accepting community.

Some of the obstacles the authors encountered when creating the service-learning course included scheduling, inconsistent enrollment at schools, and the cost of materials and supplies. Mini-grants provided by the university, however, offset the cost of materials and supplies for the teacher candidates to create lasting projects with their community. The teacher candidates felt that the benefits of the service-learning projects—such as the enhanced pedagogy, the real-world connections, and the lasting impact on the schools—outweighed the drawbacks—such as the scheduling challenges and inconsistent student enrollment.

The experiences of these teacher candidates and their community partners provide examples of how environmental educators might incorporate service learning effectively into their programs. By providing students with exposure to real-world environmental issues, collaboration with community members, and the opportunity to reflect on their experiences, students develop a better understanding of what it means to work across cultures. They also experience deeper learning of the core course concepts, and, in the process, benefit the community partners.

### **THE BOTTOM LINE:**

Service-learning experiences can help students think critically in real-world settings. Such experiences expose students to a variety of community members, developing the skills to work across differences and in collaboration with others. By using a service-learning approach to teach and reinforce

key class concepts, the students can become more civically minded while also providing a valuable service to their community partners. The students also benefit by reflecting on, and engaging more deeply with, the academic content through the experience. It is important that researchers design service-learning projects in a way that includes the needs and voice of the community partner.

Hildenbrand, S. M., & Schultz, S. M. (2015). Implementing service learning in pre-service teacher coursework. *Journal of Experiential Education*, 38(3), 262–279.

## **MAKING EARLY SCIENCE EDUCATION HANDS-ON, HEADS-ON, AND HEARTS-ON**

Skilled educators know that using a diversity of teaching approaches and strategies can create a more engaging learning environment for students. Science education researchers are interested in exploring the ways in which varied pedagogical approaches might influence science-learning outcomes and documenting those processes in practice. To that end, this paper's authors undertook a qualitative research study examining how science education with early childhood audiences might be more effective when it transcends simple hands-on or activity-based pedagogies. The findings suggest that there are many ways to facilitate and encourage young children's knowledge of, interest in, and experience with science.

Understanding the foundations of the constructivist paradigm is essential to effectively implement hands-on, heads-on, and hearts-on (3Hs) science education. Influential educational theorists, such as John Dewey, Jean Piaget, and Maria Montessori, believed that children actively construct their understanding of the world based on personal experiences. According to constructivists, acknowledging this active participation in their own learning processes is a critical component of facilitating children's education. Teachers who foster a constructivist-based classroom, which invites student engagement on multiple levels, must be prepared to manage what

some teachers might consider classroom “chaos” in more traditional perspectives. Constructivist classrooms encourage students to have direct experiences with the subject, and teachers must be prepared to facilitate this inquiry-based process.

The 3Hs take a whole-child perspective to engage students’ cognitive, social, communicative, physical, and psycho-emotional skills. Hands-on learning focuses on project-based and active engagement with a subject; heads-on learning encourages student-led inquiry and independent problem-solving processes; and hearts-on learning emphasizes interest in and enjoyment of learning about specific topics. Using the 3Hs, researchers simultaneously view children as independent, competent entities, as well as social beings who work collaboratively. Particularly in early-childhood classrooms, play-based education can be an effective path to integrating the 3Hs into science education.

The researchers conducting this study were primarily interested in addressing the following question: How can teachers integrate the 3Hs into preschool classrooms to improve student learning outcomes and subject engagement? To answer this, the authors studied 70 preschoolers (between the ages of three and six) led by six teachers and three teaching/research assistants at a private Turkish preschool. The authors collected data through classroom observations, interviews with students and teachers, artifact documentation (such as children’s drawings and photographs of classroom organization), and field notes.

At this site, preschool teachers offered activity stations throughout the classroom that, ultimately, demonstrated effective integration of the 3Hs in early science education. Within this structure, students moved freely between stations, thereby demonstrating autonomy in their own learning process (hands-on and hearts-on). Activities included experiment stations, such as placing a piece of lettuce in various conditions to evaluate what causes and/or prevents decomposition; cooking stations, such as using

measurements to make cookies; earthworm examination stations; animal heart examination stations; and a station examining food and plants, such as investigating what is inside walnuts. Activity stations integrating hands-on learning allowed students to use their science skills, such as practicing observation. Heads-on learning at stations encouraged students to ask questions, such as, “Does a bag of water burn?” and “What is inside an apple?” Hearts-on learning in stations developed students’ love of and interest in science through activities such as pretending to be animals, listening to animal sounds, and play-acting science scenarios.

This study highlights principles of a whole-child approach to science and environmental education. Perhaps more importantly, however, this study demonstrates that teachers must not only provide opportunities for learning, but also actively facilitate learning. Even if a teacher provides activity stations and multiple ways of engaging with science in the classroom, it is important to scaffold children’s learning. By providing multiple activities and ways for students to engage with science, teachers enable students to choose which learning approaches may be engaging for them. The authors conclude that using the 3Hs as guidance allows educators to develop activities that appeal to different aspects of student learning.

### **THE BOTTOM LINE:**

Integrating hands-on, heads-on, hearts-on learning (the 3Hs) can be an effective way to teach early science education. By being given the agency to choose from a variety of activity stations, children can guide their own learning and develop a deeper, intrinsically motivated understanding of science. When integrating the 3Hs, teachers continue to provide guided scaffolding and serve as facilitators of scientific knowledge, inquiry, and appreciation.

Inan, H. Z., & Inan, T. (2015). 3Hs education: Examining hands-on, heads-on and hearts-on early childhood science education. *International Journal of Science Education*, 37(12), 1974–1991.

## DEVELOPING LEADERSHIP SKILLS THROUGH SERVICE-LEARNING COURSES

In recent years, employers have increasingly emphasized the importance of leadership training and service learning in developing workforce skills. Moreover, researchers have found service learning to have a positive impact on leadership development. In this article, the author provides direction in planning, developing, and implementing a service-learning course that helps students develop leadership skills through experiential education. The author bases this advice on eight years of instructing and iteratively refining a service-learning course called Community Leadership.

To design the course, the author researched service-learning and leadership courses, as well as related opportunities offered at a number of universities. In this process, the author noted two important aspects of successful courses: first, successful leadership and service-learning courses were uniquely tailored to reflect the structure of the particular university that was offering or hosting the course; second, including community leaders was a critical element of success. To implement these two aspects in his leadership and service-learning course, the author formed an advisory group comprised of local leaders. The author collected data from advisors related to topics such as the time commitment that they deemed appropriate to dedicate to such a course, the importance that students placed on having community leaders as guest speakers in the class, and how many times per year to offer the course in order to design meaningful community-partner projects. (In this particular community and university setting, the finding was once per year.)

The class design emphasized experiential learning and reflection opportunities for effectively developing leadership skills. The author acted in a facilitator role and, drawing on notions of effective pedagogical practice, used transformational teaching techniques, such as reflective

journaling, group projects, guest speakers, and student-driven topics. Researchers evaluated students based on five primary criteria: midterm project status reports, end-of-term project status reports, teammate evaluations, presentations, and final reflection papers.

The course centered on service-learning projects, and the author highlighted the importance of the project selection process for the course. Findings showed that students must be excited about their project in order to maximize project success and personal engagement. The author emphasized the importance of beginning the project selection process several months before the start of the course and described a process for doing so. The process included community leaders submitting project proposals, registered students reading the proposals, and students indicating their project preferences by rank. In this way, the instructor was able to assign all students one of their top two or three choices. To maximize leadership learning, the instructor further recommended that the project be divided into components that each student in a group could manage individually.

Over the eight years of the course, 223 students completed 65 service projects for over 50 local nonprofit organizations. The author gathered feedback from students and community leaders each year and revised the course, as needed, to enhance success. Students reported that their favorite parts about the course included: working with local community members, having practical leadership experience, the flexibility and freedom of the projects, and working outside the classroom. The author provided year-by-year data on the suggestions for improvement and the biggest challenges encountered by the students. Such challenges included the need for community leaders to provide more specifics in their project proposals, students procrastinating and needing help with time management, students avoiding projects with political implications or motivations, and the need for more relevant guest speakers.

The author addressed these issues in a number of ways. Project specificity issues were addressed by providing the community leaders with a project proposal template that

detailed the desired scope of the work. Drafts of project proposals were collected and the author encouraged students to address clarity issues immediately; three mandatory meetings were required between the students and community leaders.

Students reported developing leadership skills throughout the course, including gaining skills in communication, planning, organizing, self-confidence/the ability to make a difference, and teamwork/collaboration among others. The author notes all of these are skills that today's employers see as critical.

The author's eight years of experience in developing, teaching, and improving the Community Leadership course provides an example of how environmental education can be a part of service learning at higher education institutions. Faculty members can emphasize environmental education opportunities as one avenue for meaningful projects; similarly, environmental education practitioners can engage in service-learning projects with students and universities.

### **THE BOTTOM LINE:**

When thoughtfully designed, service-learning courses can provide students with effective opportunities for developing leadership skills. Experiential learning, combined with reflection activities and transformational teaching techniques, are important components for a successful course. Building relationships with community leaders, and involving their perspectives, is also critical for the success of such a course. Well-constructed project proposals that achieve buy-in from students and community partners can create a course in which students apply classroom knowledge to real-life experiences outside the classroom; those experiences can serve a rich purpose for students and community partners alike.

Lester, S. W. (2015). Melding service learning and leadership skills development: Keys to effective course design. *Journal of Experiential Education*, 38(3), 280–295.

# SENSE OF PLACE AND NATURE CONNECTION

## PLACE- AND COMMUNITY-BASED EDUCATION IN CHINA CONTRIBUTE TO LEARNING OUTCOMES AND PERSONAL GROWTH

With the advent of rapid urbanization, China—like many other countries today—faces immense environmental problems, ranging from air and water pollution to species extinction and massive habitat destruction. At the same time, younger generations are increasingly disconnected from the environment. Because high school and college entrance exams rarely test for knowledge related to local history, ecology, geography, and culture, most classroom teachers do not emphasize this kind of information in their curricula. This disconnection between youth and the environment is particularly troubling as research suggests that formative nature-based experiences in childhood often influence pro-environmental attitudes and behaviors later in life.

In reaction to these challenges, the Chinese Ministry of Education made an impressive commitment: In 2003, the ministry mandated that all public schools incorporate environmental education (EE) into every subject at every grade level. Yet, to date, there have been numerous barriers to implementation and few success stories documented.

One initiative in the highly urbanized city of Kunming, however, has demonstrated positive learning outcomes and personal growth among students in fulfillment of this mandate. In this case, an innovative teacher developed a volunteer docent program for her fifth- and sixth-grade students at the Yunnan Provincial Museum, which houses exhibitions related to local history, culture, and environment, in addition to exhibitions about larger-scale environmental issues. Through this program, the students provide interpretive programs for museum visitors.

Of the teacher's more than 400 students, 73 participated in the semester-long volunteer docent program. In preparation for the



students' role, the museum's director of public education led docent trainings, and the teacher provided her students with supplementary training related to the museum exhibits. The teacher supervised her students throughout their volunteer service term to ensure student participation and engagement.

Researchers evaluated this EE initiative by observing student activity, soliciting feedback from museum visitors, and analyzing written and verbal self-evaluation forms completed by the students. Analyses of the evaluation data indicated that the docent program influenced a number of positive outcomes related to environmental knowledge as well as other factors contributing to pro-environmental behavior.

In the self-evaluations, students reported increased knowledge about local history and ecology, in addition to broader marine-related environmental problems. Many students reported that this environmental knowledge prompted them to make more environmentally friendly choices, although the students did not describe specific changes. Additionally, some students indicated that the program motivated them to educate others in order to encourage pro-environmental behavior.

Although such increases in knowledge are important, research has shown that knowledge alone does not lead to pro-environmental behavior. Nevertheless, the docent initiative did address some of the other important factors that support pro-environmental behavior, such as self-confidence, self-efficacy skills, and connection to place.

Perhaps most significantly, the docent program influenced a self-reported increase in student confidence as a result of interacting with and informing the public about the exhibits. Positive visitor feedback regarding student docent performance further facilitated the students' confidence and sense of accomplishment. Past research has demonstrated that self-confidence, or a sense of empowerment (elements also related to developing a strong locus of control), is critical for supporting pro-environmental behavior because individuals need to believe their actions are meaningful and that they have the ability to undertake those actions.

Additionally, many students developed a sense of connection with their local community and environment as well as a sense of satisfaction from volunteering. Both of those outcomes—connection to place and enjoyment of community service—can build on environmental knowledge in contributing to pro-environmental behaviors.

Many students reported that their docent experience improved their academic performance due to their increased knowledge of local history and the environment; they indicated drawing on this knowledge base in academic contexts. Furthermore, the student docents' time spent volunteering did not negatively impact their test scores. In fact, many students stated that their docent experience improved their academic performance due to their increased knowledge of local history and the environment.

Yet, those positive outcomes did not come easily. The teacher noted that developing the docent program required significant time and effort to research and prepare new materials as well as to supervise the students while at the museum. Nevertheless, the teacher emphasized that her work with students in this initiative was fulfilling and provided motivation to continue the program.

### **THE BOTTOM LINE:**

Community-engaged projects that bring students out of the classroom and engage them with relevant, local, hands-on learning, can bolster students' environmental knowledge and place-based connections. One example of this—a museum docent program in China—provided students with an opportunity to teach others about local culture, history, and environment. This process boosted the students' environmental knowledge, connection to place, self-efficacy, and other precursors to pro-environmental behavior. Although designing and implementing such a program may require more effort from the classroom teacher in terms of student training, supervision, and partner collaboration, the student benefits will be substantial.

Efird, R. (2015). Learning places and “little volunteers”: An assessment of place- and community-based education in China. *Environmental Education Research*, 21(8), 1143–1154.

## EXPANDING OUR UNDERSTANDING OF THE BENEFITS OF SCHOOL GARDENS

School gardens have rapidly risen in popularity within the sphere of environmental education because of their myriad benefits to health, environment, and the learning system more broadly. This is often because many school gardens are designed with an overall progressive approach to learning and, therefore, hold great potential as an alternative learning space. Many existing school-garden studies emphasize benefits related to health and education, as well as to the well-being of students. They highlight benefits related to teaching how food is cultivated, the way it affects our bodies, and the functions and impacts of agricultural systems on the environment. This study, however, expands on the prior literature using a lens that accentuates the reciprocity in encounters between human and nonhuman entities and forces. The authors use a new materialism approach as a framework for understanding how children’s experiences are shaped by—and help shape—the garden environment beyond the topic of food.

During a typical gardening class, children explore the space, observe biological processes, pick up objects, and build structures. The new materialism perspective describes all of those encounters as *intra-actions*, rather than interactions. The term *intra-actions* refers to the idea that two entities simultaneously influence each other when in contact and, as a result, those two entities become different versions of themselves. In other words, while humans are capable of altering animate and inanimate aspects of the natural world around them, they may, in turn, be transformed as well.

Using the new materialism approach as a guiding framework, this study examined the role of food gardens at three Australian primary schools with a demonstrated

commitment to sustainability education. The authors collected data from 53 children over four years. Data sources included the children’s own stories about their favorite locations within the garden, photographs of the garden, and maps of their ideas for the garden. The researchers also collected data through observing five gardening lessons at each of the schools. In the authors’ final report, they analyzed three photographs that depicted different activities in each of the three school gardens, and they paired those photographs with corresponding interviews describing the scene in question.

The three photographs portrayed children building a trellis out of bamboo, standing around the edge of a sunflower maze, and building a cubbyhole from broken branches around a tree trunk. Each scene provided an example of how both the human and nonhuman entities were changed by the process of *intra-action*. In the trellis example, the bamboo was physically modified when it was woven and lashed into a permanent structure. Through the *intra-active* encounter, the children were also changed as they learned about the properties of bamboo, the biological benefits of a trellis, related engineering principles, and how to work cooperatively. Similarly, the maze embodied the notion of reciprocity: the children distributed the sunflower seeds while the sunflowers taught the children about beauty and adventure. In the cubbyhole, the children transformed the branches from a lifeless form on the ground into an inventive structure. Because of the benefits of the natural world, the children were then able to use this place as a site for self-transformation through games and imagination.

Through these examples, the authors concluded that the nonhuman forces in the garden setting were influential factors in how children emerged from the experience. The authors concluded that *intra-action* with these entities can help children develop knowledge beyond a narrow scope of how humans benefit from food production; children can also develop a greater sense of connection with all living things through *intra-actions*. This perspective is a key piece in beginning to understand the ethics of sustainable living. The authors’ findings are significant because they show that

the educational rewards of school gardens reach beyond helping children develop an understanding of food and food systems. The mutual intra-action between children and the natural world can foster a vision of human and nonhuman entities co-existing sustainably.

### **THE BOTTOM LINE:**

School gardens are important sites not only for teaching about food and food systems, but also for expanding young people's understanding of the connection between human and nonhuman entities. Within those settings and using creative interactions such as storytelling, games, and imaginative play, young children can develop an intra-active relationship with gardens that helps them connect with human and nonhuman organisms. Developing this connection can help students become more aware of the relationship between the human and nonhuman worlds as well as understand and embrace the ethics of sustainable living.

Green, M., & Duhn, I. (2015). The force of gardening: Investigating children's learning in a food garden. *Australian Journal of Environmental Education*, 31(1), 60–73.

# PROFESSIONAL DEVELOPMENT

## IMPROVING PROFESSIONAL DEVELOPMENT FOR SCIENCE EDUCATORS

Science and environmental educators in the United States have faced increasing pressure to incorporate inquiry-based, hands-on, active science practices into their curricula since the Next Generation Science Standards were released in 2013. Many of those educators, however, are concerned that there are not enough professional development opportunities to help improve practices around around teaching science and engaging with the new standards. Professional development workshops, such as those conducted by Project Learning Tree (PLT), are one way to prepare teachers to address those new standards.

PLT provides curricula and resources for educators, parents, and local science and environmental education leaders. PLT offers workshops in a variety of formats, including one-day, multiday, and even semester-long programs. The workshops are often separated by audience to reflect the grade/age levels of the PLT curriculum, such as K–8 (kindergarten through eighth grade) and secondary (high school and community college).

This study focused on New York PLT (NYPLT) professional development workshops and addressed three primary research questions related to the following areas: understanding the relationship between workshop attendance and the educators' own work, identifying the most helpful elements of the workshops for educators, and understanding the barriers to implementing PLT curricula.

To address those research questions, the authors conducted two online surveys: one with NYPLT facilitators and one with educators who had participated in a PLT workshop in New York. Overall, 26 facilitators (21% response rate) responded to the first online survey and 94 educators (5% response rate) responded to the second survey; however, only 58 (61%) of the surveys were fully completed.



Within the set of completed educator surveys, the respondents hailed from a variety of teaching settings, including both informal and formal, and included classroom educators teaching at preschool through college levels. The majority of respondents indicated that they taught at the elementary-school level. Most of the participating informal educators reported that they worked for nonprofit organizations and included a variety of audiences in their programming.

In addition to the surveys, the authors conducted semi-structured interviews with the participating educators. The researchers coded the interview data and statistically analyzed those data to further explore the relationships between the amount of time that the participants spent implementing the curriculum and the type of workshops in which the educators had participated.

The researchers found that the types of workshops in which the respondents had participated in the past five years were similar to current workshop offerings. The most frequently attended workshop was a daylong workshop (between 4.5 and 6 hours in length) designed for pre-kindergarten through eighth-grade teachers. The next-most popular was the early childhood workshop (two to three hours in length), followed by workshops on the secondary modules (two to three hours in length). Respondents rarely reported participating in semester-long, pre-service programs.

The first research question investigated whether a relationship existed between the type of workshop in which an educator enrolled and the educator's frequency of use of the PLT curriculum. In response to this question, the researchers found a statistically significant relationship between participating in a secondary-module workshop and using the PLT curriculum regularly. Respondents who participated in the two- to three-hour workshop were more likely to use the PLT curriculum weekly or monthly. More than half of the educators reported incorporating PLT activities into their everyday work, either bi-annually, monthly, or more often.

The data collected to address the second research question, which inquired about what the participants found to be the most useful aspect of the workshop for teaching science and environmental education, indicated that the majority of participants found the hands-on activities that helped educators adapt activities to be the most beneficial part of the workshop. Furthermore, the participants reported that the workshop materials—such as the curriculum guides linked to standards, resource pages, links to websites, and technology—as well as the collaboration with NYPLT facilitators and educators were particularly beneficial aspects of the workshop.

Finally, the third research question asked about barriers to implementation in formal and informal education as well as how PLT might more effectively engage additional educators in using the PLT resources. Participants indicated that the primary barrier to implementing PLT curricula was the lack of time. They suggested that PLT might improve workshops by demonstrating how activities aligned with state and common core standards; in this way, the educators would feel that their time spent implementing PLT would address not only environmental education needs and interests, but also those of the state and common-core standards. The respondents suggested that PLT might assist in overcoming barriers by providing more resources (such as resource guides and materials) as well as follow-up support (such as information about upcoming PLT workshops) after the workshops.

The educators who participated in the two- to three-hour secondary module were the only ones who spent a greater amount of time using the curriculum in their work. Interestingly, only 2 out of 20 participants in the secondary module self-identified as high-school educators.

Overall, the researchers made the following recommendations based on their findings: (1) offer more and shorter workshops to address the time constraints that the educators described; (2) provide workshops that focus on a specific theme, with an accompanying curriculum guide relating solely to that theme; (3) offer a wider range of workshops specific to a variety of audiences, such as

workshops that address a specific grade level or mission of an organization; and (4) establish a professional learning community through online or in-person groups that form relationships with each other and the facilitator to provide and receive mentoring and sustained professional development. As PLT facilitators lack the time or resources to mentor each participant individually, those learning communities would create space and time for the educators to reflect collectively on the efficacy of implementing the PLT curriculum in their professional lives.

The authors also described the benefits of online professional development. Although educators noted that they preferred in-person workshops to online workshops, they also said that they would participate in online workshops depending on scheduling constraints. The authors suggested that PLT, as well as similar curriculum providers, might consider offering a hybrid of the two models (in person and online) by providing supplemental materials online to support the in-person training sessions. This format would allow PLT to distribute more materials easily and cost effectively and to reach a broader audience; this format would also serve as a workshop follow-up and sustained professional development.

### THE BOTTOM LINE:

In science and environmental education professional development workshops, providing mentors as well as peer networking for educator participants is a particularly effective strategy. This is especially true when working to reduce teacher attrition and create a shared professional-development community among educators. The authors recommend that science and environmental education professional development workshops be designed with a concise, theme-based, audience-specific structure. In addition, creating and nurturing professional learning communities that facilitate collaboration, networking, and mentoring, over time, can increase teacher learning through providing sustained professional development and helping time-strapped educators reach the recommended in-service training allotment. This also will connect teachers with their peers and mentors to increase teacher learning and create a strong educator community.

Velardi, S. H., Folta, E., Rickard, L., & Kuehn, D. (2015). The components of effective professional development for science educators: A case study with environmental education program Project Learning Tree. *Applied Environmental Education & Communication*, 14(4), 223–231.

## LEARNING TO BE LEADERS FOR CHANGE

For the past 30 years, interest in education for sustainability has been on the rise. Yet recent research in Australia indicates that pre-service teacher training institutions may be lagging in preparing teachers to educate for sustainability in school settings. This study's authors described their experience trialing a strategy, called the Mainstreaming Change Model, to enact system-wide improvements in teaching education for sustainability in two Australian provinces. The authors found that pre-service teacher educators in those provinces lacked leadership capacity and knowledge of change strategies; the authors argue that both of those must be developed to drive systemic change.

The Mainstreaming Change Model assumes that long-term sustained change is most likely to occur when all members of the pre-service teacher education system—including schools; pre-service teacher educators, staff, administrators, and students; unions; and government agencies—share the same goal. The model proposes three stages: first, mapping and understanding the relationships with the pre-service education systems; next, building a common vision among all stakeholders; and, finally, developing strategies to coordinate changes and monitor incremental improvement.

This paper simultaneously describes a project that built the profile of education for sustainability in Queensland and the Northern Territories, while also evaluating the effectiveness of the Mainstreaming Change Model. Baseline data suggested that, prior to the start of this initiative, 80% of Australian teachers were unaware of or did not understand the concept of “education for sustainability.”

By way of explaining the purpose of the project, the authors differentiate “education for sustainability” and “environmental education.” Environmental education, they explain, focuses on problem-solving and action-oriented goals in direct response to environmental issues, while education for sustainability emphasizes socio-economic and political dimensions of environmental problems. Although the authors focus their research on education for sustainability, they acknowledge the rich contribution of environmental education to this field.

This education-for-sustainability project and study occurred over 16 months. In the first four months, project leaders trained the participants (pre-service teacher educators) whom leaders had recruited for the study. Because participants were identified through existing education-for-sustainability networks, they already held field-level leadership positions. Over the next eight months, the authors tested the model and gathered data through baseline surveys and embedded assessments. Participants attended group workshops to learn about action research and systems approaches to change. Because it was difficult for participants who lived far away from each other to remain connected, each participant noted personal reflections in a learning journal. The participants then shared their reflections during community discussions via email, Skype, and/or Facebook.

The authors spent four months analyzing data from the various sources. They found the Mainstreaming Change Model to be moderately useful in generating changes in the two provinces studied. The authors observed that the participants had enhanced knowledge about and skills in education for sustainability; they also observed that the institutions had developed new positions and policies related to sustainability.

Despite those aspects of success, the research highlighted constraints to complete systemic change. Lack of content knowledge and leadership capacity, in particular, inhibited participants’ abilities to initiate and drive change. Those findings suggested that being an academic or professional with skills or expertise related to education

for sustainability did not necessarily mean that one would also be an effective leader of systems change. The authors argue that such leadership skills must be targeted and developed; they then proposed strategies to do so.

Drawing on their data, the authors suggest that, to be an effective change-related leader, pre-service teacher educators must have in-depth understanding of their organizations and build an adequate knowledge base about education for sustainability and systems change. Project leaders addressed participants’ knowledge gaps by providing resources, such as articles, guest-speaker workshops, and email or telephone support and advice. The leaders used an online forum to facilitate conceptual discussions around such topics as the differences and similarities between education for sustainability and environmental education. Participants and project leaders sought assistance and support from external consultants who were well-versed in change management.

Three main issues emerged related to leadership in the Mainstreaming Change model: participants’ willingness to initiate change, personal perceptions of leadership capacity, and ability to inspire others in the process. To overcome those issues, some participants strategically leveraged other individuals in positions of authority to gain credibility and generate enthusiasm for the change process. Ultimately, the authors found that holding a position of power was important for being an effective leader, but even more crucial for leadership effectiveness was for the individual to believe in his or her own ability to initiate and sustain change.

To create widespread change in large, complex organizations and successfully embed education for sustainability in the curriculum, the authors found that pre-service teacher educators must learn how to be leaders for change. The authors note that their findings are applicable in related fields such as environmental education. Refining leadership skills and developing new strategies for leading change will influence success in project implementation as well as in pre-service teacher education.

**THE BOTTOM LINE:**

To create lasting and meaningful change around education for sustainability, various aspects of the educational system must be engaged in and committed to the effort. Teachers can be leaders in these efforts but, in order to do so, they must be explicitly supported through capacity building and leadership development.

Ferreira, J., Ryan, L., & Davis, J. (2015). Developing knowledge and leadership in pre-service teacher education systems. *Australian Journal of Environmental Education*, 31(2), 194–207.

# OTHER RESEARCH

## UNDERSTANDING EXPECTATIONS OF ZOO VISITORS

Having prior knowledge of learner expectations can help educators design experiences in ways that meet visitors' needs. In the case of zoos, however, little is known about the intentions and expectations that visitors bring with them to a zoo visit; in other words, most educators know little about what visitors hope to learn and what experiences they expect to have. Therefore, this paper's authors investigated the relationship between zoo visitors' learning expectations and zoo staff members' perceptions of visitor learning agendas.

To that end, the authors explored three areas. First, the authors asked questions related to visitors' expectations. Specifically, they asked: Do zoo staff believe their visitors come with the expectation of learning? Relatedly, do visitors actually come to zoos with such expectations? Second, the authors investigated questions about learning agendas, specifically asking: What do staff members believe their visitors come to learn, and what methods do staff members use to evaluate visitors' motivations and learning agendas? Third, the authors compared the topics about which zoo visitors wanted to learn with the topics zoo staff believe are of interest to their visitors. The authors used interviews and surveys to address those questions.

The first phase of the study included a 62-item online questionnaire, which asked staff from 593 zoos in 72 countries to report on how they design, implement, and evaluate their formal and informal education programs. The questionnaires were completed by 172 zoos representing 48 countries, totaling a 29% response rate. Zoo employees, particularly education staff, completed these questionnaires, which asked employees what they thought visitors wanted to learn during their zoo experience. The study's second phase focused on nine individual zoo case studies, which included observations of and interviews with visitors and zoo educational staff. The case studies consisted of 28 staff member interviews across the nine sites, and 60 visitor interviews per site, for a total of 540 visitor interviews. The researchers asked zoo educational staff: "Do you think that general visitors come to your zoo with an expectation or hope of learning?" Concurrently, the researchers asked the



visitors about their primary motivation for visiting the zoo, what they hoped to learn, the importance of zoo activities, animal visibility and signage, their educational needs, and the day's highlights. The researchers analyzed the quantitative data to see if there were any significant differences between staff and visitor responses; the qualitative data were coded into response themes, focusing on trends and patterns.

Through the online questionnaire, the researchers found that 75% of zoo staff believed their visitors come to learn. By contrast, during the in-person zoo staff interviews, only 39% of the zoo staff members indicated that they believed their visitors came to the zoo to learn. From the in-person zoo visitor interviews, interestingly, the researchers found that the majority (72%) of visitors indicated that learning or discovery were among their main motivations for visiting the zoo. The online responses regarding visitor learning by the zoo staff members were similar to the in-person responses of the actual zoo visitors. The results, however, indicate a mismatch in the zoo staff perceptions expressed through the online questionnaires and in-person interviews. In two cases, the same staff members responded differently on the questionnaires than they did in person. The authors suggest that this difference in responses may be due to the tendency to provide more conservative responses in person than on an online survey, which may feel less personal. The authors suggest the "true" response may lie somewhere between the two.

The study found that of the 72% of visitors who indicated that they came to the zoos to learn, the largest proportion of them went specifically to see animals. Those visitors described their interest using terms such as seeing "new," "unusual," "exotic," or "live" animals. According to the zoo surveys, 90% of zoo staff members reported that their visitors' top learning goals were animal biology and ecology, which the authors suggest may reflect similar, or at least compatible, learning priorities. Although the authors categorized 25% of the visitors as having an indeterminable learning agenda,

only 3% of visitors reported that they did not have any kind of learning agenda at all.

When considering the evaluation methods that zoos use to assess their visitors' learning preferences, the authors found that, on average, more than half of the zoos (58%) used primarily informal measures, such as casual feedback, observations, and anecdotes. On average, 41% of zoos used primarily formal strategies such as questionnaires, surveys, and interviews. Only approximately 15% of the zoos used both informal and formal measures.

The authors concluded that, based on the zoo questionnaires and the visitor interviews, the zoos seem to have an accurate understanding of their visitors' learning agendas. The authors further conclude that the zoos would benefit from using formal evaluation methods for enhanced accuracy when assessing their visitors' needs and learning agendas.

### **THE BOTTOM LINE:**

Zoos provide an important context for raising awareness of and motivating action related to environmental issues. By analyzing visitor and staff perceptions of what visitors hope to gain from zoos, the researchers expanded on current understandings of learning-related expectations of visitors and staff. The findings indicate that, not only do most zoo visitors come with a learning agenda, but they also prefer to see and learn about animals. As such, zoo learning experiences focused on the animals on display and ensuring that visitors are all able to see the animals would engage visitors and also support their learning agendas. Addressing visitor goals, expectations, and experiences when designing exhibits and developing interpretation will help zoos better support conservation and sustainability efforts.

Roe, K. & McConney, A. (2015). Do zoo visitors come to learn? An internationally comparative, mixed-methods study. *Environmental Education Research*, 2(6), 865–884.

## INCREASING DIVERSITY IN THE NATURAL-RESOURCE FIELD

There are numerous complex reasons that individuals from non-White racial and ethnic minority backgrounds traditionally have been underrepresented in natural resource-related fields. Previous research has suggested that common reasons may include lack of exposure to the outdoors, lack of knowledge about the field, and lack of academic support, among others. With the intention of helping academic institutions and nonprofit organizations enhance their support of minority students entering careers in these areas, this study focused on two of those reasons: barriers to and perceptions of careers in the field. This study also focused on minority students' motivations for entering careers in natural resources.

The researchers worked with college-aged students majoring in natural resources and liberal arts, and they compared the students' perceptions and career motivations related to careers in natural resources. The researchers framed the study around three research questions: what factors motivated career choice among both groups of undergraduates; what barriers to natural-resource career paths affected students, particularly minorities; and what perceptions both groups of students hold related to those careers.

As a framework to guide a two-phase study, the authors used social cognitive career theory, which proposes that self-efficacy and outcome expectations influence career interests. The study's first phase included structured and semi-structured interviews. The second phase included focus group discussions with questions about career motivations and barriers; those questions emerged from the interviews. The authors focused on the most commonly mentioned motivations and barriers during each of the focus groups.

The focus group activities included individual reflection time, a ranking exercise, and an open discussion. With the ranking exercise, the researchers sought patterns that provided insight into the group's perceptions of

natural-resource careers. The students ranked, in order of importance, barrier and motivation statement cards. With this process and using Q methodology and factor analysis to assess the students' responses, the authors identified the most influential motivations and barriers.

To address the first research question about factors motivating career choice for natural-resource majors and liberal-arts majors, the authors found that all of the natural-resource students recalled having positive outdoor experiences as children. Influential adults and media were the biggest motivators for careers in natural resources. The authors used factor analysis to categorize the students' motivations for a natural-resource-related career into five factors, or groupings. Each factor represented groups of individuals with a shared perspective: experience with environmental problems and outdoor recreation; family vacations and nature/science media; jobs and research experience; influential teachers and museums or nature centers; and concern for the environment. The authors found no patterns within students' race or gender that influenced the categorization of the five factors.

The second question explored the barriers for students—particularly minority students—pursuing natural-resource careers. In the interviews, natural-resource majors were most likely to indicate that school difficulty and family pressure created barriers for them; liberal-arts majors most often mentioned outsider perceptions and school difficulty. Minorities in both majors cited family pressure to follow traditional career paths as an important barrier. Using factor analysis, the authors categorized the focus group barrier statements into six factor groups: financial issues; ethnic and racial issues; self-confidence and gender issues; lack of knowledge about career opportunities; money problems; and lack of role models. Again, the researchers did not identify any race or gender patterns among responses.

Finally, the authors addressed the perceptions of students from both majors regarding natural-resource careers. The authors found that students from both majors perceived

natural-resource careers as being exotic, involving a lot of travel, and providing a low salary/pay structure. Although natural-resource majors felt that they would make a positive impact on the world, they also had a sense that careers in the field were prone to stereotyping and lacked perceived societal value. Liberal-arts majors viewed natural resource-related careers as dangerous, rare, and more of a hobby than a career.

Based on the researchers' findings, and similar to past studies, the authors suggest that a relationship exists between spending time outdoors and the likelihood of pursuing a career in natural resources. The authors also suggest that environmental education experiences that encourage outdoor exploration and solidify family values can influence future career choices. The findings regarding barriers to natural resource-related careers echo prior research: a lack of family support, as well as discrimination and stereotypes, are particularly important barriers for minority students entering science, technology, engineering, and mathematics (STEM) or related fields, such as natural resources. Additionally, the respondents also reported a lack of confidence as a salient barrier.

### **THE BOTTOM LINE:**

By identifying the motivations and barriers that influence career choices of students—especially those from traditionally underrepresented backgrounds—in pursuing natural-resource careers, the authors suggest that environmental education provides many opportunities for encouraging, developing, and supporting interest in those careers for youth. The authors recommend that environmental educators focus on creating positive natural resource-related experiences for diverse groups of children and families. They also suggest that further research is needed to evaluate the effects of such programs on individuals' career goals and choices.

Haynes, N. A., & Jacobson, S. (2015). Barriers and perceptions of natural resource careers by minority students. *Journal of Environmental Education*, 46(3), 166–182.

## **SUPPORTING DIVERSE STUDENTS' ENVIRONMENTAL SCIENCE IDENTITIES**

Youth from non-dominant groups—whether racial and/or ethnic groups, or others—often face identity-related barriers to participating in nature-based activities and science practices. Shared notions of “outdoorsy people” and “scientists,” for example, may be at odds with some people's sense of self and the ways their identities are expressed in the place they live, what they do, and with whom they associate. Identity-based obstacles can pose a serious challenge, then, if environmental educators desire for all young people to understand and care about biodiversity.

From a social justice perspective, such obstacles are compounded by the fact that youth from non-dominant groups are more likely to grow up in communities impacted by environmental hazards. This paper's authors investigate how an environmental program's norms, practices, and tools might support environmental science identity development among youth, with a particular emphasis on those from areas where environmental hazards are paramount.

In 2011, the authors examined a high-school summer enrichment program focused on herpetology, or the study of reptiles and amphibians. Called the Herpetology Research Experience (HRE), the program was offered as a summer elective as part of a year-round college access initiative for high-school students with great financial need or no family history of college attendance. Students attended the four-week program for two hours per day, four days per week. Of the 16 HRE enrollees,

nine identified as female and seven as male; and 38% indicated their racial/ethnic background as Black/African American, 31% as White (non-Hispanic/Latino), 25% as Hispanic/Latino, and 6% as Native American. The program primarily consisted of working alongside field scientists to collect and analyze data on the activities of reptiles and amphibians living in the local area.

The researchers used ethnographic methods, including observing and writing field notes, as well as recording audio and video of the program activities. They also conducted 45-minute interviews with 15 of the 16 participants at the end of the program. As the authors analyzed their notes and recordings, an emergent pattern of instances in which the youth were working through fearful emotions struck the authors. Many of those instances related to the students' reluctance to interact with or handle the animals. The HRE program put students in situations that many had never encountered before, pushing the boundaries of their sense of self. As a result, the authors called those moments when students were out of their comfort zones instances of "identity boundary work."

Since the authors saw those moments as potentially productive for aligning students' identities with the identities of environmentalists or scientists, the authors analyzed the moments to determine what program elements seemed to help the students as they worked through their discomfort. The authors identified the following important factors: boundary objects, time and space, social supports, collective agency, and knowledge.

By "boundary objects," the authors refer to physical tools that helped students try new activities and move out of their comfort zones. The use of waders, for example, helped students overcome their fear of entering the water, which represented an important hurdle to overcome in order to take snapping-turtle measurements. Using cameras to record data also helped some students get closer to the animals, as they were able to focus more on getting a good photograph than how afraid they initially were to approach the wildlife.

"Time and space" refers to the flexible and responsive way in which the program allowed students to gradually increase their participation as they gained confidence. This aspect of the program, which contrasted with schools' traditionally strict schedules and calendars, was crucial for students grappling with new ideas of themselves and what they could accomplish.

As the students worked through new experiences, their social relationships also proved important. In the face of challenges, the youth cheered for each other, and more adventurous students modeled research activities for their peers. The students cared what others thought of them, and collaborating on activities made new things possible with which individuals would have struggled had they worked on their own.

Finally, the researchers found scientific and anecdotal knowledge to be important. As the students gained understandings of the animals' physiology and behavior, they better understood how to interact with those animals in safe ways. Some students also reported learning, for the first time, that frogs do not, in fact, give humans warts. In those ways, knowledge contributed to the students' willingness to push beyond their normal behaviors and concepts of self. The "field stories" told by program scientists further supported the students' growing sense of a community of field ecologists with shared experiences. By the end of the program, the students told their own field stories on bus rides returning from the field, signaling their early feelings of belonging to that community.

Although the program was relatively short and, therefore, the identity boundary work seen in the study may not necessarily be indicative of permanent shifts in the students' identities, the paper suggests several qualities of environmental education programs that could be promising. Those qualities include the use of boundary objects, the cultural norms of social support, flexible timing and space, and scientific and informal knowledge.

### THE BOTTOM LINE:

Students from non-dominant groups may face significant identity-related challenges to participating in environmental education and ecological science-focused programs. It has become commonplace to assume that such students will learn most effectively when educational offerings are made “culturally relevant” to them. Allowing some fear and discomfort, however, may be productive for learning if handled in an empathetic and caring manner. Educational program designers might consider how physical tools, social supports, flexible timing that allows for gradually increasing participation, and forms of scientific and informal knowledge may help learners overcome trepidation and stretch their self-identities.

Carlone, H. B., Huffling, L. D., Tomasek, T., Hegedus, T. A., Matthews, C. E., Allen, M. H., & Ash, M. C. (2015). “Unthinkable” selves: Identity boundary work in a summer field ecology enrichment program for diverse youth. *International Journal of Science Education*, 37(10), 1524–1546.

### JOINT ATTENTION: FAMILY LEARNING TALK IN MUSEUMS

Museums facilitate free-choice learning experiences or self-guided exploration driven by one’s own curiosity. The self-directed nature of these settings allows visitors to follow their own interests, build on past experiences, engage in personalized meaning-making, and create both individual as well as social learning experiences that are tailored to one’s own motivations. Yet, within these self-directed contexts, multiple objects often compete for attention, resulting in a splintered focus. This can detract from what research has demonstrated are the benefits of joint attention, which occurs when people focus on the same object or subject in their surroundings. Psychologists have found that joint attention represents a critical component of language development and communication learning for infants and children, in particular.

Little research exists, however, addressing the role that joint attention plays in supporting “family learning talk” in museums. Therefore, this study’s authors examined parent-child dyads (pairs) to understand better whether and how increased joint attention may lead to more family learning talk and, subsequently, enhanced learning. Through observations, voice recordings, and interviews, the authors asked: To what degree do families notice objects and establish joint attention while controlling for time spent? And once families engage in joint attention, do they engage in learning talk about the objects?

The authors describe family learning talk as conversation that surpasses simple naming and pointing out of objects; rather, learning talk occurs when family members make connections, comparisons, and explanations, or when they connect the object in question to previous experiences. To better understand family learning talk and learning within museums, the authors worked at the Carnegie Natural History Museum in Pittsburgh, Pennsylvania, where they designed two interventions on joint attention in seven natural history diorama displays featuring fish and birds. The authors approached 54 parent-child dyads who were new to the museum; those dyads were invited to participate in the study. All of the children in the dyads were between the ages of 5 and 8.

The researchers divided the families into four equal-sized groups. For the first intervention, the authors asked 25% of the families to view the dioramas in a dark room using a flashlight, which the child controlled. They asked another 25% of the family sample to view the dioramas in a fully lit room. The researchers intended for the flashlight to enable the child to indicate clearly which object she or he was viewing; in this way, the flashlight facilitated joint attention between the child and parent.

The second intervention involved 25% of the families viewing the dioramas with signage prompts designed to promote deeper engagement with the objects. The final 25% of the families viewed the dioramas without any prompts.

Each of the participant dyads entered the diorama exhibits one at a time with a researcher. The researchers observed the families' interactions and audio recorded their conversations. The researchers also conducted a post-exhibit interview with some of the dyads. To analyze the data, the researchers coded the recordings for aspects such as noticing, joint attention, and learning talk. In addition, the researchers conducted a two-way analysis of variance (ANOVA) for the three categories for both interventions.

To examine the correlation of joint attention with family learning talk, the authors coded the recorded transcripts to whether the learning talk came before, after, or did not coincide with instances of joint attention. The researchers found that 71% of learning talk followed an instance of joint attention. By analyzing the family talk and joint attention in the self-illuminated and control groups, the researchers found that joint attention can enable learning talk, but that it may not be the only factor that enables learning talk. Finally, to understand the impact of the self-illuminated intervention, the authors conducted a stepwise regression, which indicated that the self-illuminated intervention was successful in increasing learning talk through joint attention.

Overall, the authors found that creating an exhibition where the child visitor illuminates the dioramas with a flashlight is a direct way to increase joint attention and, as a result, enhance family learning talk. Contrary to the authors' initial hypothesis, the signage prompts did not have the same effect. This perhaps may be attributed to an overload of information given the number of prompts provided and the reading required. Although this study is limited by the sample size and does not include pre- and post-treatment measures, the results may be relevant for designing museum exhibits and other similar programs that facilitate learning.

### **THE BOTTOM LINE:**

Museum settings have the potential benefit of encouraging joint attention and promoting family learning talk, with the outcome of deeper learning and engagement for visitors. Yet object-based museums may find it more difficult than interactive museums to establish and facilitate those joint attentional processes; as such, using mechanisms such as a darkened exhibition and a flashlight to narrow the field of focus may help visitors engage in joint attention and promote family learning talk. In those and other ways, museums can encourage family learning talk and facilitate deeper learning.

Povis, K. T., & Crowley, K. (2015). Family learning in object-based museums: The role of joint attention. *Visitor Studies*, 18(2), 168–182.