RESEARCH BULLETIN

ABOUT THE RESEARCH BULLETIN

The *Environmental Education Research Bulletin* is a project of ChangeScale and ee360, a cooperative project of the U.S. EPA and the North American Association for Environmental Education (NAAEE), and 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 *Research Bulletin*, as well as past issues, is available online through the ChangeScale website, www.changescale.org, as well as on the NAAEE website at https://naaee.org/eepro/research/eerb. Please send questions and feedback to eeresearchbulletins@changescale.org.

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INTRODUCTION

Dear Colleagues,

ChangeScale and the North American Association for Environmental Education (NAAEE) have collaborated with researchers at Stanford University to create this 12th issue of the *Environmental Education Research Bulletin*. Talented environmental educators are conducting high-quality 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 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 bridge research and practice by summarizing recently reported research and helping practitioners use findings 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 2016) of a number of environmental education-related journals, including *The Journal of Environmental Education, Environmental Education Research, Applied Environmental Education & Communication, Australian Journal of Environmental Education, Journal of Experiential Education, Science Education, Journal of Interpretation Research, Journal of Environmental Psychology,* 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: eeresearchbulletins@changescale.org.

We encourage you to check out and contribute to the research blog on eePRO, NAAEE's professional development community. To join the eePRO community section devoted to research and evaluation, visit: https://naaee.org/eepro/groups/research-and-evaluation. You may also be interested in the NSF-funded Relating Research to Practice resource, a joint effort of the Exploratorium, the University of Washington, King's College London, and the Afterschool Alliance. The website is available at: http://relatingresearchtopractice.org/.

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

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EQUITY AND INCLUSION IN ENVIRONMENTAL EDUCATION

ADDRESSING ENVIRONMENTAL JUSTICE IN HIGHER EDUCATION DEGREE PROGRAMS

Interdisciplinary does not mean equi-disciplinary. Yet, interdisciplinary environmental and sustainability (IES) studies in colleges and universities are often seen as an opportunity to address elements of environmental education's past, which has been exclusionary at times. Because of time-and-resource limitations, curriculum construction in any area of study entails active decision-making of what to include. At the same time, this involves consideration of what and who the curriculum leaves out. The exclusionary practices are often unconscious, but they become particularly important when curriculum designers and educators leave content areas such as environmental justice (EJ) out of the IES curricula. Pinpointing exactly what influences whether EJ appears in IES curricula remains difficult, however.

In this study, the authors attempt to analyze institutional and program-level factors contributing to the inclusion of EJ themes and content in IES curricula. This study's authors consulted two major information sources from the National Center for Education Statistics (NCES) to construct and test their hypotheses. The survey data, collected from 297 IES degree programs in 179 higher education institutions, asked IES program leaders to discuss program structures, partnerships, curriculum design processes, and program leadership and faculty. The researchers considered an EJ emphasis in the curriculum to be representative of the personal importance of the topic to survey participants as representative of its perceived value.

The researchers juxtaposed these findings with institutional and student characteristics such as diversity at both the institution and program-level, definitions of educational goals, and instructional values and attitudes. Additionally, the researchers analyzed responses regarding an ideal IES curriculum based on content and skill building.

The researchers found that 54% of the IES programs analyzed were considered science, technology, or engineering-based; 29% were at the graduate-level; 30% showed increasing enrollment of students of color; and 45% were in private institutions. With respect to the relationship between the importance and the actual inclusion of EJ, researchers found that the level of importance placed on EJ in a curriculum generally matched the level of emphasis placed on EJ in the degree program's actual content. Of the IES programs examined that indicated the high value of EJ, however, only 58.5% strongly emphasized EJ in their actual curriculum. The authors suggest that lack of resources, as well as lack of autonomy with regard to curricular design, might explain this disconnection.

Because communities of color and low-income communities are core to the EJ movement, this study considered whether student demographics factored into the inclusion of EJ in IES curricula. The researchers found that increasing numbers of enrolled students of color do not appear to influence higher values toward EJ in an IES curriculum. However, IES degree programs that showed increasing numbers of enrolled students of color indicated a significantly higher emphasis placed on EJ in the actual curriculum.

The educational goals of IES degree programs and prioritization of certain disciplines over others also returned interesting results. This study showed that IES degree programs that valued business or economic sustainability, ecology, and statistics had less emphasis on EJ in the actual curriculum. By contrast, those that emphasized social sustainability had more emphasis on EJ in the curriculum. The study found that IES degree programs in science, technology, or engineering fields exhibited significantly lower levels of importance on EJ in a curriculum and did not influence the inclusion of EJ in the actual curriculum. Programs in social sustainability, history, and normative thinking skills exhibited higher levels of emphasis on EJ.

The authors recognize that these results do not show whether IES degree programs fully integrate EJ content. They, therefore, call for deeper exploration of these topics, perhaps using qualitative approaches.

THE BOTTOM LINE:

Many factors, including educational goals and student demographics, influence the value placed on environmental justice (EJ) content in interdisciplinary and environmental sustainability degree programs. Identifying, focusing on, and working to address those factors can provide a more positive pathway toward increasing an EJ emphasis within the actual college or university curricula. Various forms of direct action, including hiring EJ-focused faculty, creating awareness of EJ issues, supporting EJ-focused research methods, protecting EJ researchers from industry retaliation, and defending EJ curricular content to normalize its value and integration across IES degree programs, may assist with overcoming the barriers to integrating EJ in higher education environment-and-sustainability programs.

Garibay, J. C., Ong, P., & Vincent, S. (2016). Program and institutional predictors of environmental justice inclusion in U.S. post-secondary environmental and sustainability curricula. *Environmental Education Research*, 22(7), 919–942.

BEHAVIOR

BECOME A COYOTE NINJA USING EXPERIENTIAL EDUCATION

Expanding human populations and sprawling urban areas are increasing human–wildlife interactions. When human–wildlife populations overlap, discussions around coexistence become more important—and yet potentially more difficult, especially with species that are perceived to be threatening, such as bears, wolves, and coyotes. To mitigate conflict and enhance public safety, coexistence requires an educated and engaged public. Typically, environmental and conservation educators and interpreters present wildlife education in a passive manner, such as through presentations, pamphlets, and signage. Yet, research has demonstrated that this type of knowledge dissemination alone rarely changes people's attitudes or behaviors. More recently, research based on learning and behavioral sciences has found that educators and interpreters can improve wildlife education programs by using more engaging experiential tactics, which provide an interactive foundation for understanding knowledge acquisition, formation, and retention.

To further investigate the link between experiential learning and wildlife education, this study's authors created a coyote education program to target attitudes, risk perceptions, and preventative measures toward coming into contact with coyotes. They conducted the program, *Sharing Space: Living with Coyotes*, in Cape Breton Highlands National Park in Nova Scotia, Canada, where a coyote caused a human fatality in 2009. This event caused more negative attitudes and fear among local residents. The authors tested the effectiveness of the program by measuring changes in participants pre- and post-attitudes and emotions toward interactions with coyotes.

The program's creators designed it around the experiential learning framework. Specifically, the framework's focus is on engaging participants in a challenging situation where an educator facilitates learning experiences and the participant(s) work through and process the experiences individually or in groups. The experiential learning process includes stages of experience, reflection, generalization, and application, while incorporating elements of

thinking, feeling, perceiving, and behaving. All of these occur while connecting the learner to the task, activity, and location.

Sharing Space: Living with Coyotes had five modules, each of which use the experiential learning cycle: (1) understanding personal attitudes, (2) perceived and actual risk of human–coyote interactions, (3) being a coyote, (4) stop being a coyote yard sale, and (5) becoming a coyote ninja. The *becoming a coyote ninja* activity, for example, gets participants to physically practice the appropriate behaviors they should take in response to different types of coyote interactions, such as sightings versus attacks. The opportunity to physically embody and practice moves helped participants understand the actions and embrace the power they possess to defend themselves. The group work, reflection, sharing, and question-asking forum, as well as interactive and physical activities, created a memorable platform that supports retention.

The researchers used an immediate pre-, immediate post-, and a one-year delayed post-questionnaire to test for changes in participants' attitudes toward coyotes and risk perceptions. They defined risk perceptions as fear of, control over, and the likelihood of coming into contact with coyotes.

In fall 2013, Cape Breton Highlands National Park advertised the program on the local radio station, through posters around town, and through social media. Park rangers conducted the program 20 times over 5 weeks. In that time, 150 participants completed the program, with an average class size between 6 and 10 people. Attendees represented the general gender and age demographics of the area, with 66% of the participants being female and the age range being between 18 and 65 years old.

The researchers found that overall, the *Sharing Space: Living with Coyotes* program created a significant positive effect on people's attitudes toward coyotes, decreasing their fear of coyotes as well as the sense of the likelihood of coming into contact with coyotes. If they were to potentially come into contact with a coyote, the participants had a significant increase in their sense of control over that interaction. Initial data analysis suggests that, one year later, those changes remained. Despite the statistically significant changes in these four outcomes, the mean differences showed only a small change in response from one concept to the next (such as, for example, from slightly agree to moderately agree) between pre- and post-test.

THE BOTTOM LINE:
Wildlife education often targets issues related to human–wildlife conflicts, with the intention of affecting people's attitudes and behaviors toward wildlife. Yet, those educational programs are minimally effective when designed based on an information-transmission model. Using experiential education approaches can significantly enhance participants' attitudes, values, knowledge, concerns, and potentially even their behaviors toward wildlife. In particular, designing interventions and outcomes that focus on an audience's specific needs can increase positive attitudes and decrease fear toward species that residents consider potentially harmful. Targeted experiential education provides useful tools and tangible takeaways for participants; such tools can be effective for a range of age groups to create engaging, positive, and lasting wildlife–human-related learning opportunities.

Sponarski, C. C., Vaske, J. J., Bath, A. J., & Loeffler, T. A. (2016). Changing attitudes and emotions toward coyotes with experiential education. *The Journal of Environmental Education*, 47(4), 296–306.

INCREASING YOUNG ADULT ENVIRONMENTAL AWARENESS FOR MARINE SUSTAINABILITY

The history of marine environmental stewardship and ocean access in Taiwan has been fraught over the past century. From 1945 to 1987, the Taiwanese government largely banned civilians from Taiwan's coast, which primarily was reserved for military activity.

Those restrictions, which impeded its citizens' personal interactions with coastal and marine resources, negatively impacted the public's relationship with the ocean. Because of this, the public has had little understanding of and demonstrated low levels of concern about marine sustainability.

Within this context, this study's authors set out to explore Taiwanese university students' perceptions of and interactions with the ocean. The researchers sought to understand how university students, as future environmental decision-makers, view the ocean, one of the country's most important natural resources. Notably, university students have largely grown up in a more liberal era than older Taiwanese citizens: in 1987, martial law ended and, by 2000, the new Democratic Progressive Party began implementing more environmentally conscious marine development and protection policies. Despite those changes, the island still faces significant challenges from coastal energy use and infrastructure development. The authors posit that these challenges will require problem solving and leadership informed by educated perspectives.

To explore how current university students think about marine resources, environmental stewardship, and ocean sustainability, the authors administered a structured questionnaire to 1,000 students across Taiwan. Of those students, 500 completed the survey online, and 500 completed it in person. From those, 825 of the surveys included valid responses related to three core areas: environmental attitudes, marine knowledge, and environmental behavior.

To assess environmental attitudes, researchers modified the New Environmental Paradigm to reflect marine issues and students' concerns with intergenerational equality. To assess marine knowledge, the authors developed 18 items inspired by leading experts in the field of marine sustainability augmented with information found on government environmental agencies' websites. Finally, to consider behavior, the questionnaire addressed five categories of action: persuasion, consumer action, ecological management, political action, and legal action.

The questionnaires recorded Likert scale responses to measure students' attitudes, knowledge, and behavior. The study found that students generally had positive attitudes toward the environment, with females scoring higher than males. The students reported having a moderate level of marine environmental knowledge, and those who had completed marine-related courses or participated in marine recreational or conservation activities had higher levels of marine knowledge. With regard to specific activities and topics, the students were particularly unfamiliar with ocean acidification and exclusive economic zones. The topic of environmental behavior received the lowest mean scores overall, with scores differing significantly between those who took marine courses or participated in marine conservation and recreation and those who did not.

Ultimately, similar to prior studies, the findings suggest that environmental behavior correlates with attitude and knowledge. The authors argue that the gap between positive environmental attitudes with moderate marine knowledge and little marine or environmental action must be filled by linking environmental concern with better avenues for environmental behavior. They further suggest that students with greater marine knowledge and engagement in marine activities may be able to increase their overall marine environmental awareness.

The authors recommend that universities increase the availability of marine-related activities, clubs, courses, and events in safe, easily accessible settings. They cite safety concerns as a major barrier to many respondents' physical engagement with the ocean, which is a key component of participation in marine activities. Another area for improving marine environmental engagement and awareness is to provide more opportunities for learning about legal- and policy-related dimensions of environmental health. The authors point to a need for further research on how learning about political and legal action could lead to a sense of environmental responsibility and, in turn, to environmental behaviors.

Given Taiwan's rather fraught marine history, this study helps illuminate the country's needs with respect to

improving human–environmental interactions in and around the coastal zone and ocean. By improving access to learning and engagement opportunities, the authors suggest that universities could play a key role in filling the gap between environmental concern and environmental action.

THE BOTTOM LINE:

In places like Taiwan, where university students, who are future leaders, may not traditionally have had an opportunity to build their knowledge and skills related to the coastal and marine environment issues, universities should consider providing opportunities for and lowering barriers to entry in marine-related education and activities. Doing so through coursework on a range of dimensions, including law and policy as well as marine science and ethics, increases the likelihood that university students will be well-educated in the coastal and marine zones, and related issues, and through the course of those educational experiences, given opportunities to engage with issues through legal, political, conservation, and lifestyle avenues. Such heightened knowledge and active engagement are critical to long-term marine environmental health.

Chen, C. L., & Tsai, C. H. (2016). Marine environmental awareness among university students in Taiwan: A potential signal for sustainability of the oceans. *Environmental Education Research, 22*(7), 958–977.

COMMUNITY YOUTH GROUP PARTNERSHIPS MEET MULTIPLE GOALS

Many environmental educators know firsthand how valuable youth participation in community action projects can be in terms of developing leadership skills, such as environmental problem solving, effective communication, and group process. However, to design and implement such a project successfully, educators may need assistance and support. Program staff might talk with community members to co-design an activity such as a neighborhood cleanup, but the environmental education staff may not know how to approach a youth organization or why young people might be interested in these activities. Individuals who can bridge institutions, expectations, and needs can link youth, community organizations, and agencies in productive partnerships to improve the community and build youth action competence.

Using the context of wildland fire, a team of researchers explored seven U.S.-based case studies of wildfire education programs for youth. They purposely chose programs that were as different as possible, as long as they met the initial criterion: educators actively working with youth in the community to reduce the risk of wildland fires.

The selected cases included:

1. An after-school opportunity for middle-school-aged youth to build leadership skills by forming a Firewise Committee for their community and sponsoring education and clean-up projects with the local fire department, the state forest agency, and Keep Texas Beautiful.
2. A summer field school for high-school students to collect and interpret data about fire risk and vegetation for agency and community leaders for college credits, with Bureau of Land Management and local municipalities.
3. A Girl Scout Firewise badge enabling youth to understand how to reduce the risk of fire in the wildland–urban interface and communicate information to adults, with Florida Forest Service and local fire departments.
4. High-school geography teachers using a unit developed by the Minnesota Department of Natural Resources and engaging youth in mapping the risk of wildfire and sharing information with homeowners.
5. A coalition of environmental education organizations offering field trip opportunities around Lake Tahoe to involve youth in planting trees to reduce erosion or remove vegetation to reduce the risk of wildfire, with U.S. Forest Service and local teachers.
6. A high school in West Virginia that adapted the Minnesota curriculum to engage at-risk youth with

a homeowner association to assess and communicate risk in a hillside subdivision, with West Virginia Division of Forestry.

7. A county fire-safe council educational unit for sixth-grade teachers to increase awareness of wildfire risk, plan for evacuations, and help improve their ability to withstand a fire, with CalFire and U.S. Forest Service.

Researchers visited each program site and interviewed people associated with each of these programs, such as agency staff, educators, community members, volunteer firefighters, and youth. In the 81 interviews, the researchers asked questions about the programs, the processes that led to the programs' development, and the recorded outcomes, thus far.

The researchers recorded and transcribed the interviews, then analyzed the data to identify themes and patterns. They found several themes about the ways in which the educators and other program planners/managers developed the initiatives that might enable others to have similar success.

In the successful programs, the key partners formed collaborations to create opportunities for youth to work in their communities. Most programs engaged staff from state or federal agencies, local fire or emergency responders, and environmental organizations to work alongside an educational or youth-group partner. Individuals often initiated those opportunities because that person spanned multiple organizations or perspectives. Sometimes, for example, a family connection brought organizations together, while other times someone with a vision and strong community connections found people who shared a common goal.

Each partner involved was able to meet their own needs—a factor that was core to effective partnerships. Agency members did not merely offer a field trip or guest lecture; rather, they prepared the youth to convey their message, reduce community risk, or collect needed data. Educators and parents perceived these to be equal partnerships where the youth developed leadership skills, gained public-speaking experience, and realized the benefits of community service. The youth saw these programs as ways to implement the concepts and ideas they learned in the classroom into the world; through the projects, the students' actions could reduce the threat of a wildfire or even save lives.

Maintaining the programs was a challenge for partners. Since local partnerships were at the core of all of the programs, they required equal amounts of goodwill, perceived need, and community connections. The partnerships were at risk if an individual champion moved to a new challenge. In some cases, agencies institutionalized the program and were committed to providing funding, but needed new leaders to do the work. Some programs were in the process of expanding beyond their community boundaries. This expansion was easy when other individuals were identified who could see the value of the partnership, but was challenging when connections to "boundary workers" were not readily available.

Findings from these case studies offer insights for building community support for youth actions that lead to community resilience and are applicable to contexts beyond wildfire, including disaster recovery, water-quality enhancement, or ecosystem restoration. Although youth age was not particularly relevant, leadership opportunities were better suited to youth over age 12. The dearth of programs like these suggest, however, that boundary workers and champions may be in short supply. If university courses could help pre-service teachers learn about the needs and perspectives of regional, state, and federal agencies, and if natural resources students learned how action projects could enhance youth development, more people might see opportunities to meet multiple goals through youth–community partnerships.

THE BOTTOM LINE:
Partnerships among environmental agencies, community organizations, and environmental educators can support programs that enable youth to engage in authentic, meaningful, community projects that build skills and

improve the environment. Partnerships are more likely to thrive when projects are designed for all partners to attain their goals and when topics are broadly seen as working in the community's best interest. Such partnerships require recognition of an important issue; authentic opportunities for youth involvement; respect and benefits for each group involved in the partnership; and development of social capital norms.

Monroe, M. C., Ballard, H. L., Oxarart, A., Sturtevant, V. E., Jakes, P. J., & Evans, E. R. (2016). Agencies, educators, communities and wildfire: Partnerships to enhance environmental education for youth. *Environmental Education Research*, 22(8), 1098–1114.

TURNING ENVIRONMENTAL KNOWLEDGE INTO ENVIRONMENTAL ACTION

Knowledge, attitudes, and behavior form the trifecta of environmental education (EE) outcomes, yet research repeatedly demonstrates that the three are not linear and do not necessarily lead to one another. In some situations, teaching-and-learning approaches, such as community-engaged and/or place-based experiences, allow students to align knowledge and attitudes in a way that their behavior with community groups provides an avenue to practice and deepen the related behaviors.

This article's authors taught an undergraduate course at the University of Wisconsin-Eau Claire (UWEC). In the course, assignments helped translate students' environmental knowledge into action-oriented community outreach projects that educated wider audiences. The authors co-taught the course, focusing the curriculum on sustainability and the environment. The class had 18 UWEC students, and their primary project was to devise a "Pedal and Paddle Pollution Tour" of the Lower Chippewa River State Natural Area (LCRSNA), a main natural feature of the campus and surrounding city. According to the authors, the students came from a wide array of disciplinary backgrounds and worked either individually or in groups to develop the tours.

In forming their projects, students used a variety of media and pedagogical approaches, which ultimately resulted in two tour "guide" formats. The first was a physical map of the Lower Chippewa for people seeking a self-guided approach to biking, hiking, and canoeing along the river. The second was a digital guide that included a series of short films about pollution and related environmental issues.

The course instructors aimed for students to achieve three main learning goals en route to their final project deliverables, which the authors identified as critical for both teaching and actively engaging in sustainability. Those learning objectives included: (1) developing a sense of place in a setting familiar to students, in order to foster stewardship behaviors in places students might consider their own; (2) learning to identify and subsequently communicate scientifically valid environmental information; and (3) connecting with local stewardship agencies to effectively communicate their tour programs and inspire place-based environmental action. To track the progress of these learning objectives, the instructors collected survey data from students at the start and end of the course.

The authors noted that attachment to place and understanding of local environments were low across the majority of students at the beginning of the semester, particularly with respect to water quality and pollution. Therefore, the instructors aimed to help students feel an emotional connection to the Lower Chippewa River, with the goal of spurring environmental stewardship of the water motivated by a place attachment. To achieve this goal, instructors engaged students with the river through a canoe trip at the beginning of the semester. On this trip, students learned about the interactions between the river's ecosystem and surrounding human systems, and saw firsthand some of the effects of pollution on the Lower Chippewa.

To supplement and complement students' place-based learning and sense of place in Eau Claire's natural environment, the class focused on information literacy, the second learning objective. Students dove into the peer-

reviewed scientific literature on pollution, environmental issues, and water quality. According to the authors, most students had little information literacy at the start of the course, which translated directly into a lack of focus on scientific validity when pitching ideas for their Pedal and Paddle Tours. Most of the undergraduates were more likely to uncritically accept and use information found on the Internet than consult peer-reviewed scientific evidence to support their river-pollution messages. As a result, the instructors required a greater use of peer-reviewed scientific literature throughout the course. By the project's end, the instructors noticed a large drop in students' citations of government information (many of the remaining citations were legitimate) and commercial websites, which the authors claim indicates strong gains in environmental and information literacy.

Community partnerships, the third major learning objective, helped students engage with a real-world environmental-stewardship example. The pre-course surveys revealed that all 18 students wanted to participate in environmental activism and/or stewardship, but that none actually had done so prior to the project. The authors suggest that this may have been a result of students not knowing how to engage with local issues or groups. By connecting students with local stewardship groups and initiatives, the instructors provided opportunities for the undergraduates to follow through on their intentions to act and learn about real-time, local pollution concerns. These partnerships, according to the authors, enabled a clear sense of civic agency among students, as indicated by anonymous self-reflection reports at the end of the term.

The findings from this case report indicate that students achieved, to varying degrees, each of the instructors' three main learning objectives. These achievements occurred despite students' disparate baseline knowledge about water pollution. Ultimately, the authors suggest that the experiential course design successfully developed students' sense of place, enhanced environmental information literacy, and engaged the students in community partnerships. By achieving those goals, the course provided students with the knowledge needed to create pollution awareness programs, as well as the platform to implement the programs on a local level.

THE BOTTOM LINE:

Place-based and community-engaged environmental education can empower students to exercise greater civic agency related to sustainability. This type of experiential pedagogical approach can inspire environmental action, not only among students, but also in surrounding communities. One effective way of engendering successful and sustainable community engagement is through partner organizations that focus on aspects of local, pressing environmental issues, such as river pollution. The combination of place attachment and collaborating with a local group may foster meaningful knowledge and action outcomes for environmental education participants.

Cronje, R. J., Neff, P. K., Mowry, D., & Running, G. L. (2016). Undergraduates as environmental educators: The Pedal and Paddle Pollution Tour experience. *Applied Environmental Education & Communication*, 15(3), 225–233.

REDUCING LITTER IN SCHOOLS THROUGH A NORMS-BASED INTERVENTION

Littering remains a significant environmental issue, especially among young children, who research suggests litter more than adults do. However, researchers rarely focus on the efficacy of interventions to reduce littering among school-aged children. This study considered an intervention to reduce littering within that particular population, using a culture of sustainability to contextualize the intervention.

The program planners named the intervention Maui's Dolphin Challenge (MDC) after the highly endangered Maui dolphins that live off New Zealand's coast. Four theoretical frameworks guided the project: caring/

compassionate values, embodied learning, a sense of efficacy, and perceived social norms. The intervention aimed to help students develop compassion for the Maui dolphins, effectively act on those compassionate feelings by picking up litter, create a social norm that littering was unacceptable, and encourage students to pick up their own litter, as well as that of other people.

Taking place at a secondary school in Auckland, New Zealand, the research involved 600 students, ages 13 and 14. The MDC offered to donate $200 once a week for three weeks to WWF's Maui Dolphin conservation work. For every piece of litter found at the school, however, MDC would remove $1 from the $200 donation. The program planners implemented the intervention twice, each for a three-week period. Researchers from the University of Auckland oversaw the first round (MDC1); students from the school, with faculty assistance, oversaw the second round (MDC2).

Researchers asked two questions during the program: (1) Did the intervention reduce littering among students? (2) What behaviors and attitudes motivated students to pick up, or not pick up, litter? In both MDC1 and MDC2, researchers conducted a waste audit three days per week to compute the amount of litter. They used the lowest audit number (in order to increase student efficacy) to subtract one dollar per litter item from the $200 total, based on the number of pieces of litter found. The researchers surveyed the areas three times the week before the first count to establish a baseline litter count.

In MDC1, the researchers used a questionnaire to gather information on students' attitudes toward litter; in MDC2, the researchers used interviews and a focus group with students and teachers. During both MDC1 and MDC2, researchers hung posters in classrooms that explained information about the dolphins and the project, including how the dolphins were being threatened and the amount of money (after subtracting the litter amount) that would be donated to WWF. More posters were hung during week 2: one poster restated the challenge; the second appealed to the students' values by showing an injured dolphin; the third used a normative appeal and showed a clean area with no litter, stating that most people do not litter; and the final poster appealed to efficacy, showing that the WWF donation would have a meaningful impact.

The study found that, in MDC1, the intervention reduced the amount of litter at the school during the three weeks of the program, as well as one week after. Student surveys indicated that the students reduced their littering because they cared about the dolphins, wanted to maximize the dollars donated, and felt like their actions were effective. Students often framed the challenge in positive instead of negative terms, even though the researchers framed the challenge through a negative lens, using phrases that highlighted avoidance language such as suggesting the need to pick up litter to avoid *losing money* that would be donated.

Results from MDC2 also demonstrated reduced litter, with half the amount of litter from the baseline by the last week of the challenge; the reduction continued a week after the intervention. In teacher and student interviews, both groups said that the appeal of the dolphins was important to the success of the program. They thought that deeply understanding the problem was important, especially in understanding how littering affected not only dolphins, but also other sea life. The students felt it was important to talk about the environmental action happening at the school, as well as within the broader community. Shame often prevented students from picking up other classmates' litter. The school had used picking up litter as a punishment previously and that association lingered even during the intervention.

THE BOTTOM LINE:

A school-based intervention may be useful in reducing students' littering. Helping students feel compassion toward specific species, such as the Maui dolphin, can be effective, especially when coupled with learning about how littering affects not only that species, but also the environment in general. The context of littering at a

school is also important. If picking up litter previously was used as a punishment, for instance, it may be more difficult to normalize this action within a school setting, even if students care about the environment. Alternatively, engaging student leaders in picking up litter might be a way to demonstrate positive norms, making this action more acceptable within a school community.

Townrow, C. S., Laurence, N., Blythe, C., Long, J., Harré, N. (2016). The Maui's Dolphin Challenge: Lessons from a school-based litter reduction project. *Australian Journal of Environmental Education*, 32(3), 288–308.

TEACHING METHODS

TEACHER EXPERIENCES WITH GLOBAL SUSTAINABILITY

Educating young people about environmental sustainability on a global scale has become increasingly important over the past 20 years. However, those ideas are often entangled in complex historical issues: colonialism and its legacy, economic inequality, and marginalization and unequal power relations between the Global North versus Global South. This study examines how educators consider and deal with such issues in their lessons when teaching high-school students about global sustainability.

This paper's author interviewed six high-school teachers from three Swedish towns. All of the teachers had been involved in sustainable development-related education and had hosted teachers and students from schools in the Global South. The teachers were between the ages of 35 and 55 and had been teaching for between 9 and 28 years. The interviews were up to one hour in length, and the interview questions focused on how teachers identified relevant knowledge for students, how the teachers structured their lessons, and the significance of Swedish students interacting with visiting students from schools in the Global South.

The author recorded and transcribed the interviews. For analysis, the author used a variation of an educational tool to identify thematic ideas for education programs tackling North–South history and politics. The author pared the themes from seven to four: contextual–historical, which addressed how teachers relate sustainability to colonial history; affective, which focused on how teachers raise ideas of benevolence, charity, and responsibility in their lessons; political, which examined how power relationships between the North and South are discussed; and epistemological, which concentrated on how teachers deal with different types of knowledge.

Analyzing the interviews through the contextual–historical lens, many of the teachers stressed the importance of putting sustainability issues into a broad context, especially with regard to colonialism. One teacher commented that he wanted students to apply the facts outside of a Swedish context, especially when meeting students and teachers from the Global South. Another teacher stressed the importance of treating the issues on a global scale.

Through the affective lens, all of the teachers thought that responsibility and fairness were important dimensions to address in global sustainability issues. Three teachers commented that students should be able to move beyond paternalistic views of the Global South without dampening their generosity, and described cultural encounters as one way to do this.

All of the teachers emphasized the political lens in dealing with sustainability and wanted their students to see alternative ways of considering politics, often moving beyond individualistic ideas. One teacher said that his hope was to empower students to be more politically aware; another said he wanted students to see both themselves and other people as agents for political change.

Finally, most of the teachers spoke to the epistemological lens, pointing out how cultural norms and values shape how students see the world, and that not everyone comes from the same culture. One teacher discussed the importance of talking about issues with people who have different frames of reference, citing discussions about motherhood between her students and those from the South as an example.

Civics and history teachers most frequently mentioned the contextual–historical lens, although other teachers were aware of it as well. All teachers emphasized the importance of emotions in connecting students to the issues and driving students to action. Similarly, all the teachers spoke to the political aspects of the issues and wanted their students to feel they could take action. Most of the teachers touched on epistemological concerns, particularly in relation to student interactions providing access and openness to other perspectives.

THE BOTTOM LINE:
Addressing sustainability on a global scale is complex, intertwined with issues of colonialism and inequalities between the Global North and South. In particular, educators need to take a critical eye when teaching about these issues. In addition to teaching practices, educators must consider the historical context and implications of

global-sustainability discussions and actions. This holistic lens also includes a personal dimension as educators bring their own ideas and experiences about the topic to the course.

Sund, L. (2015). Facing global sustainability issues: Teachers' experiences of their own practices in environmental and sustainability education. *Environmental Education Research*, 22(6), 788–805.

HANDS-ON ACTIVITIES AND POSITIVE EMOTIONS FOSTER ENVIRONMENTAL KNOWLEDGE

Research has long supported the idea that outdoor experiences can support various environmental education (EE) outcomes, including environmental knowledge, attitudes, and behaviors. Researchers and practitioners view such outcomes as important elements of environmental literacy, yet there is some contention as to whether traditional, school-based EE and informal, outdoor EE function differently when fostering those outcomes.

To address those variances, this study's authors set out to assess cognitive knowledge gains and emotional change among students who participated in a nature-based conservation program. Through hands-on engagement, the authors were interested in examining how positive emotions might influence cognitive achievement in outdoor settings. The authors hypothesized that experiential EE in outdoor settings might successfully support cognitive achievement and eventually knowledge gain, particularly with the use of experiential, engaging follow-up activities.

To focus on the impact of out-of-school, informal EE on the linkages between affect-cognition and knowledge gain, the authors studied outcomes of students' direct experiences with nature in the Bavarian Forest National Park in Germany. Using this focus, the authors targeted two primary objectives: (1) maintaining a hands-on structure for the entire intervention, including follow-

up activities (designed as games and posters), and (2) measuring cognitive achievement, as well as situational emotions, to better understand affect–cognition linkages.

The national park provided weeklong experiential programming about regional geology, biology, ecology, and conservation for 298 fourth- and fifth-grade participants in the study, all of whom were from the region. The program primarily took place outdoors, with the goal of fostering positive physical and emotional connections to the landscape. Content mostly included forest ecology and conservation of the wolf and lynx—two reintroduced, endangered species. Outdoor educators worked with groups of 7 to 12 students at a time and used a variety of games and activities to teach topics such as species identification, ecological succession, and species population distribution. Nightly journaling and thematic review posters supplemented the field-based components of the program.

All students participated in the same program, but researchers split them into two groups: Group 1 (G-1; n=170), and Group 2 (G-2; n=128). The researchers also had a comparison group (n=60) of students who did not participate in the program or any intervention. The 60 students in the comparison group answered questionnaires to test cognitive achievement and situational emotions before and after the residential program. All 298 G-1 and G-2 students also responded to these questionnaires, which included 15 multiple-choice questions related to knowledge, and 9 five-point Likert questions focused on three situational emotions: well-being, interest, and boredom. Students responded to questionnaires in a pre-, post-, and retention test format. The pre-test occurred in the two weeks before the national park program (at T0); the post-test occurred on site, immediately following the completion of the program (at T1); and the retention test occurred at the students' schools four to six weeks after the program (at T2). Testing students at T0, T1, and T2 provided baseline data across all participants and allowed researchers to assess short- and long-term knowledge and emotional outcomes.

The students in G-1 and G-2 participated in two different intervention formats, in addition to responding to the three questionnaires. The 170 students in G-1 interacted with posters that depicted the most important thematic content of the program, while the 128 students in G-2 interacted with these posters *and* played a competitive board game based on the programmatic content, which was meant to produce emotions among participants.

Analysis of questionnaire results across the three groups using linear mixed models in R revealed that the comparison group did not demonstrate a statistically significant knowledge gain over time, while students in both G-1 and G-2 demonstrated statistically significant knowledge increases over the short-term (T1-T0) and the long-term (T2-T0). This held true when broken down into the three main themes: forest, wolf, and lynx. Furthermore, students in G-2 experienced significantly more knowledge gains than G-1 across all time scales.

With respect to situational emotions, the authors found that participants' well-being and interest had small, but statistically significant, impacts on long-term knowledge outcomes. Well-being also affected short-term knowledge gains.

This research suggests that a combination of content-based interventions (the posters) and interventions with emotional linkages (the competitive, content-based board game) may be one successful method of increased cognitive achievement, as measured through longer-term EE knowledge retention. In particular, the researchers emphasize that hands-on, affectively focused programs might engender positive emotions, which, in turn, support deeper, more lasting learning outcomes.

THE BOTTOM LINE:

Although nature-based environmental education programs can be powerful, they require follow-up activities that are hands-on to maintain and solidify their impact for students. Furthermore, the effectiveness of such activities is strengthened when they incorporate or encourage positive emotions, which may increase the desired knowledge outcomes of a program.

Dieser, O., & Bogner, F. X. (2016). Young people's cognitive achievement as fostered by hands-on-centered environmental education. *Environmental Education Research*, 22(7), 943–957.

EXPLORING UNCERTAINTY AND HUMAN AGENCY IN CALIFORNIA SCIENCE TEXTBOOKS

Textbooks provide a key source of information for teachers and students alike on a range of topics. Because they often serve to anchor lessons, the perspectives they espouse can be enormously, and at times disproportionately, influential in terms of how they affect beliefs and knowledge about ideas. Therefore, it is important to understand how textbooks convey scientific content, particularly with regard to issues that some may perceive to be controversial, such as climate change.

This study investigated how textbooks frame climate-change information. Specifically, the authors analyzed the language used in four sixth-grade science textbooks adopted in California. The authors asked (1) how the language used in science textbooks reflects how confident scientists are that climate change is occurring, and (2) how human beings are positioned, or not, as the causes of or the solution to climate change.

The authors used Systemic Functional Analysis, a linguistic method that seeks to identify patterns in how language conveys meaning in various content areas, such as mathematics or science. The authors also drew from framing theory to investigate the language choices textbooks use in presenting climate-change information.

Specifically, the researchers investigated whether the textbooks align to the scientific discourse (i.e., climate change is an environmental problem that poses an immense risk that is in need of urgent action) or to the public discourse (i.e., climate change is an unsettled science with high levels of uncertainty among the scientific community).

The authors found that textbook language around climate change was tentative, rather than assertive, and contained several instances of modal verbs, such as "would," "could," and "might." The authors also found that textbooks were not specific in the percentage of scientists who agree that climate change is occurring, and used determiners such as "some" and "not all" to describe the agreement among the scientific community around this issue. By using vague determiners instead of exact percentages, textbooks leave up to student and teacher interpretation what "some" and "not all" mean, rather than echoing scientific reports indicating that 97% of scientists agree that climate change is happening due to human-induced activities.

In relation to framing theory, the authors report that, when textbooks discussed climate change, they do not mention human-related causes of this phenomenon or, if they do, they describe those causes generally. Omitting this connection between human-related causes and climate change in sixth-grade textbooks contrasts with how scientific circles discuss the issue. Similarly, when the textbooks mention "scientists," they describe their actions as "thinking" or "believing" in the reality of climate change. Rarely did the textbooks describe what we know about climate change as based on concrete evidence gathered by scientists through measurement and experimentation.

Finally, the authors indicated that the textbooks in the study do not present climate change in a confident or urgent tone. Yet, the preponderance of the scientific community believes that climate change is the most pressing issue of our times. In fact, the language in these textbooks underestimates the catastrophic consequences of inaction around climate change. The authors conclude that this use of inactive language is mostly aligned with the

public discourse and reinforces the public's misconception that climate change is distant in time and place, rather than a current problem that we, as a society, need to act upon and address in the short-, medium-, and long-term.

THE BOTTOM LINE:

Although teaching materials, such as worksheets, activity guides, interactives, and textbooks, can be helpful supports for educators, it is important to be aware of biases and representations that the materials include. In particular, with topics such as climate change, which some may perceive as controversial, educators should be aware that textbooks' language and content might not depict the subject matter in a way aligned with the scientific consensus. Educators who are aware of such discrepancies can guide in-classroom discussions that probe questions around aspects of climate change, including it being a phenomenon related to human activity, widely agreed upon by scientists, and an urgent and timely matter.

Román, D., & Busch, K. C. (2016). Textbooks of doubt: Using systemic functional analysis to explore the framing of climate change in middle-school science textbooks. *Environmental Education Research*, 22(8), 1158–1180.

A RESILIENCE FRAMEWORK FOR EDUCATION

Many educators consider developing a resilience mindset to be a key goal of environmental education. Applying the resilience frame to climate change, one of the most pressing issues facing the world today, is a natural extension that fits within the scope of many EE programs. Ideas of resilience can provide skills that help people adapt to climate-related changes and disasters.

Although climate-change disturbances affect communities globally, how those disturbances might affect EE practice at more local and regional scales remains unclear. By interviewing staff from locally based environmental organizations, this study's authors investigated how Hurricane Sandy changed EE practices in New York City, particularly with regard to fostering climate-change resilience. The authors' findings suggest that climate-related disasters with local impacts, such as Hurricane Sandy, provide an opportunity for incorporating climate-change resilience and action into EE practices.

The authors examined resilience from an interdisciplinary perspective, including psychological resilience, community resilience, ecological resilience, and social-ecological systems resilience. Psychological resilience was defined as reflecting individual adaptation to disturbance, while the researchers considered community resilience when a group of people copes with social, environmental, or political change. The authors defined ecological resilience as how an ecosystem responds to disturbance, and social-ecological systems resilience as adaptation to change in larger communities and systems.

To conduct the study, the authors compiled a list of environmental organizations in New York City that were likely to have seen physical damage from Hurricane Sandy or had participants directly affected by Hurricane Sandy. The resulting sample consisted of 44 environmental organizations that likely changed their practices following the hurricane. The authors interviewed at least one EE representative from each organization between 12 and 16 months following the hurricane, asking questions about how the organization's practice and messaging had changed. The authors then conducted a second interview, with representatives from 14 of the 44 organizations, about resilience. For those second-round interviews, the authors chose organizations that mentioned resilience in their initial interview. They asked organizations to provide a working definition of resilience. The authors analyzed the interview data using descriptive codes to identify common themes.

Of the 44 organizations, all but one changed their practices following Hurricane Sandy. Organizations generally incorporated information about Hurricane Sandy to reinforce existing educational content, increase community stewardship through land restoration

activities, and foster resilience through implementing green infrastructure changes and community programming. Post-hurricane recovery also provided an opportunity for organizations to engage new members and obtain more funding.

The 14 organizations interviewed about resilience tended to provide a working definition that went beyond a single disciplinary focus and, instead, emphasized community engagement. The organizations viewed resilience from psychological, community, ecological, and social-ecological systems' perspectives.

Organizations' levels of change following Hurricane Sandy varied in depth. Some incorporated resilience as a buzzword into their content without implementing deeper action-based change. Other organizations, however, increased community engagement through linking ecological and social impacts and, thus, achieved transformational change. Incorporating resilience into climate-change education increased local community action and engagement, but did not transform EE in New York City on a broader level.

Scientists expect climate-change-related disasters to increase in frequency and intensity; this increase underscores the importance of using these disasters as an opportunity to foster climate-change resilience through environmental education. The authors recommend that practitioners incorporate notions of resilience from an interdisciplinary perspective into educational practice. To accomplish this change in practice, the authors encourage collaborative partnerships between EE practitioners and researchers.

THE BOTTOM LINE:

Climate-change disasters with particularly local impacts, such as Hurricane Sandy, provide an opportunity to foster resilience through environmental education. In such situations, practitioners can incorporate resilience to climate-change-related disasters using an interdisciplinary lens in a range of organizational practices and educational activities. Individual reflection and action in restoring social and ecological systems following the disaster can improve psychological resilience, while community-level engagement in stewardship and restoration activities can promote community-level resilience. Linking social and ecological impacts of climate disaster at the local level increases community engagement with EE organizations and cultivates action. Collaborative partnerships with researchers can help practitioners incorporate resilience practice into climate-change education.

Dubois, B., & Krasny, M. E. (2016). Educating with resilience in mind: Addressing climate change in post-Sandy New York City. *The Journal of Environmental Education*, 47(4), 255–270.

iPADS IN ENVIRONMENTAL EDUCATION

Young people are increasingly learning about the world around them through digital technologies. In the classroom, researchers find that digital technologies can increase student engagement and aid in understanding lesson content. Environmental education centers and facilities have been incorporating digital technologies, ranging from microscopes to e-books, into their programs, but not enough is known about how best to integrate these technologies with studying the natural world. Therefore, this research examines children's responses to using digital technology, specifically iPads, during an environmental education program.

Taking place over six months, the researchers observed the introduction of iPads into the River Connections environmental education program at the Riveredge Nature Center in Saukville, Wisconsin. The program teaches fifth graders about the macroinvertebrates in the Milwaukee River and the impact of water quality on those organisms. The iPads replaced a paper worksheet used for data collection during the program.

One researcher, acting as a non-participatory observer, watched nine classes weekly. Each class had different

students. The researcher noted how the children behaved with the iPads, both as a class group overall and in smaller groups. This study was framed through a social constructivism model, or the idea that children develop intellectually through social interactions. The study gave particular emphasis to questions of how children used the iPads in relation to and in collaboration with their peers.

The researchers compiled and analyzed observations and notes based on grounded theory techniques so that the data generated the following seven codes:

- *Reaction to mobile device* encompassed the children's reactions when educators first revealed the iPads; generally, the children's reactions indicated positive attitudes toward the devices.
- *Group interactions* related to how the children shared the iPads. In some groups, children would not share the device and required teacher intervention; however, the children resolved most disputes on their own.
- *Nature prevails* addressed the time children spent looking at the macroinvertebrates versus the iPads and showed that the children were often captivated by the invertebrates.
- *Digital natives versus digital immigrants* addressed the fact that, as digital natives, few children had difficulties operating the iPads; this was in contrast to the adult teachers.
- For *introduction of mobile devices*, researchers noted that the way the educators introduced the iPads majorly affected how children used the device. Lengthy introductions bored them.
- *Mobile devices in the hands of children* related to observations of children handling the iPads (mostly carefully and gently).
- *Instruments for learning* addressed how children used the iPads to further their understanding of the macroinvertebrates, often reading individually about a single invertebrate, or working collaboratively (in groups of two or three) to compare different invertebrates.

Overall, the results from the study showed that children were engaged and interested in using the mobile devices. Importantly, the study found that the children's interest in the mobile devices did not overshadow their interest in nature. The authors conclude that mobile devices can be introduced effectively in a variety of outdoor learning environments as educational tools, but that they should not be the primary focus of an outdoor education activity or program.

THE BOTTOM LINE:

With the growing use of digital devices as teaching supports, not only in classroom settings but also in outdoor, field-based settings, it is increasingly important for educators to understand the social and ecological implications of such technological interactions. Devices such as iPads can be effective in augmenting learning during environmental education programs, but educators must be careful in the ways that they use and introduce such devices. If educators emphasize that the devices are a tool for furthering scientific understanding and exploration, this can help ensure that the devices support learning rather than distracting from the focus of the lesson.

Kacoroski, J., Liddicoat, K. R., & Kerlin, S. (2016). Children's use of iPads in outdoor environmental education programs. *Applied Environmental Education & Communication*, 15(4), 301–311.

SENSE OF PLACE AND NATURE CONNECTION

DEVELOPING LONG-TERM ENVIRONMENTAL IDENTITY

Understanding the long-term impacts of environmental education (EE) is one way to assess programs' overall success in cultivating environmental stewardship. However, it can be difficult to track those impacts over time and directly link the behaviors to particular EE experiences. In this study, the authors attempt to illuminate those complex, multifaceted linkages between non-formal programs and eventual stewardship behavior by examining the role of EE in influencing participants' social environmental identities.

To explore social environmental identities, the researchers use the anthropological framework of social practice theory as described and applied by Holland and colleagues (1998). Social practice theory builds on the notion that interacting with other people, as well as surrounding environments, influences the formation of different identities, which correspond to different parts of a person's life in a dynamic way. Through these ongoing, ever-changing processes, people adopt the vocabulary, behaviors, and practices of others. One of these identities, in particular, is "social environmental identity," which reflects how people view and identify themselves with respect to an environmental group, such as an outing club or WWF.

According to the authors, social practice theory has implications for outcomes related to environmental stewardship behaviors as people form identities in the course of taking actions. Therefore, understanding pivotal moments in identity formation—such as salient memories of participation in a certain environmental group experience, such as a non-formal EE program—is critical to linking programs to their influence on stewardship behaviors.

Given this foundation, the authors attempted to test whether memories could illuminate how environmental identities develop in childhood. To do so, the researchers conducted unstructured interviews with former participants of Thorne Nature Experience, Wild Bear Mountain Ecology Center, and the University of Colorado's Science Discovery program (CUSD wilderness camp). The authors interviewed 18 former participants, who ranged in

age from 19 to 50 years old and had been participants between 5 and 40 years prior to when the interviews were conducted. All but one participant had repeated student experiences in their program. During the interviews, the researchers asked the interviewees about their memories of the nature-based programs, as well as their self-perceived identities.

The researchers used a process of narrative inquiry, which allowed interviewees to control the direction of the conversations as they relayed their most salient memories. Throughout the interviews, emergent themes included sense of wonder, self-efficacy, influence on environmental identity, and sense of place.

The authors framed their analysis in relation to the three components of social environmental identity formation predicted by social practice theory. With respect to the first theme—attentiveness to the natural world and environmental problems—16 of the 18 interviewees said their experiences permanently altered their view of the natural world, although none said that their experiences had contributed to an awareness of environmental problems. Regarding the second theme—identification with environmental action—the majority of participants mentioned some element of this in their memories by describing a sense of responsibility, sense of community, and overcoming fears. The third theme—gaining knowledge through action—was not a primary focus of the authors' analyses, given its inextricable links to the second theme; thus, the findings from those two areas may have been intertwined.

Ultimately, the authors found social practice theory to be useful for examining the formation of long-term social environmental identities. They also emphasized that social practice theory, like previous research, indicates that EE must occur over a series of experiences that contribute to identity formation. To continue this line of work with respect to EE, the authors suggest further narrative-based research with more diverse participants and former participants with concretely established—rather than self-reported—identities as environmental actors.

THE BOTTOM LINE:

The longer-term development of social environmental identities of participants is a key goal for many EE programs. Practitioners hoping to help participants form long-term social environmental identities and create effective programs should incorporate a series of experiences that allow participants' social environmental identities to form over time. This could include helping participants develop a sense of responsibility, build a sense of community, and overcome fears. One way to encourage and support formation of participants' identities is to allow young people increasing levels of responsibilities.

Williams, C .C., & Chawla, L. (2016). Environmental identity formation in nonformal environmental education programs. *Environmental Education Research*, 22(7), 978–1001.

YOUNG CHILDREN'S EMBODIED ENCOUNTERS WITH NATURE

Understanding how young children develop an awareness of the natural world is vital to creating effective environmental education programs. However, few researchers have studied how embodied experiences, with hands-on interactions in natural spaces, impact the ways in which children relate to and think about the environment.

This study investigates how children develop a sense of wonder and environmental consciousness when playing in nature. To frame an understanding of the ideas "sense of wonder" and "environmental consciousness," the author drew on concepts from the work of philosopher Merleau-Ponty (1962), specifically about the body as the main way people make sense of the world. Embodied sensory interactions are a vital part of how children construct their relationship with nature. Children's sense of wonder is connected to their sensory interactions with an environment and their emotional attachment to that space. The author considered environmental consciousness as a sensory openness toward a natural space and the creatures that inhabit it.

The author collected data through an ethnographic field study of Norwegian kindergarteners. The fieldwork involved 34 children (15 girls and 19 boys) from ages 1 to 6. All of the children were ethnic Scandinavian. The researcher accompanied the children on their outdoor play periods in two environments: (1) a small, uninhibited island in the fjord that included a long-term settlement until 1912; and (2) a woodland area around a campsite, with rope toys and wooden shelters. Following these children for 30 days, the author recorded field notes and informal conversations, and she also took photographs.

On the island, the children explored the coastline, as well as the inland forest and some of the tunnels and buildings left over from when the area had been inhabited. In the woodland area, children played among the structures, and explored the trees, rocks, and caves around the campsite. Based on her field observations, talking with the children, and her photographs, the author constructed two main analyses: narrative maps and narrative accounts.

For the narrative maps, the author drew maps of the island and woodland areas, placed landmarks where children played, and marked where significant events occurred. For the narrative accounts, she constructed three main stories of children exhibiting a sense of wonder and developing an environmental consciousness.

Narrative #1, "Bringing the jellyfish home," involved children on the island discovering a great number of jellyfish washed ashore during a low tide. Led by one boy, ten children touched and examined the creatures, eventually deciding to pick them up and return them to the water. Narrative #2, "Lilla Billy," involved children at the campsite who were intrigued by a small, common bug, which they named Lilla Billy. The children tried to keep the bugs as pets, carefully putting them into pens they had constructed with leaves and sticks. Narrative #3, "The Bakugas and the knights," saw children creating a story about a tunnel on the island, imagining a monster, the Bakuga, who lived in the tunnel. The children moved between the tunnel and the beach, playing with the sand as a way to handle the monster, with many children adding to the story over a number of weeks.

THE BOTTOM LINE:

Embodied nature experiences offer a unique way to help children develop a relationship with the environment. In particular, giving children the chance to experience natural spaces for themselves, while using their senses and engaging in tactile play, may help them develop a sense of wonder about nature and an environmental consciousness. Educators would benefit from using local natural spaces not just for structured environmental education lessons, but also for unstructured play and exploration, allowing children to engage and interact with nature around them on their own terms.

Jørgensen, K. A. (2015). Bringing the jellyfish home: Environmental consciousness and 'sense of wonder' in young children's encounters with natural landscapes and places. *Environmental Education Research*, 22(8), 1139–1157.

BENEFITS OF A YOUNG ADULT URBAN GARDENING INTERNSHIP

Research demonstrating the benefits of gardening interventions for youth development led to the formation of the East New York Farms (ENYF) Project. The project recruits youth to participate in a nine-month garden-based internship that teaches skills such as gardening, environmental knowledge, leadership, and self-efficacy. Although researchers had evaluated the short-term impact of the program between four and six months following completion, no researchers had conducted long-term follow-up studies on the efficacy of this or similar garden-based youth interventions. Therefore, these researchers set out to investigate how the ENYF program influences participants' career trajectories, life skills, community involvement, and environmental attitudes and behaviors.

ENYF recruits youth from diverse backgrounds, between 13 and 18 years old, who live in New York neighborhoods located east of the city. Each year, 33 new and returning interns participate in the program. Students practice sustainable farming; manage farmers markets; discuss food-system-related concerns, such as food access and diversity; and develop possible solutions to problems specific to their community. ENYF aims to use the experience of working on and managing a farm to develop skills to improve involvement and success in higher education and employment.

To investigate the long-term impact of this program, the researchers sent out questionnaires to 107 past participants. The questionnaires included items with open-ended, as well as 5-point Likert-scale response options, and explored topics including current level of education and employment; health-related behaviors; feelings about self, food systems, and community involvement; and leadership skills.

Fifty past ENYF participants completed the survey. For youth between the ages of 16 and 24 in the East New York area, compared with the average rates of attending school (either high school or higher education), a higher than average percentage of ENYF participants who completed the survey were still in school. Further, in comparison with Asian, Black, and Latino young adults living in the East New York area, the unemployment rate for the ENYF participants was below average. Researchers also noted a theme of health-related interests and behaviors among participants. Participants most commonly listed the health professions when asked what careers the participants were interested in pursuing or were currently pursuing or in what subjects they had earned a degree. The questionnaire asked participants to rank from one ("never") to five ("often") how frequently they were involved in particular health- and food-related behaviors. The participants scored high for a wide variety of outcomes, including eating fruits and vegetables (4.78), cooking (4.32), and participating in physical activity (4.52). Only 12% of participants indicated that they ate fast food frequently, with many indicating that they almost never ate fast food. Among the health- and food-related questions, researchers also asked about involvement in gardening, as this was a focus of the ENYF curriculum. Participants noted, however, that they did not garden frequently (2.68).

Along with possible benefits of the ENYF internship on health behaviors, the researchers believe the program may have had positive impacts on valuable life skills. The longer students participated in ENYF, for example, the higher the students scored on items related to communication and decision-making. Further, participants recorded high scores on items measuring self-esteem, working with individuals from diverse backgrounds, and the ability to make a difference in the community. Lastly, analyzing the qualitative data from the free-response questions indicated that ENYF provided participants with an awareness of food systems, community, and responsibility; improved communication skills; and a greater sense of self-efficacy. The researchers argue that those skills may benefit the participants not only in the short term but also in the long term, particularly in relation to their educational and employment pursuits.

THE BOTTOM LINE:

Learning how to work on and manage an urban garden can help high school-aged students develop personal, academic, and professionally relevant skills. Effective urban gardening programs include theoretical topics, such as food access and diversity, as well as practical ideas, such as sustainable gardening and managing farmers markets. Programs that invest in long-term relationships, such as those that last a year or longer, help students develop better decision-making skills, communication strategies, and confidence.

Sonti, N. F., Campbell, L. K., Johnson, M. L., & Daftary-Steel, S. (2016). Long-term outcomes of an urban farming internship program. *Journal of Experiential Education*, 39(3), 269–287.

EXPLORING A CRITICAL PEDAGOGY OF PLACE IN URBAN SCIENCE EDUCATION

Merging place-based education with critical pedagogy, *critical pedagogy of place* offers a potentially powerful framework for learning. The framework, developed by Gruenewald (2003), seeks to engage youth in challenging dominant practices that have led to the exploitation of the natural world. It aims to foster critical consciousness within youth and empower them to take action to transform their local environment and ways of living. A critical pedagogy of place promotes reinhabitation, or the restoration of Earth's natural biodiversity and ecological systems, while recognizing humans' interconnectedness with nature.

Despite the educational potential of using critical pedagogy of place as a lens in science and environmental education, few researchers have examined its effectiveness and role in formal science education. To that end, this study explored how youth reinhabited place within their deindustrialized U.S. Rust Belt city and demonstrated critical consciousness about social and environmental issues. The high school, Lakeshore High, is located in a city that is home to heavily polluted vacant lots and waterways and has experienced significant economic and population declines. Set in an urban high-school environmental science classroom with a racially diverse population of students, over half of whom are eligible for free or reduced-price lunch, the study included 20 participants (12 females and 8 males). Over the course of one academic year, the researcher collected six forms of data, including teacher interviews, weekly classroom observations, student work samples, and student interviews. The researcher then qualitatively coded data from those sources to identify themes using a critical place pedagogy perspective.

Over the course of the year, the researcher found that the environmental science teacher, Mr. Lincoln (a pseudonym) integrated local environmental science issues by engaging students in urban park restoration. He established environmental remediation activities where he and his students cared for their community's environment together.

By grounding the curricula in local issues, Mr. Lincoln helped the students make connections between their everyday knowledge and mandated science content.

By engaging in this park remediation work, students had the opportunity to reinhabit urban places in ways that facilitated understanding and connection with nature. In discussing park restoration, students demonstrated their deepened understanding of ecology within a specific, local environment. In interviews, for example, several students talked about the role of invasive Japanese knotweed in reducing the region's biodiversity. In interviews, youth also frequently expressed their connection to the places where they worked, as well as a belief that they could affect change within those places.

Evidence suggested that the youth developed some degree of critical consciousness. Many students spoke critically of the ecological impact of common cultural practices, including littering and city-mandated lawn care. Others expressed critical consciousness by attempting to transform the dominant narrative of their community as "failing." Rather than focus on the city's decline, they spoke of converting brownfields to green spaces and changing their community for the better.

This study revealed a formal science education context—urban park restoration—in which aspects of a critical place perspective would be appropriate and helpful. However, this study also uncovered complications: Although students learned about the historical and social forces that led to the park's polluted state, and there was an aspect of consciousness to their work, they did not engage deeply in critical reflection. The author suggests that this was because that sort of deep reflection was absent from the curriculum.

This study demonstrates that, despite complexities and tensions, a critical place pedagogy lens can be enacted in formal science education. Learning opportunities, such as park restoration, could help students develop critical consciousness, as well as deepen their connections to local places.

THE BOTTOM LINE:

Critical pedagogy of place can offer a powerful framework for science learning. It can deepen youths' connections to place, as well as their understanding of ecological systems through activities such as local park restoration and remediation. In fostering youths' critical consciousness, this framework encourages students to question the historical cultural and social practices that have led to environmental degradation and take action in transforming them. The promise of critical reflection is important, but developing students' skills in this arena is not without challenges: To be successful, critical reflection should be included in curricula to allow teachers to engage students in dialogue, reflection, and action.

Schindel, D. A. (2016). Exploring the potential and complexity of a critical pedagogy of place in urban science education. *Science Education*, 100(5), 814–836.

RESTORATION FROM NATURAL SPACES IN ADOLESCENTS

Adolescents today experience increasing amounts of stress and deal with more mental health issues and higher levels of mental fatigue than previous generations. Although many practitioners and researchers believe that interacting with or being in nature has positive impacts on health and wellbeing, past research has shown this relationship to be more complex than one might imagine. Teenagers, for example, can have a multidimensional, conflicted, and, at times, negative view of the environment in comparison with that of younger children or adults.

To explore the relationship between adolescents and nature, this study examined the restorative power of nature for adolescents in outdoor versus indoor environments through the lens of the conditions of being alone, being with a friend, and being on the phone. The study sample included 120 adolescents (66 females and 54 males). All participants were from a sixth-form college in Southwest London. The research took place in indoor and outdoor environments that students would actually use, plus two outdoor spaces that were not usually open to students.

Stress, and then restoration from the stressful condition, were measured with three indicators: blood pressure (both systolic and diastolic), heart rate (in beats per minute), and attention (measured through the Necker Cube Pattern Control Test [NCPCT]).

First, the researchers took baseline measurements of blood pressure, heart rate, and attention. Next, the researchers administered four tasks designed to stress out the participants and create mental and attentional fatigue. Three of the tasks were cognitive tests: memory, mental arithmetic, and shape sorting. The fourth task had participants give a speech on the topic of "what [they] like about [themselves]" to four other people, after which researchers took measurements of blood pressure and heart rate again. The participants then randomly chose a slip of paper that placed them in one of six categories: "outside alone," "outside with a friend," "outside with a phone," "inside alone," "inside with a friend," and "inside with a phone." After spending 20 minutes either inside or outside, the researchers took blood pressure and heart rate measurements again, and the participants completed the attention test.

Heart rates were reduced during both the "alone" and "phone" conditions in both the inside and outside conditions, although slightly more in the inside environments than the outside. Blood pressure, both the systolic and diastolic measurements, decreased significantly in the inside and outside conditions. Participants scored significantly better on the NCPCT test after spending time outside rather than inside for all conditions; they achieved the best scores when they had spent time talking to a friend as compared to being on their phone. Participants reported an increase in positive feelings after spending time outside rather than inside. The participants also reported an increase in positive feelings when they were outside with a friend than when they were outside alone or on their phone. Finally, in both the indoor and outdoor locations, attentiveness decreased after 20 minutes. Being with a friend outdoors decreased attentiveness, while being with a friend indoors increased attentiveness.

The results of this study suggested that nature may be restorative for adolescents. The authors note, however, the indoor environment in this experiment might have been particularly negative for the participants, as the indoor room had no windows, a condition that researchers have found can create a negative effect on mood. The results also show that most positive, restorative outcomes for adolescents occur when they are with a friend more than when they are alone or alone with their phone. In fact, being with a friend outside actually increased participants' heart rates, which may be because adolescents find being with their peers stimulating. Specifically in outdoor spaces, providing structures such as beanbags, benches, and/or blankets may make such natural spaces more attractive to adolescents and promote social interaction, facilitating restorative benefits such as reduced stress and mental fatigue and improved mood.

THE BOTTOM LINE:

Nature's restorative powers can benefit adolescents, even when only interacting with natural spaces found in everyday environments. Additionally, being in nature with a friend may be particularly helpful for teenagers, in terms of recovering from stress and mental fatigue. Adolescents, many of whom face increasing pressure in school environments, may benefit from time outdoors in welcoming spaces, especially when those spaces encourage social interaction.

Greenwood, A., & Gatersleben, B. (2016). Let's go outside! Environmental restoration amongst adolescents and the impact of friends and phones. *Journal of Environmental Psychology*, 48, 131–139.

ZOO, AQUARIUM, AND SCIENCE CENTER EDUCATION

CONSERVATION EDUCATION AT ZOOS AND AQUARIUMS

Zoos and aquariums offer unique opportunities to educate the public about environmental conservation; as such, many of these places consider conservation education to be their primary purpose. Although these informal institutions often place significant importance on educating their visitors about conservation issues, few studies consider how the 700 million people who visit zoos and aquariums annually regard the role of conservation education.

This study investigated visitor perceptions of conservation education at zoos and aquariums. To do so, the researchers administered a questionnaire in six zoos and seven aquariums in the United States, United Kingdom, Canada, and South Africa, to a total of 1,546 visitors (705 from zoos and 841 from aquariums). The researchers approached visitors at these sites; therefore, findings from this self-selected sample may not apply more broadly to all zoo and aquarium visitors.

The questionnaire included six categories of questions. The first category—*perceptions of the roles of zoos and aquariums*—addressed visitors' understanding of the roles of zoos and aquariums in relation to the animals, the visitor experience, and conservation learning. The second category, *priorities when visiting zoos and aquariums*, asked visitors to rank five items on how much the items impacted their decision to visit the zoo or aquarium. Category 3 assessed the visitors' *interests in wildlife*, while category 4, *preferred content of interpretive signs*, asked what visitors thought about the content and use of interpretive signs. Categories 5 (*satisfaction with the visit*) and 6 (*preferences regarding post-visit resources*) asked about the factors that contributed to visitor satisfaction with their experience and what types of educational materials visitors would want to receive following their visit, respectively.

Differences in visitor opinions between zoos and aquariums were explored using statistical analyses. Overall, the visitor participants were similar for zoos and aquariums: one-third females aged 20–39; one-third females in other age groups; and one-third males of

all ages. There was one important difference between the participant samples: 75% of zoo visitors indicated that they were locals, while only 57% of aquarium visitors indicated that they were locals.

Overall, visitors believed the main purpose of zoos and aquariums was to provide information about the animals and a relaxing, engaging visitor experience. While respondents placed the highest importance on the social experience of visiting a zoo or aquarium, they rated "giving visitors conservation information" as equally important as having a fun outing. Aquarium visitors placed slightly higher importance on learning about conservation than zoo visitors, and they were more likely to say they were interested in learning about environmental issues. The difference between the visitors to zoos and aquariums might partially be explained through the observation that more tourists visit aquariums, because in the sample, tourists were more likely than locals to think about how their actions impacted nature. Both zoo and aquarium visitors enjoyed watching wildlife-television documentaries. For signage, visitors at both locations placed more importance on scientific information (such as name, species, and genus) than conservation information for interpretive signage content.

Although visitors rated observing animals highly in terms of "satisfaction," 77% of the respondents indicated it was more important to know that the zoo or aquarium contributed to conservation efforts than it was to see zookeepers feeding animals. The majority of visitors thought it was important to provide educational materials after the visit, with one difference: zoo visitors were less likely than aquarium visitors to want a take-home DVD.

THE BOTTOM LINE:
Understanding how visitors approach zoos and aquariums is essential to designing experiences that meet visitor expectations for enjoyment and conservation education. Although socializing and entertainment may be the primary reasons people visit zoos and aquariums, visitors are also interested in learning about environmental conservation. Designing educational experiences that

allow visitors to discover through different senses; pique curiosity and fascination; and make choices about their learning path can create a learning situation that meets visitors' social needs, as well as addresses their conservation questions. These kinds of learning settings can benefit not only the visitors, but also the zoos and aquariums.

Ballantyne, R., & Packer, J. (2016). Visitors' perceptions of the conservation education role of zoos and aquariums: Implications for the provision of learning experiences. *Visitor Studies*, 19(2), 193–210.

SCIENCE CENTERS SUPPORT ADULT SCIENCE LEARNING ACROSS INTERNATIONAL CONTEXTS

Researchers continue to be interested in the ways that people successfully pursue science education throughout their lifetimes, especially as adults. Focusing on an adult population requires understanding how adults assimilate new information. In particular, science-based museums, or science centers, comprise a large portion of most adults' exposure to science and technology, regardless of their nationality.

This article's authors explore the relationship between science centers and adults' level of science and technology literacy in countries around the world. In particular, the authors address the lack of research on science centers' ability to successfully engage and educate adults. In the past, studies have assessed adults' science and technology literacy through knowledge-based testing, but this study's authors also assessed other educational outcomes, including identity and curiosity.

To implement this approach, the authors designed a study spanning 13 countries and 17 communities, resulting in 6,089 participants drawn from a representative sample of each community. The surveys used a variety of indicators to assess the ways in which adult experiences at science centers might connect to educational outcomes related to science and technology. Those metrics included: science and technology knowledge; interest in science

and technology; identifying oneself as confident in science and technology; creativity and problem solving; and participation in science- and technology-related jobs, vocations, hobbies, and leisure experiences.

The surveys also addressed free-choice learning, a primary component of adults' experiences in science centers, as most adults voluntarily visit these educational spaces. Free-choice learning is a lifelong, informal pursuit of an education on topics and in settings of the learner's own choosing. The free-choice aspect of adults' science-center visits makes it challenging to have rigorous control variables in such a study.

To address the complexity and variability of science learning and science-center experiences, the authors implemented an epidemiological research approach with quantitative surveys as the primary data collection method. Although the science of epidemiology examines the distribution and incidence of disease, the methods that epidemiologists use to design their studies are applicable to any social science inquiry that faces validity issues due to a large number of complex, interconnected factors. These types of studies reveal patterns across varied demographics, rather than across individuals. This approach makes sense in the context of science centers, where visitors representing innumerable demographics have different levels of exposure to exhibits and other forms of informal education.

The research instrument was a paper-and-pencil survey designed for the comprehension level of a 14-year-old. The questions related to the aforementioned outcome variables, including knowledge and understanding, interest, and confidence in science and technology, as well as participation in science- and technology-related leisure activities, hobbies, and vocations. The researchers distributed the survey in 13 countries, as they recognized the importance of ensuring that the survey was culturally relevant; as such, they modified language and took into consideration input from the local science centers.

On the survey, 44% of respondents reported that they had previously visited a science center. Participants with higher levels of education reported they had visited science centers more frequently; in general, more frequent science center visits correlated with stronger outcomes. The researchers suggested, then, that level of exposure was relevant to the overall effect of the institutions. For example, more visits correlated with increased curiosity and interest.

The authors noted that a limitation of this study and its findings was the possibility of self-selection bias, which is unavoidable in free-choice learning environments such as science centers. The authors note that, while this likely influenced some of the observed correlations, it is not the primary driver of positive correlations.

After accounting for self-selection bias, the findings indicate that science center visitation had positive impacts on science literacy, regardless of factors such as education, interests, previous experiences, and income. The authors conclude by noting that there are likely significant positive correlations between adults' visits to science centers and (1) science and technology knowledge and understanding, (2) interest and curiosity in science and technology, (3) participation in science and technology activities, and (4) confidence and identification with science and technology.

THE BOTTOM LINE:

Although much of the focus on science education is on youth and families, finding ways to support science literacy for adults continues to be a critical need worldwide. Science centers can be important resources for doing so, as they provide opportunities for adults to continue engaging in science-and-technology ideas throughout their lives. Active, relevant, and changing programs and exhibits are avenues to attract new, as well as returning, adult visitors, who benefit from gains in a range of science- and technology-related outcomes, including knowledge, interest, engagement, and confidence.

Falk, J. H., Dierking, L.D., Prendergast Swanger, L., Staus, N., Back, M., Barriault, C., Catalao, C., et al. (2016). Correlating science center use with adult science literacy: An international, cross-institutional study. *Science Education*, 100(5), 849–876.

ENHANCING ENVIRONMENTAL EDUCATION THROUGH SHARED FAMILY MEMORIES

In today's world, people can learn about science in a variety of informal settings, such as museums, afterschool programs, and outdoor spaces. However, the factors contributing to long-term learning in these informal settings are vast, complicated, and not widely understood. This study's researchers set out to examine some of those factors by considering how memories, conversations, and social interactions among family members influence learning during an informal nature walk.

Previous research suggests that, if educators prompt students to remember, thinking about past experiences can enhance learning. This happens because memories can influence how an individual derives meaning from an experience. Called "meaning-making," this study's researchers applied the process to a broader social unit, focusing on how families make meaning from a nature-walk experience through conversations about past informal learning experiences.

The researchers collected data at the Shaver's Creek Environmental Center (SCEC). They followed 16 families, which included 54 individuals of varied ages. Families participated in short, guided hikes during which researchers listened for conversations about memories of informal learning experiences. The researchers recorded those conversations and analyzed them to see how memories may have influenced learning on the trail.

To analyze the data, researchers categorized the type of places that families discussed when recalling past informal learning experiences. Categories included everyday experiences, such as gardening; organized programs for science learning, like Boy Scouts; designed spaces, such as museums or aquariums; and science media. The researchers then traced pathways that connected those memories to the nature walk.

The results suggested that families were able to derive more meaning from objects and concepts on the nature walk when they related the objects and experiences to a memory. One study participant, for example, connected an observed plant to one he had seen in his backyard. Children were likely to connect the nature walk to past learning experiences during the SCEC camp.

Overall, this study's results confirm that family discussions of memories, and connecting those memories to present experiences, can enhance learning in informal educational settings. By tracing the connection between memories and meaning-making in informal settings, this study highlights the importance of connecting with past experiences in environmental education. This emphasizes the value of memories in making meaning on the trail, even if those memories are from months or years past.

THE BOTTOM LINE:

Informal learning experiences are most effective when they build on one another. When participants draw on the past to make meaning of their current experience, especially in a social context or setting, they learn and retain more. If environmental educators help participants draw upon their memories to enhance meaning-making in informal settings, educational programs can be more powerful catalysts of long-term environmental learning.

McClain, L. R., & Zimmerman, H. T. (2016). Memories on the trail: Families connecting their prior informal learning experiences to the natural world during nature walks. *Journal of Interpretation Research*, 21(2), 21–42.