

ENVIRONMENTAL EDUCATION

RESEARCH BULLETIN

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ABOUT THE RESEARCH BULLETIN

The *Environmental Education Research Bulletin* is a project of Dr. Nicole Ardoin and her team at Stanford University, with support from ChangeScale and ee360, a cooperative project of the U.S. EPA and the North American Association for Environmental Education (NAAEE). 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 (<https://naaee.org/eeopro/research/eeerb>). Please send questions and feedback to eereseearchbulletins@changescale.org.

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TABLE OF CONTENTS

EQUITY AND INCLUSION IN ENVIRONMENTAL EDUCATION

Tensions in Promoting Equity Through the Ambitious Science Teaching Approach	Page 5
Culturally Responsive Environmental Education and Immigrant Children	Page 6
Scholarship Initiatives and Wilderness Attitudes Among NOLS Students	Page 7
Authentic Teacher Care Encourages Reflective Environmental Engagement Among Minoritized Youth	Page 8

BEHAVIOR

Environmental Attitudes Are Strong Predictor of Post-Program Environmental Projects	Page 10
Prompting Students to Recycle Through Using Emoticons	Page 11
Using Social Learning to Encourage Renewable Energy Use in Homes	Page 12
Intergenerational Learning About Flood Preparedness	Page 13

TEACHING METHODS

Shared Decision-Making Frameworks for Youth Environmental Action	Page 15
Motivations to Teach Climate Change	Page 16
Connecting Prior Knowledge and Student Engagement During Field Trips	Page 17
Using Social Media to Learn Argumentation With Scientists	Page 19

SENSE OF PLACE AND NATURE CONNECTION

- Lasting Impacts of Urban Woodland Restoration on College Students Page 21
- Field Philosophy and Environmental Education in Isle Royale National Park Page 22

TECHNOLOGY IN ENVIRONMENTAL EDUCATION

- Countering Misinformation About Climate Change on Social Media Page 24
- Using Virtual Animal Encounters to Foster Environmental Knowledge Page 25
- Understanding Local Watershed Issues Using Photovoice Page 26

ZOO, AQUARIUM, AND SCIENCE CENTER EDUCATION

- Question-Asking in Exhibit Labels to Encourage Metacognition Page 28
- The Directed Use of Personal Mobile Communication Devices in Museum Page 29
- Designing a Playful and Collaborative Family Science Activity Page 30

INTRODUCTION

Dear Colleagues,

ChangeScale and the North American Association for Environmental Education (NAAEE) have collaborated with researchers at Stanford University to create this 13th issue of the *Environmental Education Research Bulletin* (EERB). Talented environmental educators are working with communities, using hands-on strategies, and making critical links that help enhance environmental awareness, build skills, and support informed action. Yet many of those committed professionals lack the time to keep up on the latest research, which may provide insight into how to improve the effectiveness of their work. We hope these Research Bulletins can help bridge the research-to-practice gap by summarizing recently reported research and helping practitioners use the results to enhance their programs.

This issue includes synopses of peer-reviewed journal articles that are particularly relevant for frontline environmental education practitioners. We reviewed issues (published between January and June 2017) of a number of environmental education-related journals, including *The Journal of Environmental Education*, *Environmental Education Research*, *Applied Environmental Education & Communication*, *Journal of Experiential Education*, *International Journal of Science Education*, *Science Education*, and *Visitor Studies*.

If you are interested in this research-and-practice interface, we encourage you to participate in the research and evaluation discussion on eePRO, NAAEE's professional development community. Visit <https://naaee.org/eepr/groups/research-and-evaluation> to join eePRO. You may also be interested in the NSF-funded Relating Research to Practice resource (<http://relatingresearchtopractice.org>), a joint effort of the Exploratorium, the University

of Washington, King's College London, and the Afterschool Alliance. Finally, if you have specific comments or questions about our summaries, email eerresearchbulletins@changescale.org.


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



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EQUITY AND INCLUSION IN ENVIRONMENTAL EDUCATION

TENSIONS IN PROMOTING EQUITY THROUGH THE AMBITIOUS SCIENCE TEACHING APPROACH

Ambitious Science Teaching is a teaching approach designed to improve deep understanding for students of all backgrounds through activities focused on central ideas, discourses, and problems within the science discipline. The four-part framework at its core emphasizes “intellectual engagement” and “attention to equity.” Encouraging educators to draw from interactions with students and embed learning within students’ experiences, Ambitious Science Teaching aims for meaningful science teaching and learning based on evidence-based explanations.

Yet, there are tensions in promoting equity in Ambitious Science Teaching. Equity-based learning strives for academic and social success for all students. It requires students to be active participants in constructing their own knowledge, rather than envisioning teachers and curricula as the sole sources of knowledge. In this study, the researchers observed a science educator to see how such tensions affected her teaching strategy.

Based on previous work, researchers classified tensions by four categories: conceptual (what counts as knowledge), pedagogical (competing learning goals), cultural (bridging students’ expectations with those of the school), and political (working in existing systems of accountability). The researchers concluded that those tensions are not only part of, but also are critical for, disruptive pedagogies such as ambitious science and equity-based learning. Managing and overcoming those tensions can help create a teaching environment in which all students can thrive.

The study focused on Ms. Dawson (a pseudonym), a middle-school science teacher in Seattle, because of her extensive experience teaching science and equity-based learning in a multicultural setting. The researchers observed her in two contexts: a public middle school and a summer program for low-income students.



To examine Ms. Dawson's teaching framework, the researchers gathered data through in-class observations, videos of classroom discourse, and follow-up interviews. They used focused, open, and selective coding (or a mix of inductive and deductive approaches) to analyze the interview and video transcripts for evidence of different kinds of tension.

The researchers found two main results with regard to tensions that were common across both contexts. First, conceptual and political tensions surfaced as Ms. Dawson became concerned whether students were learning the "right" thing. Sometimes she facilitated knowledge building (hands-on science/experiments), while other times she defaulted to more traditional knowledge displaying (texts/documentaries) as she worked to fulfill the obligations of the set curriculum. Second, pedagogical and cultural tensions interacted as Ms. Dawson struggled to teach students using their lived experience while also introducing fundamental academic ideas. For example, students created knowledge using their own vernacular, but they could not necessarily communicate the same concepts using academic vocabulary. Ms. Dawson was hesitant to privilege one way of understanding above another, but she felt obligated to prepare students for future academic success. Because of those tensions, Ms. Dawson was able to incorporate and use some principles of Ambitious Science Teaching, but not others.

THE BOTTOM LINE:

Ambitious Science Teaching, an equity-focused approach, includes practices designed to create a teaching environment in which all students can thrive. Teaching with an equity-focused approach or framework is likely to always have tensions between such new pedagogies and traditional teaching and school contexts. Educators, therefore, should not feel compelled to adhere solely to these methods but, rather, leverage some aspects of these pedagogies that are most appropriate to their specific teaching and learning setting. Teachers should pay particular attention, for example, to points where there may be roadblocks and/or obstacles, such as challenging language. In those instances, combining traditional and new practices may

help facilitate understanding and provide productive starting points. Similarly, educators might develop productive pedagogical frameworks by engaging some of these tensions through discussions and reflection with their colleagues.

Braaten, M., & Sheth, M. (2017). Tensions teaching science for equity: Lessons learned from the case of Ms. Dawson. *Science Education*, 101(1), 134–164.

CULTURALLY RESPONSIVE ENVIRONMENTAL EDUCATION AND IMMIGRANT CHILDREN

Considering student perspectives or allowing for significant student action within environmental education (EE) can be challenging, despite students often learning more when EE material relates to their background. Immigrant youth, in particular, bear this burden, as EE is seldom grounded in their cultural contexts. However, culturally responsive EE, as well as EE situated through nurturing a sense of place, not only aids students' personal development, but also allows them to bring what they learn home to their families. This study asked whether immigrant students in Quebec who engaged in EE programs were able to actively connect their families with environmental learning.

Over two years, the researchers who designed and implemented this study collected quantitative and qualitative data through interactions with students, teachers, and parents at a school in Quebec. First, the researchers led focus groups with students, grades 4 to 6, asking them open-ended questions about their experiences with EE. A multiple-choice questionnaire was also included, assessing how children learned about the environment in school and at home. Second, the researchers held 90-minute focus groups with teachers, asking questions about culturally responsive EE. Third, the researchers had five 60-minute focus groups with the students' immigrant parents. Researchers asked parents about: communication between the school and home,

how and if the school took their cultural backgrounds into consideration, their interest in the environment, and their perception of children's roles in the family. The data were coded thematically, first by the research team looking through the data and creating codes as a group, and then using HyperResearch, a code-and-retrieve computer data-analysis program.

The researchers found that EE that takes into account student background helps youth create connections between their schools, homes, and communities. Teachers elaborated on immigrant children being a special link between the schools and their parents; for example, children could talk to parents who did not speak English or French. Acting as environmental educators within their homes, students talked with their parents about what they learned in school, and some parents even changed their behaviors based on these conversations. Taking this active role helped increase children's sense of self-efficacy and agency.

Students also brought their cultural contexts into the classroom; for example, EE in the West often emphasizes recycling, but when students talked to their parents, they described how more things were reused rather than recycled in their home countries. Children could then bring up the topic of recycling versus reusing to their teachers. However, even when considering culturally responsive EE, most opportunities continued to be unidirectional, with information moving from school to student to parents, and rarely the other way around.

THE BOTTOM LINE:

Taking into account the cultural backgrounds of immigrant students not only serves the youth better in learning about the environment, but it also fosters personal development. These children can act as educators when interacting with their families and communities. They can also bring their own cultural context to the classroom, providing a different outlook on pro-environmental behavior than typical Canadian ways of thinking (e.g., recycling versus reusing). Finally, culturally responsive EE can also connect young immigrants to public life as well as further their identity and role as citizens.

Blanchet-Cohen, N., & Reilly, R. C. (2017). Immigrant children promoting environmental care: Enhancing learning, agency and integration through culturally-responsive environmental education. *Environmental Education Research*, 23(4), 553–572.

SCHOLARSHIP INITIATIVES AND WILDERNESS ATTITUDES AMONG NOLS STUDENTS

Outdoor experiential education programs can deeply shape students' attitudes about the environment and, as such, are a promising way to increase the diversity of people and ideas that are welcomed in environmental spaces. Recognizing the disparity in demographics between typical experiential program participants, who tend to be white and upper-middle class, and the broader U.S. population, outdoor education programs have implemented a number of initiatives to increase their accessibility and relevance to a wider range of participants.

One such initiative is the Gateway Scholarship Program of the National Outdoor Leadership School (NOLS), a scholarship awarded based on an interest in the outdoors and financial need, primarily for students who self-identify as persons of color. The researchers conducting this work were interested in whether students participating in NOLS through the Gateway Scholarship had significantly different wilderness attitudes than nonscholarship participants before and after their course experience.

Researchers surveyed a total of 74 NOLS students in the autumn after their participation in a summer course. Of those, 33 students had applied for and received a Gateway Scholarship and 41 had not. The researchers also interviewed 19 of the students for insights into the particular ways their attitudes about wilderness and environment had changed.

Results indeed showed significant differences between scholarship and nonscholarship participants in both

pre-course wilderness attitudes and in perceived change as a result of the course. The researchers note, however, this may have been partly driven by nonscholarship participants' consistently high responses about their pre-course attitudes.

Promisingly, the surveys and interviews suggest the NOLS course made students—especially scholarship participants—feel more connected to their ecological community and more aware of negative human environmental impacts. Participants also highlighted elements of their experiences that were especially meaningful; namely, the wilderness medicine and Leave No Trace Skills components and the time allotted for reflecting on their outdoor experience. Gateway scholarship participants' attitudes toward wilderness were significantly more positive following their NOLS course. Importantly, however, they also voiced concerns about barriers to participating in other wilderness experiences due to cost, distance, and continued perceptions of how removed wilderness seemed to be from their home environment. The way that wilderness and environment are perceived by program participants, even after course involvement, thereby seems to be impactful for continued participation and a key element of making such experiences relevant in the long term.

THE BOTTOM LINE:

Outdoor experiential program scholarships may be constructive avenues toward making wilderness experiences more accessible and relevant for a broader range of students. To meaningfully diversify such outdoor spaces, however, programs should also focus on expanding the narratives and relationships with the outdoors that they explicitly voice and value. To do so, programs can examine the underlying narratives about wilderness that their curricula communicate, as well as the implicit assumptions that participants and instructors may have about wilderness. Program leaders can consider the ways in which wilderness ethics are, or are not, transferable to everyday life, and purposefully invite—from instructors and the students

themselves—broader narratives of how connections to nature can be achieved, both during and after the program.

Gress, S., & Hall, T. (2017). Diversity in the outdoors: National Outdoor Leadership School students' attitudes about wilderness. *Journal of Experiential Education*, 40(2), 114–134.

AUTHENTIC TEACHER CARE ENCOURAGES REFLECTIVE ENVIRONMENTAL ENGAGEMENT AMONG MINORITIZED YOUTH

Education literature has long established that authentic care from adult mentors is crucial for youth—particularly minoritized youth—to develop positive relationships with each other, their school, and their wider community. This study affirms those connections and applies them to the environmental sphere by exploring how the authentic care shown by an environmental science teacher encouraged his students to expand their care for the ecological renewal of their local neighborhood.

In this critical case study, the researchers collected in-depth qualitative data about a particular teacher, his students, and their joint academic and extracurricular activities. The researchers conducted a combination of four interviews with the teacher, six group interviews with a total of 18 students, and more than 30 classroom and extracurricular environmental activity observations. The diverse demographics of the school (63% free/reduced lunch eligible; 55% white, 23% black/African American, 18% Hispanic/Latino, and small populations of American Indian, Alaska Native, Asian, and multiracial students) and the history of environmental and economic degradation of the city as a result of deindustrialization also provide important contexts for the study. To guide their work, the researchers used Nel Nodding's (1992) influential framework of an *ethic of caring*, which takes

the stance that compassion and authentic care need to be central parts of educational decision-making, rather than secondary considerations.

This study makes a key connection with Nodding's ethic of caring framework in distinguishing between *aesthetic* and *authentic care* when examining the behavior and beliefs of the environmental teacher. Aesthetic care refers to the support and approval given to students for following school policies, such as attending class and completing assignments. In contrast, authentic care involves working to understand students and their families or, as the students in the group interviews shared, "really caring about [us] as people and not just as learners." Previous literature suggests that, once students feel authentic care, they are more likely to respond to aesthetic care; students must first, however, unambiguously perceive this relationship of unconditional care. The students in this study represented the teacher as caring about them regardless of adherence to school policies, and as always being willing to engage with them when they were present, independent of prior behaviors or trancies.

Importantly, the teacher also intentionally extended his authentic care to relationships between the students and their environment, purposefully connecting ecological lessons with a politicized ethic of care for the students and their homes. The teacher often led discussions that examined relationships between the economic, social, and health aspects of environmental impacts in the students' local communities, such as discussing asthma rates related to a nearby air pollution source. In purposefully expanding authentic care to the students and their environments, the teacher consistently emphasized teaching for the environment and related social issues as a part of learning *about* the environment. A noteworthy consequence for the students, then, was that they frequently discussed the community's improving well-being in positive, hopeful ways, in contrast to the "failing community" narrative that pervaded other local perceptions. These emphases on renewal, care-driven

collective action, and within-community environmental justice were particularly important ways in which the teacher's authentic care was successfully passed on to the students and increased their ability to recognize the potential they have to shape their local spaces.

THE BOTTOM LINE:

Just as caring adults can help connect youth more strongly with academic trajectories, those same adults can demonstrate authentic care for students, their families, and their communities with cascading beneficial effects for environmental connections as well. Practitioners and educators can facilitate students' orientation toward taking action within their communities by purposefully presenting how much they care that their students are impacted by, and in turn can impact, their local environment. Building authentic relationships between marginalized youth and their ecological community is a persistent goal for environmental and educational equity; practitioners and educators can create unambiguous, authentic caring relationships to act as a focal point for strengthening these student-environment connections by demonstrating authentic care for students, their families, and their communities.

Schindel, A., & Tolbert, S. (2017). Critical caring for people and place. *The Journal of Environmental Education*, 48(1), 26–34.

BEHAVIOR

ENVIRONMENTAL ATTITUDES ARE STRONG PREDICTOR OF POST-PROGRAM ENVIRONMENTAL PROJECTS

Environmental education addresses complex environmental, sustainability, and conservation-related issues through a range of approaches that seek to positively impact participants' attitudes, values, knowledge, and efficacy-related skills. Yet when it comes to taking action on those issues, a question remains: How might young people appropriately and effectively engage in locally relevant, meaningful actions—and, perhaps more importantly, how might those actions be sustained over time?

In this survey-based study, researchers examined youth environmental action in the short and long term by evaluating several key dimensions of a conservation program. The researchers defined “environmental actions” as those actions that explicitly contribute to addressing environmental problems. In this study, the actions ranged in their impact on environmental concerns and were generally measured through the students' implementation of conservation projects, such as recycling systems, carpooling programs, and rooftop gardens.

The study was implemented with participants in the Student Climate and Conservation Congress Program (SC3), implemented by the Green Schools Alliance and the U.S. Fish and Wildlife Service. The program, designed for youth environmental leaders, is a weeklong event for high-school students. During the program, the students engage with complex environmental issues through presentations, discussions, community service, outdoor recreation, and conservation-project planning.

To recruit survey respondents, the researchers invited all high-school-age youth attending the SC3 to participate in the study through an introductory letter, which included a parent consent form. The researchers conducted a pre-, post-, and delayed post-program survey, with the delayed-post survey taking place 8 months after the program's completion. Pre-survey respondents included 98 out of 103 SC3 attendees, and 45 respondents (of the initial 98) also completed the delayed-post survey. The pre-survey respondents were in grades 8 through 12; 63% identified as female and 37% as male. With regard to race and ethnicity, 60% identified as Caucasian, 18%



as Asian, 12% as Latino, 7% as African American, and 3% as Native American. About 40% of the respondents received financial aid to attend the weeklong program.

To design the survey, the researchers adapted most of the measures from other studies to gain the benefit of using previously validated instruments. The pre-program survey, adapted from the Earth Force Student Survey, measured environmental attitudes, locus of control, and sense of personal responsibility. The post-program survey measured the same variables as the pre-program survey, as well as intention to act through inquiring about the planned environmental project. The delayed post-program survey focused on implementation of the projects and commitment toward future involvement in environmental action, such as leading their school or community in actions to address environmentally related issues, becoming involved in environmental volunteerism, taking environmentally related courses, or pursuing an environmentally related career.

Using correlational analysis and multiple regression, the researchers found that variables that predicted environmental action included a student's environmental attitude as measured before the program. First, pre-program environmental attitudes were significantly correlated with environmental action such that students who had more positive environmental attitudes at the beginning of the program were more likely to follow through with their projects after the program.

Interestingly, participants whose environmental attitudes increased after the program were less likely to follow through with their environmental action projects. Participants whose attitudes did not change or decreased after the program were more likely to follow through on their projects. However, a student's pre-survey environmental attitude was the only significant predictor for environmental action in a model that included all four variables (environmental attitudes, locus of control, sense of personal responsibility, and environmental action).

Second, pre-program environmental attitudes and personal responsibility were predictors of intention for

future involvement in environmental action. However, pre- to post-program changes in environmental attitudes, personal responsibility, and environmental action were not indicators of future involvement. And third, environmental action and intention toward action were not predictive of future involvement in environmental action, suggesting that working on an environmental project may not necessarily lead to future environmental action.

The researchers caution that the sample size of this study was small, may have been biased toward students selected for their environmental leadership qualities, and reflects one specific program. Because of those considerations, the findings require further research before they can be generalized to a broader population.

THE BOTTOM LINE:

Research finds that incoming environmental attitudes can be a strong predictor of environmental-action outcomes of education programs, particularly among youth. Therefore, selecting at least some participants who demonstrate strong pro-environmental attitudes may be important when considering group composition, as those participants can be more likely to have success in following through with environmental action projects. Those who are predisposed toward environmental causes might also be active agents in encouraging action among their peers.

Ernst, J., Blood, N., & Beery, T. (2017). Environmental action and student environmental leaders: Exploring the influence of environmental attitudes, locus of control, and sense of personal responsibility. *Environmental Education Research, 23*(2), 149–175.

PROMPTING STUDENTS TO RECYCLE THROUGH USING EMOTICONS

One effective strategy to promote desired behaviors can be to use a point-of-decision prompt: this involves priming people at the time they are making a decision. Point-of-decision prompts have been used in promoting pro-environmental behaviors, such as signs that remind

one to turn off the lights when exiting a room. However, previous research has dealt with points of decision after an action or as a way to discourage future actions. In that vein, this paper considers point-of-decision behaviors related to recycling as influenced by negative emoticons: specifically, red frowny-face emoticons. The researchers asked whether prompting students with emoticons on trash cans would result in more pro-environmental recycling behaviors.

The researchers decided to use red frowny-face emoticons as past research has shown that frowny faces can symbolize disapproval, while the red can denote avoidance or “stop” (on stop signs, for example). The experiment had two phases: first, a field study at an elementary school in Bloomsburg, Pennsylvania (known for being a green community); and second, a laboratory study at a northeastern university. The two methods allowed for a more generalizable result beyond the young children. At the elementary school (750 students and faculty), the researchers followed regular recycling patterns over 2 weeks, and then put red frowny-face emoticons on the trash bins for the next 2 weeks. At the university, where 192 undergraduates participated, the researchers told students they were assessing scissors for a market study. The undergrads used the scissors to cut a paper into four pieces. They were asked to dispose of the paper, and then walked past trash and recycling bins outside of the testing room. For some, the trash lids featured an emoticon stuck on the lid; for others, there was nothing featured on either of the bins.

In the first experiment with elementary-school students, the researchers calculated the ratio between how much the recycling weighed and how much both the recycling and trash weighed. A larger ratio suggested that more materials had been recycled, while a smaller ratio meant more material had been trashed. The results showed that, for the two weeks with the emoticons, the ratio was significantly higher in terms of recycling than the weeks without. For the second experiment with the university students, when the frowny faces were present, students

were significantly more likely to recycle their paper than when they were absent.

Both of these experiments suggest that the presence of frowny face emoticons affected young people’s behaviors. Although adolescents and young adults are often less responsive to more intensive environmental programs, this research suggests that simple point-of-decision prompts, such as emoticons, can positively impact desired resulting behaviors.

THE BOTTOM LINE:

During environmental programs and/or interventions, using small prompts at key points of decision can be a simple way to encourage pro-environmental actions. For example, placing red frowny-face emoticons onto trash cans next to recycling bins may offer an inexpensive, effective way to encourage people to use the recycling rather than the trash bin. Such a technique is likely to be most helpful when paired with an existing environmental education curriculum.

Meng, M. D., & Trudel, R. (2017). Using emoticons to encourage students to recycle. *The Journal of Environmental Education*, 48(3), 196–204.

USING SOCIAL LEARNING TO ENCOURAGE RENEWABLE ENERGY USE IN HOMES

Many homeowners are interested in using more renewable energy within their houses, but are unsure how to incorporate or use those systems. An educational option for homeowners is eco-home open days, or Open Homes. In Open Homes, homeowners who have made energy refurbishments open their houses to people who are interested in adding green-energy systems to their residences.

This study takes place in Finland, using a variation on the Open Homes idea as part of a climate initiative for local governments. The researchers asked two questions about Open Homes events: First, during such events,

what kinds of learning happens at individual, network, and institutional levels? Second, do Open Homes events have the potential to be self-sustaining?

The framework of Open Homes draws from social learning theory, which suggests that people learn complicated social behaviors by attending to and imitating others. Learning from one's peers offers an alternative, and perhaps more effective, way to teach about sustainability and energy conservation than top-down, expert-based approaches.

The Open Homes visits took place in three municipalities in Finland. Each visit was 3 hours, moving between three to four homes with renewable energy heating systems. The researchers identified three levels for analysis: the individual, the network, and the institutional. To gather data at the individual and network levels, the researchers noted what homeowners said and did during the visits, invited some of the homeowners to complete a short survey, and asked if the homeowners would be willing to complete a follow-up interview. Of the 54 people who responded to the survey, the researchers interviewed 10 homeowners 1 to 2 years later. To analyze the institutional level, the researchers interviewed and emailed local government officials.

On the individual level, the researchers found three main kinds of learning: participants and their peers learned about renewable energy systems through (1) directly interacting with the systems themselves, (2) seeing the types of people who use the systems, and (3) gaining hands-on information about the systems. Only 2 of the 10 participants interviewed proceeded to invest in similar energy systems, and a few others went on to make minor changes inspired by the tours. However, almost all of participants said they were more energy conscious after attending the Open Homes.

On the network level, Open Homes prompted conversations about renewable energy during and after the tours, helping create new advocates and inspire existing ones. On the institutional level, Open Homes successfully continued in one location, Mynämäki, but not in the two others.

THE BOTTOM LINE:

Open Homes, which is a demonstration educational program that offers hands-on tours of real houses using energy-efficient systems and face-to-face interactions with peers, offers an effective way for communities to encourage the use of renewable-energy systems. Within the Open Homes context, seeing regular people using such systems reveals that such systems are solutions that participants can use, too. Peer-to-peer learning can extend beyond the program as well: Open Homes participants talk with people who did not attend the program, telling them about both the homes as well as renewable energy solutions.

Heiskanen, E., Nissilä, H., & Tainio, P. (2017). Promoting residential renewable energy via peer-to-peer learning. *Applied Environmental Education & Communication*, 16(2), 105-116.

INTERGENERATIONAL LEARNING ABOUT FLOOD PREPAREDNESS

With the frequency of flooding increasing in the United Kingdom and around the world, flood-risk management and preparedness has emphasized the need for learning how to live with floods and adapt at local levels. However, children are underrepresented in flood preparedness efforts and undervalued as agents of change. This study explored whether intergenerational learning—specifically, children teaching adults—could be a useful strategy for building household and local community resilience to floods. The researchers developed a flood education resource for children ages 7 to 9 and asked two main questions: First, how did the intervention affect children's learning about flood and flood preparation? Second, did children share what they learned with their families?

The researchers used a “new sociology of childhood” approach, related to participatory methodological theory, to evaluate the effectiveness of their flood education resource. Three ideas underpinned the study: (1) children should be active participants in and benefit from the experience; (2) children should be recognized as a group that can effect change and take action in dealing with

climate change; and (3) children should be involved in the research process, including the development of research experiments.

Using this theoretical framework, the researchers worked to collect data in three phases with 68 students from two UK schools in deprived areas. In Phase 1, researchers talked about flood preparedness with groups of children in their classrooms; the children then made “treasure boxes” or flood boxes. The researchers put key flood preparedness information into the finished boxes, which children brought home to their families. For Phase 2, the researchers interviewed each child to explore what they learned from the activity, what they did with their treasure boxes and whether they discussed flood preparedness with their families. Finally, in Phase 3 the researchers conducted semi-structured telephone interviews with 21 parents. The interviews focused on whether they knew about their children’s flood preparedness activity and whether any intergenerational learning or changes in family behavior had happened. The researchers interviewed children and parents. The interviews were recorded, transcribed, and coded initially; the transcripts were then destroyed. The data were then coded a second time to produce final overarching themes.

Children, teachers, and parents all spoke positively about the treasure box activity. Interviews with children revealed that most children recalled flood preparedness information from the activity with a high level of detail. Seventy-five percent of the children reported discussing flood preparedness with their immediate and extended family after the activity. Parental interviews showed that all but one of the parents who were interviewed were aware of the treasure box and flooding activity at school.

Three thematic codes emerged from the study that might hinder or enhance intergenerational learning: empowerment/disempowerment of children within their families, parents’ disconnection, and parents’ contradiction. Although some parents were open to being educated and influenced by their children, others were not. Some parents viewed the treasure box as simply a

school project, disconnected from their own lives, and/or did not consider flooding as an actual threat to their families. Finally, all parents strongly agreed that children should be taught flooding preparedness, but some were reluctant to talk about flooding with their own children, believing that they were too young or the information was too scary.

THE BOTTOM LINE:

Age-appropriate, participatory, and creative lessons and activities, such as creating “treasure boxes” filled with flood preparedness information and items, can be effective avenues for teaching young children about flooding and flood preparedness. Children may retain information from and enjoy such experiences; they may also bring that information back to their families. Such intergenerational learning has the potential to positively influence household knowledge of, and behavior around, flood preparedness. However, some families may not want to learn from their children and/or see flooding as a real risk. Further effort might focus on designing informal family-based preparedness programs that highlight the crucial role of children in household preparation and resilience as well as local flood risk levels.

Williams, S., McEwen, L. J., & Quinn, N. (2017). As the climate changes: Intergenerational action-based learning in relation to flood education. *The Journal of Environmental Education*, 48(3), 154–171.

TEACHING METHODS

SHARED DECISION-MAKING FRAMEWORKS FOR YOUTH ENVIRONMENTAL ACTION

Youth environmental action projects provide opportunities for fostering young people's personal growth, pro-environmental values, and civic engagement related to environmental issues. However, the sharing of decision-making power among youth and adults in such projects can elicit tensions for educators between encouraging youth autonomy while maintaining some adult authority.

This study explored this “autonomy-authority duality” from the perspective of adult educators and practitioners. Participants included 33 educators and practitioners who facilitate participatory environmental action projects with youth (ages 10 to 18) across the United States. In interviews, the researchers asked these practitioners to reflect on successful components of participatory environmental action projects. The authors defined environmental action projects as solutions-focused, iterative processes that incorporate civic engagement and science through youth-led inquiry. In this study, examples of environmental action included working in community gardens and/or undertaking habitat restoration activities; monitoring water quality; installing filters to improve air quality; and addressing environmental justice-related issues. The researchers identified study participants through peer referrals or national award programs relevant to the study's focus. They then selected participants with a range of positions, such as informal and formal educators. They selected for a range of types of program and climate, programmatic contexts, educational settings, and geographic locations to maximize the sample's diversity. The primary researcher conducted semistructured interviews (either by telephone or in person) with all 33 participants asking each to tell the story of a specific action project, with a particular focus on examining the steps and role of youth.

The authors inductively coded the interview data by identifying two to three main themes for each interview and then finding emergent categories. Reviewing the overarching themes iteratively, they refined codes and categories relating to the experiences of shared decision-making processes. All interviewees described experiencing tensions in sharing decision-making power and reported diverse strategies they used to navigate those tensions. Four key strategies emerged:



structuring youth participation, supporting youth, valuing mutual learning, and communicating transparently to develop equitable relationships.

The interviewees described a spectrum of control and responsibility given to youth participants in the programs. Common trends were also evident, including a democratic structure giving power to youth, support through guided reflections, and workshops that prepared youth to use new skills. Equitable relationships between youth and adults relied on the last two components: recognition of mutual learning opportunities through the decision-making process, and transparent communication that created a safe space for youth to lead and value adult wisdom in true partnership.

Practitioners/educators reported creating a structure for youth decision-making that included setting an overall project goal within which young people decided how to implement that goal. The structure also helped them assess the feasibility of different potential directions. Educators supported youth by preparing them through initial training (such as workshops and skill practice) and by facilitating reflections as well as asking guiding questions. Educators also recognized themselves as learners in environmental action and supported mutual learning opportunities with young people. Finally, educators created safe spaces for honest, transparent communication to develop equitable relationships among themselves and youth.

THE BOTTOM LINE:

Adult educators who seek to facilitate young people's authentic participation in environmental action can experience tensions in sharing decision-making power. Yet educators can use diverse and creative strategies to navigate those tensions. Such practices fall within the broad themes of: creating an effective structure for youth decision-making and participation; fostering mutual learning; supporting youth prior to and/or throughout the project to help develop skills and agency; and creating opportunities for youth to reflect and voice their perspectives on the project. Educators can tailor those

strategies in their own project based on context, young people's interests and capabilities, their own level of comfort with sharing decision-making power, and factors such as resources, time, and/or program requirements.

Schusler, T. M., Krasny, M. E., & Decker, D. J. (2017). The autonomy-authority duality of shared decision-making in youth environmental action. *Environmental Education Research*, 23(4), 533–552.

MOTIVATIONS TO TEACH CLIMATE CHANGE

Despite the potentially controversial nature of climate change, polling suggests that as many as 70% of middle-school science teachers are already teaching about some aspect of the topic. On average, however, teachers only spend one hour per year on the topic. This study's researchers believe that climate change, a complex, systemic issue, needs more time to be taught effectively. To that end, the research team sought data about classrooms where climate change is taught more extensively and successfully.

This study used focus-group conversations with middle-school teachers who actively engaged with the topic of climate change in their classrooms to investigate how educators teach about climate change. The authors hypothesized that teachers were partially motivated to address climate change because of its recent inclusion in the Next Generation Science Standards (NGSS).

The authors recruited middle-school teachers via email invitation using professional contacts, listservs, and snowball recruiting to participate in one of three online focus groups, each with between five and eight participants. The participants were from different states and schools to maximize diversity in the sample. The states where participants taught included some significantly affected by climate change; some with left, right, and mixed political leanings; and some that had, as well as others that had not, adopted NGSS. The focus group

participants were all middle-school science teachers with at least two years of teaching experience who reported that they annually taught about climate change.

The researchers initiated the group conversations by asking about participants' motivations for teaching about climate change, their sources of climate change-related information, strategies they used to sustain their teaching on climate change, their experiences with and strategies for handling controversy in their classrooms, and whether they received support from their administration. The researchers recorded, transcribed, coded, and analyzed the conversations between participants, focusing primarily on teachers' statements about their motivations for teaching about climate change.

The findings indicated two primary trends in what motivated the teachers to educate their students about climate change. First, the researchers found that the teachers identified as scientists as strongly as they identified as educators. This not only influenced their overall motivation to teach about climate change, but also led them to engage students with scientific processes through asking questions, critically evaluating information, and drawing their own conclusions. Most had formal training in earth sciences at the undergraduate or graduate level, and all reported having confidence in their own understanding of the subject matter as well as their ability to teach about it in their classrooms. Second, many of the teachers also had direct connections with research scientists and benefited from their expertise. Those connections allowed their students to participate in climate change-related research on a local scale and make scientific contributions. The teachers' personal interest in and values toward the environment and sustainability also motivated them to teach about climate change.

Overall, the study's findings did not confirm the researchers' initial hypotheses. None of the teachers mentioned the adoption of the NGSS as a reason for including climate change education in their classrooms, and little reference was made to the controversial nature of teaching about climate change. Most teachers believed that, by engaging

with climate change through scientific research and data-driven inquiry activities in which students draw their own conclusions, they were able to circumvent controversy. The researchers conclude that the teachers demonstrate that more collaboration among educators, as well as between educators and scientists, could enhance teachers' comfort related to teaching about climate change.

THE BOTTOM LINE:

Although climate change can be a challenging, complex topic for teachers to address in classrooms, many middle-school science teachers across the United States include it in their curriculum. Teachers who incorporate climate change into their lessons often draw on their own interest in science and environmental topics and issues, collaborate with local scientists, and use data-driven inquiry activities. Such strategies help not only to engage students with the topic, but also to circumvent controversy. Adopting such strategies may help educators who are hesitant to address climate change or who are just beginning to teach about the topic, thanks to the adoption of the Next Generation Science Standards. In addition, collaboration between teachers and scientists may help enhance teachers' comfort levels in addressing climate change; concurrently, such collaboration can provide students with firsthand opportunities to make sense of climate change evidence.

McNeal, P., Petcovic, H., & Reeves, P. (2017). What is motivating middle-school science teachers to teach climate change? *International Journal of Science Education*, 39(8), 1069–1088.

CONNECTING PRIOR KNOWLEDGE AND STUDENT ENGAGEMENT DURING FIELD TRIPS

Including informal learning experiences, such as field trips, in the formal school curriculum is one way to more closely link classroom experiences with students' everyday lives. Such connections can increase students' scientific literacy, learning outcomes, and overall motivation. When

working to connect school with everyday life through field-trip experiences, educators can use certain methods, approaches, and techniques to enhance learning. This study explored how educators can design a preparatory lesson that builds on students' prior knowledge and considers socioeconomic status (SES) in service of maximizing student engagement with a zoo exhibit.

The researchers conducted this study with 210 seventh-grade students (12- to 14-years-old) from two urban schools in a major Southeastern U.S. city. One school was comprised mostly of low-SES families and the other mostly of middle-SES families. The middle-SES school and the low-SES school had 35% and 82% of students receiving free and reduced lunch, respectively. Within each school, the researchers randomly divided students into two groups who received different prior-knowledge treatments a week before a zoo field trip. The experimental group participated in a preparatory lesson on the field trip-related content about brain anatomy. The control group participated in a preparatory lesson on heart anatomy, a topic unrelated to the field trip. Then, both groups visited a local zoo, spending half the time rotating through interactive indoor exhibits on neuroscience, including one specific exhibit comparing animal species' brain anatomy. Each group spent 12 to 15 minutes at the exhibit and two pairs of trained researchers observed and recorded each students' behaviors, using body language and verbal cues to rate levels of attentiveness (attentive, neutral, or inattentive) at regular 1-, 4-, and 7-minute intervals. Researchers used the scores to generate an average percentage of time spent being attentive, neutral, and inattentive with the brain anatomy exhibit for each group. Then, researchers compared the average duration of time that each group spent being attentive, using attentiveness as a measure of student engagement.

The researchers statistically analyzed the data to examine the relationship between school SES and preparatory treatment on students' engagement levels. The researchers found that, in the low-SES school, students in the experimental group (those who received the brain-related preparatory lesson) were significantly more attentive

during the field trip than those in the control group (who received the heart-related preparatory lesson). The students from the middle-SES school, however, in both experimental and control groups, showed similarly high levels of attentiveness. Furthermore, researchers found that students in the experimental group from both the low- and middle-SES schools were able to access and use their prior knowledge during the exhibit to ask and answer questions as well as discuss the animal models with the presenter and their classmates.

These findings suggest that, while a preparatory lesson on field trip-related content may be beneficial for all students, it may have greater impact in increasing engagement and learning for low-SES students. The researchers suggest that this may be because low-SES students may not have as many opportunities as others to visit zoos and museums due to associated costs; therefore, they may be less familiar with informal educational settings such as these. The researchers also found that overall larger group size was associated with lower student engagement.

Based on the study's findings, the researchers recommend that teachers consider preparing students for field trips using several specific techniques. These techniques, designed to maximize engagement and learning in informal settings, include partnering with informal educators to provide students with relevant resources, and teaching content related to the upcoming field trip.

THE BOTTOM LINE:

Informal educational experiences, such as field trips, can enhance formal curricula. To maximize student engagement and positive learning outcomes, however, educators should prepare their students prior to these experiences. Research-based strategies include partnering with informal educators to enhance and build students' relevant, specific knowledge prior to the trip, and using similar instructional approaches as those at the field-trip sites. Educators can also conduct a pre-visit site orientation, using videos or online resources, to minimize student distraction once arriving at the field-trip site. Such preparatory lessons are particularly important for lower-SES students or when students may

not have access to informal learning sites on a regular basis. Developing partnerships between formal and informal educators can assist in connecting informal-setting content with curricula as well as developing materials and tools that teachers can use with their students prior to their field trip.

Pecore, J. L., Kirchgessner, M. L., Demetrikopoulos, M. K., Carruth, L. L., & Frantz, K. J. (2017). Formal lessons improve informal educational experiences: The influence of prior knowledge on student engagement. *Visitor Studies*, 20(1), 89–104.

USING SOCIAL MEDIA TO LEARN ARGUMENTATION WITH SCIENTISTS

The adoption of the Next Generation Science Standards (NGSS) has shifted educators' focus away from knowledge acquisition to helping students understand the construction and application of scientific ideas in context. This notion of practice-based learning requires creating classroom-based opportunities for engaging in authentic science and understanding how scientific knowledge is generated and communicated by professional scientists on an everyday basis, through practices such as argumentation.

To that end, this study explored a partnership between climate scientists and students, facilitated through a social media platform. The researchers were interested in how students developed scientific argumentation skills through practice-based learning with experts. The study centered on a 6-week climate change module within a yearlong life sciences curriculum. In the module, students performed fieldwork, analyzed professional data sets, and used computer modeling to understand climate change impacts, while also developing infographics to communicate their findings. Throughout the module, students used a social media platform that connected them to scientists who periodically provided feedback on student work. Participants included three ninth-grade classes from two schools, with 49 total students. Researchers used a mix of inductive and deductive approaches to analyze students' draft and final infographics as well as scientists' feedback.

Overall, through cycles of feedback with expert scientists, students improved their infographics, according to an assessment rubric that the researchers developed. Common revisions included adding text to support the students' claims and/or providing new evidence, adding graphs or figures, reorganizing information, and removing elements. Students improved their infographics by adding evidence or increasing their depth of explanation, often by adding mechanistic explanations. Although initial infographics were typically simplistic, they grew in complexity over time.

Results demonstrated that, in their feedback to students, scientists modeled their own practices and processes of building arguments and communicating, encouraging students to seek additional evidence. Often, in seeking more evidence, students engaged in additional scientific practices, such as asking probing questions and using mathematical thinking. According to the researchers, scientists' feedback pushed students to engage more holistically in scientific practices, as doing one practice often involved incorporating many other practices. Also, researchers described the infographics and the data sets that students used as "boundary objects" through which students could learn in partnership with scientists. The work provided a connection point where students could construct personally relevant ideas and engage in practice-based learning along with real scientists. This finding suggests that practice-based science learning should include publicly available, professional data sets, as they provide a window for students into the everyday practices of scientists.

THE BOTTOM LINE:

Experiences in which students work with expert scientists can support more holistic engagement in scientific practices. Working through cycles of feedback with scientists pushes students to incorporate several different scientific practices as they construct evidence-based arguments. Using publicly available, professional data sets helps students engage in authentic scientific practices in a way that is personally relevant and allows

for a meaningful connection point between students and scientists. Teachers can use prior examples of student/scientist partnerships as models to support practice-based learning of argumentation in their classrooms. Successful practices from prior models include encouraging students to investigate data around related research questions; engaging students in the analysis and data mining of large-scale professional data sets; and asking open-ended, probing questions that elicit reflection and more evidence seeking by students.

Walsh, E. M., & McGowan, V. C. (2017). “Let your data tell a story”: Climate change experts and students navigating disciplinary argumentation in the classroom. *International Journal of Science Education*, 39(1), 20–43.

SENSE OF PLACE AND NATURE CONNECTION

LASTING IMPACTS OF URBAN WOODLAND RESTORATION ON COLLEGE STUDENTS

Community environmental restoration, or eco-restoration, projects have the potential to lead to positive environmental impacts and affect student learning. Such projects can supplement in-class learning and, in the process, enhance students' academic outcomes, teamwork skills, personal development, civic engagement, and pro-environmental behaviors. However, past research has not addressed how long those outcomes last, especially for projects that take place in urban green spaces. Concurrently, urban restoration projects are becoming increasingly relevant, as 50% of the world's population now lives in urban areas. This study worked to address that gap by focusing on the long-term impacts of an urban woodland eco-restoration service-learning project for college students.

In this study, researchers worked with 12 college students who were part of a service-learning project with the Bloomington Urban Woodlands Project (BUWP) in Indiana. Researchers recruited potential participants by sending email invitations via the course web forum of three biology classes. The authors studied the BUWP urban restoration project as it included two primary activities: first, it included *direct service*, such as removing invasive species and planting native species. Second, it included *project-based service*, such as designing interpretive signage for the park. The researchers conducted telephone interviews with the students 4 to 14 months after they completed their service-learning projects. The interviews, which were between 13 and 27 minutes in length, addressed the students' woodland experiences, service-learning accomplishments, classmate interactions, opinions on invasive species and native restoration, and changes in environmental awareness.

To analyze the results, the researchers categorized terms and phrases into themes; then the researchers verified that those themes matched with the speakers' intent. The authors found six primary themes. First, students mentioned specific classroom content; nine students also emphasized the ways in which place-based education added to their learning. Second, students felt satisfied that the project provided a real-world impact. Third, students felt an increased



appreciation for, awareness of, and sense of ownership of urban green spaces. Fourth, students expressed a desire to continue volunteering, spread awareness about the woodland, or join the email list. Fifth, students described the importance of teamwork. Sixth, students emphasized the importance of student and adult leaders in driving the project forward.

Overall, the study's results demonstrated that the college students experienced lasting cognitive (knowledge-related) and affective (emotionally related) outcomes from participating in this eco-restoration service-learning activity, including retention of course content, as well as appreciation and stewardship of local urban woodlands. The researchers concluded that, similar to more traditional rural outdoor learning programs, urban eco-restoration projects can be effective in achieving sustained learning and pro-environmental outcomes. This study also suggests that college-aged students, not just younger audiences, are receptive to service and eco-restoration learning outcomes.

THE BOTTOM LINE:

Environmental restoration programs can offer students in urban settings an opportunity to experience hands-on environmental education in their local environment. Such programs can provide a range of short- and long-term benefits, which include, but are not limited to, retention of course-related content; greater appreciation, awareness, and sense of ownership of local urban green spaces; deeper understanding of environmental topics; enhanced teamwork skills; and a sense of empowerment for undertaking environmental actions. To develop effective programs, educators should ensure students know about local environmental history, create leadership and teamwork opportunities, and suggest ways for participants to continue the work after the program.

Knackmuhs, E., Farmer, J., & Reynolds, H. L. (2017). Student outcomes of eco-restoration service-learning experiences in urban woodlands. *Journal of Experiential Education*, 40(1), 24–38.

FIELD PHILOSOPHY AND ENVIRONMENTAL EDUCATION IN ISLE ROYALE NATIONAL PARK

Fostering ethical approaches to decision-making that take the environment into consideration is an important goal of environmental education. Giving moral weight to both human and nonhuman nature, or eco-centric ethics, contrasts with traditional Western ethical systems, which tend to prioritize humans over nonhuman aspects of the environment. Field philosophy, which refers to a way of thinking that combines ecological and ethical learning during an outdoor field-based course, may offer an avenue for teaching eco-centric ethics and fostering personal development.

In this study, researchers explored whether a wilderness experience combined with a community-focused environmental ethics course could help students develop more complex understandings of and empathy for themselves, other humans, and the environment. The course, called Isle Royale Field Philosophy, was conducted annually between 2008 and 2012 in Isle Royale National Park, located in the Upper Peninsula of Michigan. Participating students ranged in age from 17 to 27 years old, with the majority between 19 and 22. Most students were majoring in subjects related to the environment, such as fisheries, wildlife, zoology, and human biology. The course consisted of a one-week national-park camping experience, which included individual and group camping activities, such as hiking, cooking, and canoeing, as well as discussions with park rangers and ecologists. Before the course, students read articles focused on the environment and wrote short-response essays. During the trip, students took notes and wrote daily reflections in their journals. Two weeks following the trip, students wrote a three-page reflection paper and submitted a final project on what they learned from the readings and experience.

The researchers analyzed the writing (pre-course, daily reflections, and post-course) of eight students. They used the constant-comparison method to inductively code

the data using NVivo software. The researchers read the data multiple times, creating analytical codes and then developing and assigning distinct categories to the data. After analyzing all of the data, four developmental themes emerged: *self-awareness and individual development, social learning, curriculum engagement, and empathic awareness and complexity*. In terms of self-awareness and individual development, during the course, students became more aware of their own opinions and feelings as well as how they fit into the group dynamic. Social learning referred to learning that occurred within a group: students learned from their peers and reflected on the experience with each other. The curriculum engagement code referred to the process by which many students fully immersed themselves in the wilderness and coursework; they often found that the coursework and reading challenged their ways of thinking and, as a result, reexamined their values. Lastly, the empathic awareness and complexity code referred to students who formed more empathic relationships with the natural world. These students took personal responsibility for how they dealt with the environment, added nature into their moral calculations, and appreciated the complexities of human-environment interactions.

THE BOTTOM LINE:

Field philosophy, which combines environmental ethical course content with outdoor wilderness experiences, can provide an effective approach to fostering students' personal growth. Through courses that include challenging wilderness experiences as well as consistent, carefully designed individual and group reflective activities, participants can broaden their understanding of the complexity related to human-natural world interactions; develop a more empathetic moral awareness toward other humans, nonhuman species, and the natural world; and foster a sense of environmental responsibility. Environmental educators might consider applying this framework, or components of it, in their field programs as a way to encourage and support students' academic, ethical, and emotional growth.

Goralnik, L., & Nelson, M. P. (2017). Field philosophy: Environmental learning and moral development in Isle Royale National Park. *Environmental Education Research*, 23(5), 687–707.

TECHNOLOGY IN ENVIRONMENTAL EDUCATION

COUNTERING MISINFORMATION ABOUT CLIMATE CHANGE ON SOCIAL MEDIA

Consensus exists among more than 97% of credible scientists that climate change is occurring and caused by human activity, yet U.S. public opinion remains divided. Recently, social media platforms, such as Facebook, have become instrumental in guiding public discourse and opinions around such polarized issues. Given this background, this study's researchers sought to address two questions: First, how do individuals respond to climate change-related misinformation on social media, and how might their responses be different based on political orientation? Second, which social media messages are most effective in countering climate change-related misinformation?

To address those questions, the researchers recruited participants through messages posted on open Facebook groups that promoted, denied, or discussed climate change issues in English. The final sample included 406 individuals (87% U.S. based) who completed an online questionnaire; of those, 59% identified as female and 41% as male, and the average participant was 38 years old. With regard to political affiliation, 45% identified as Democrats, 21% as Republicans, 11% as Libertarians, and 5% as Green Party supporters (the researchers do not list the political affiliation of the remaining 18% of respondents).

The researchers asked participants to report their initial reaction to imagining that one of their friends had posted a Facebook message that denied climate change. They were then invited to write a response, indicating the likelihood that they would post that comment on their Facebook feed. Subsequently, researchers randomly assigned participants to read a reply to the initial post that either corrected the misinformation (correction group), disregarded the denial and urged for collaboration on clean air and water (collaboration group), or ignored the issue of climate change altogether and discussed general weather-related topics (control group). The authors used a one-way analysis of variance (ANOVA) to analyze the data.



Regarding the first question on how individuals respond to climate-change misinformation on social media, the researchers found that those with a liberal political orientation were more likely to feel frustrated and disagree with the initial climate-denying post. However, political affiliation did not correlate with the tone of the first response comment: Although liberals were more frustrated with the comment, they tended not to express that tone in their response, suggesting that liberals might self-censor while crafting a response to misinformation. The most common response among all participants was to provide more evidence to support their existing view, underscoring the erroneous belief that misinformation can be corrected through providing more information.

Regarding the second research question, related to which messages are most effective in countering misinformation, the authors found that for the participants who received the correctional comment, it tended to solidify their pre-existing belief. This result was consistent with research demonstrating that people process information in a biased manner that often supports their pre-existing beliefs. On the other hand, the collaboration comment (which disregarded the denial and urged for collaboration on working for clean air and water) received a more positive response and increased the likelihood that participants would engage in conversation through a follow-up post.

THE BOTTOM LINE:

To counter misinformation about climate change, environmental educators should resist the temptation to respond with an information-focused, fact-based approach. Research suggests that such a strategy may not only be ineffective, but might actually backfire: the person spreading the misinformation might end up solidifying their pre-existing beliefs. Instead, educators might try responding to potentially controversial issues, such as climate change, with a collaborative approach. This does not address climate change directly, but rather encourages collaboration on more neutral, socially beneficial areas, such as issues related to clean air and water. This encourages and supports productive dialogue and discussion.

Lawrence, E. K., & Estow, S. (2017). Responding to misinformation about climate change. *Applied Environmental Education & Communication*, 16(2), 117–128.

USING VIRTUAL ANIMAL ENCOUNTERS TO FOSTER ENVIRONMENTAL KNOWLEDGE

In today's digital era, many researchers, educators, policy makers, and parents express a growing interest in, yet also concern about, the role of technology in environmental education. With this interest, important and potentially tricky questions arise, such as: Can technology-based educational experiences promote and support environmental learning in ways that are comparable to live-animal and place-based experiences? Researchers explored this question in the context of a school-based environmental education program.

The researchers examined the ways in which a live interaction versus a virtual interaction might affect students' environmental knowledge related to honeybees. Specifically, the researchers compared two educational programs that aimed to foster pollinator awareness among secondary-school students: one of the programs used live honeybees and the other used a digital interactive program, in which students could observe a beehive via live stream videos from cameras positioned at different angles inside and outside of the beehive. As prior research has indicated that one of the barriers to effective learning is a perception that insects are frightening or dangerous, the researchers also sought to measure how students' differing perceptions of bees affected their knowledge in both programs.

A total of 354 students ages 10 to 14 participated in the study in Bavaria, Germany. Researchers divided the students into two groups: group 1 included 162 students in the live-bee program, and group 2 included 192 students in the virtual-bee program. The two programs used student-centered learning approaches and covered similar content about bees. They differed, however, in the way that students interacted with the bees. In the first program, students visited a local beehive and interacted

with live bees; in the second program, students used an online interactive tool to access a remote beehive and interact with bees virtually.

The researchers administered questionnaires to the students at three different times: 1 to 2 weeks before the program, immediately after participating in the program, and 6 to 9 weeks after completing the program. The questionnaires included multiple choice items related to students' content knowledge related to bees, as well as items related to students' attitudes and perceptions about bees.

The researchers found that both live and virtual programs produced comparable increases in students' knowledge about bees immediately after the program. Students also retained the knowledge gains 6 to 9 weeks after the program. For both the live and virtual groups, the researchers found significant positive correlations between students' perceptions of bee conservation and their bee knowledge at the pre-program as well as at the 6-to-9-weeks post-program time.

The authors noted that students in both programs showed significant knowledge gains whether they initially had positive or negative perceptions of bee conservation. Furthermore, there was no correlation between students' perceptions of the dangerousness of bees and their knowledge levels at any of the three time points after the program.

THE BOTTOM LINE:

Both virtual and live-animal programs can be effective for supporting environmental knowledge gains among middle-school students in the short and longer term. Programs that allow students to experience nature firsthand are associated with students' high motivation, situational emotions, and cognitive achievement. In cases where weather, time, availability, or other barriers may keep programs from providing live-animal experiences, educators should feel comfortable offering virtual experiences (high-quality live stream video, for example),

as these may be similarly effective in terms of motivating knowledge gains.

Schönfelder, M. L., & Bogner, F. X. (2017). Two ways of acquiring environmental knowledge: By encountering living animals at a beehive and by observing bees via digital tools. *International Journal of Science Education*, 39(6), 723–741.

UNDERSTANDING LOCAL WATERSHED ISSUES USING PHOTOVOICE

Reaching out to and hearing from a variety of community voices in dealing with watershed issues is vital. In particular, little research has been done as to how teenagers understand watersheds and their management. A new way of appealing to young people and hearing their perspectives is using photovoice, a method that involves taking photographs and then discussing those photos in a group. For this study, the researchers asked whether photovoice could be an effective tool for working with teens to identify their perceptions of local watershed issues and priorities.

This study took place in Washington, D.C., and considered two Chesapeake Bay watersheds. The first watershed was part of the Anacostia River and the second was part of the Patuxent River. The researchers met with local high-school students, all of whom were active in the Watershed Stewards Academy (WSA). At the first student meeting, the researchers described the project, distributed cameras, and told the students where and what they should look to photograph in the watershed. They asked the students to take at least 25 photos of any features within the watershed. After the students had taken their photos, researchers met with them for half an hour to discuss the photos; then they asked the students to complete a worksheet. They asked the students to select 10 images and write a short narrative about each image, detailing

where they took the photo, what was happening in the photo, and what positive or negative reactions they may have had to the photo, using a “thumbs up” or “thumbs down” symbol as an indicator.

The 20 participating students took a total of 468 photos, with 9 students at the Anacostia site taking 221 photographs and 11 students at the Patuxent site taking 247 photographs. When the researchers analyzed the students’ narratives, they found evidence for four main themes: water, problems with the watershed, the relationship between the community and the watershed, and stormwater management. In the narrative descriptions, students used positive terms and phrases to describe 62.6% of Anacostia photos and 68.5% of the Patuxent photos. Certain words tended to be mentioned by both groups, with “water” and “pollute, -ing, -ed” occurring frequently. Students at the Anacostia site used words in their narratives that were more often coded as negative, such as “trash,” “pollution,” and “sewers,” than students at Patuxent, who mentioned these words less frequently. This was unsurprising considering that trash is a known problem in Anacostia. Despite these differences, both groups connected pollution with the need to take action by either cleaning up the watershed and/or proactively taking care of it.

THE BOTTOM LINE:

Photovoice is a research method that can be empowering for participants, particularly youth, as it provides a way to explore the environment independently, unfiltered by researchers’ words and expectations. Photovoice’s visual aspect can be particularly powerful for identifying persistent concerns, such as those related to watershed management, like flooding, stormwater runoff, and pollution contamination. In the case of high-school students’ exploration of nearby watersheds, photovoice can focus attention on positive aspects of the watershed, while also increasing awareness of issues. Through this method, which focuses on developing agency, youth can consider age- and place-appropriate avenues toward

proposing solutions, such as taking preventative actions or cleaning up polluted waterways. In these ways and others, using photovoice as part of teen-focused environmental education initiatives may help connect youth with local environments while also developing their civic-engagement skills.

Chanse, V., Mohamed, A., Wilson, S., Dalemarre, L., Leisnham, P. T., Rockler, A., Shirmohammadi, A., & Montas, H. (2017). New approaches to facilitate learning from youth: Exploring the use of photovoice in identifying local watershed issues. *The Journal of Environmental Education*, 48(2), 109–120.

ZOO, AQUARIUM, AND SCIENCE CENTER EDUCATION

QUESTION-ASKING IN EXHIBIT LABELS TO ENCOURAGE METACOGNITION

Metacognition, or awareness of one's thought processes, is associated with increased creative thinking and problem solving. These are important skills for addressing environmental issues overall and are particularly important when addressing large-scale, systemic challenges, such as climate change. One way that educators can help learners develop and reflect on metacognition is through inquiry learning, which emphasizes question-asking rather than answer-giving.

Numerous researchers have studied the influence of inquiry learning on metacognition in formal educational settings, but fewer have done so in informal settings. Yet many environmental education programs and experiences occur in informal settings, such as museums, parks, and aquariums. To examine inquiry-based learning's role in developing metacognition in informal learning environments, researchers created inquiry-based flip labels for several exhibits at the Exploratorium in San Francisco.

The exhibits addressed a variety of social-science topics, such as unconsciously shared knowledge, facial expressions, and gender roles, so the study results would be applicable to the broader social-science field. The labels focused on asking questions to enhance interactive exhibits, which prior research has found to increase metacognition in formal education. The researchers made three kinds of labels: labels with no question (the control), labels with an exhibit-specific question, and labels with an exhibit-specific as well as a real-world question.

The researchers randomly selected pairs of participants from the total population of museum visitors. The study included 59 pairs of participants, most of whom were teenagers or college-educated young adults in male-female pairs. The researchers asked participants to interact with the exhibits initially; then read the labels; then continue engaging with the exhibit as they normally would. The researchers recorded and transcribed the visitors' conversations and coded the transcripts, searching for signs of metacognitive talk.



The researchers analyzed the interview data to study the proportion of time the participants engaged in metacognitive talk at each exhibit.

The researchers found that including an exhibit-specific question in the flip labels led to an increase in metacognitive talk. Although adding the real-world questions did not further increase metacognitive talk, those questions maintained the elevated levels of metacognitive talk initially spurred by the exhibit-specific questions. The results suggest that inquiry-based flip labels for museum exhibits can substantially increase visitors' metacognitive activity.

THE BOTTOM LINE:

Metacognition, or thinking about thinking, is an important aspect of addressing larger-scale issues, such as those evident in the environmental sphere. As a large proportion of environmental education occurs in informal learning settings, such as museums, parks, and aquariums, it is important for educators and practitioners to understand the ways in which such settings might support metacognitive skills and reflection. One way to enhance metacognition in informal settings is to focus on question-asking rather than question-answering. In an informal setting, such as a museum, this might look like inquiry-based labels that ask exhibit-specific questions to spark reflection. Also including related real-world questions can help maintain and extend the metacognitive thinking over time.

Gutwill, J. P., & Dancstep, T. (2017). Boosting metacognition in science museums: Simple exhibit label designs to enhance learning. *Visitor Studies*, 20(1), 72–88.

THE DIRECTED USE OF PERSONAL MOBILE COMMUNICATION DEVICES IN MUSEUMS

Digital technologies are becoming increasingly common in museums: as part of the interpretive signage, included in the exhibitions, and brought in by visitors themselves. However, many museums oppose or discourage the use

of personal mobile communication devices (MCDs), like cell phones or smartphones, concerned that such devices distract visitors from the museum experience.

Guided by mindfulness theory—which offers a framework for exploring attention and engagement in informal learning contexts—researchers in this study set out to investigate the potential impacts of MCDs on visitor attentiveness in museums. The authors describe mindfulness as bringing one's complete attention to the present moment and immediate surroundings. Through mindfulness, they hypothesize, visitors can develop a greater sensitivity to the environment, are more open to new information, are more perceptive, and have a greater sense of awareness.

Participants in this study included 58 young adults who engaged with and responded to a museum exhibition with and without MCDs, and with and without guidance on how to use their MCDs. The researchers randomly divided the 58 participants into three groups: (1) a control group with MCDs and no instructions; (2) a group who surrendered their MCDs on entry (“no-MCD group”); and (3) a group with MCDs who were instructed on how to use those devices (including taking photographs), with the intended purpose of describing the exhibition to their social networks (“directed-MCD group”). All participants recorded the total time they spent at the exhibition and completed a questionnaire upon exiting.

Researchers supplemented the questionnaire data with onsite observations and post-visit discussions. The survey questions, which were open- and closed-ended, focused on attention paid to the exhibits (measured by overall visit duration and at which exhibits visitors spent time); exhibition evaluations; levels of mindfulness; perceived learning; and satisfaction with the overall exhibition experience. The survey also assessed previous experiences at the study site and other museums; patterns of usual social media access and use; and affective responses to the exhibition. Four additional questions were added for the no-MCD group to capture their responses to not having their MCDs, while the control group and directed-MCD groups were asked to provide details of the photographs

they took at the exhibition. The researchers analyzed the data to see how the three groups differed, including qualitatively coding the open-ended survey items.

The researchers found differences in patterns of attention between the three groups. The directed-MCD group spent the longest time in the exhibition space; the control and the no-MCD groups spent similar amounts of time in the exhibition space. The no-MCD group was more likely to stop at exhibits with audiovisual elements. The control group, without direction, was primarily attracted to the interactive game exhibit, while the directed-MCD group tended to stop at text-heavy exhibits. The groups also differed in relation to mindfulness and perceived learning. The directed-MCD group had the highest scores on mindfulness and perceived learning, while the no-MCD group had the lowest scores. Visitors who were frequent users of social media were also significantly more likely to report perceived learning than those who were not.

Findings indicated that participants in the directed-MCD group took more and different photographs of the exhibitions than those in the control group did. Participants in the directed-MCD group primarily took photographs featuring specific exhibition sections or pieces of text they thought were important for communicating key messages to their peers. The control group, without directions, mostly took photographs of items they found interesting or fun rather than photographs in service of recalling specific information.

Overall, the results indicated that using or not using MCDs, as well as guidance on how to use the devices, impacted engagement with and responses to the exhibition. The no-MCD group paid less attention to the exhibition and were less likely to learn new things. And the control group, which engaged with the exhibition without instruction on how to use their MCDs, did so in a more superficial way. The directed-MCD group was able to use their devices to mindfully connect with the exhibits and create meaning for both personal learning and social sharing. The researchers concluded that providing young-adult visitors with guidance on how to use their personal MCDs at the

start of a museum visit may give greater control and, in the process, enhance their experiences.

THE BOTTOM LINE:

Teens and young adults are avid users of mobile communication devices (MCDs) in a variety of contexts. Informal learning environments, such as museums, which leverage mobile device technologies and practices, are therefore well-positioned to attract young adults. Providing instructions on how to use personal MCDs to engage with exhibitions, including through activities such as taking and sharing photographs, may give young-adult visitors greater control over their experiences and facilitate mindfulness; in the process, such visitors may experience more positive outcomes. Instructions could include inviting young adults, at the start of their visit, to share their museum experiences, thoughts, and images on social media, for example. This approach may also benefit other museum visitors. For museums and other informal learning environments, directing the use of personal MCDs requires developing strategies and exhibitions with these devices in mind.

Hughes, K., & Moscardo, G. (2017). Connecting with new audiences: Exploring the impact of mobile communication devices on the experiences of young adults in museums. *Visitor Studies*, 20(1), 33–55.

DESIGNING A PLAYFUL AND COLLABORATIVE FAMILY SCIENCE ACTIVITY

Fostering family learning through meaningful adult/child interaction is often a central goal of informal science education. Although previous family-learning research has focused on designed settings such as science centers and museums, recent research has expanded to include a broader array of unstructured, everyday-life settings, including homes, parks, and community spaces. In this study, researchers developed and field-tested an outdoor family science activity that aimed to promote science learning during family beach trips.

The activity, called Anytime, Anywhere, centered on the topic of coastal beaches and targeted young children (age 4 to 10) and their parents. It consisted of prompts and conversation starters that sought to promote open-ended, collaborative, and playful explorations with natural and scientific phenomena. Anytime, Anywhere used place-based learning principles to encourage participants to explore local natural phenomena on the beach, such as bluff layers, cliffs and dunes, sand patterns, and ocean waves. Instead of emphasizing science facts and “correct answers,” the activity focused on scientific reasoning and exploration through social interaction, collaboration, and play.

In what ways does Anytime, Anywhere support family science learning in everyday settings, and how can the program’s design be improved? To address these questions, researchers examined three families’ use of Anytime, Anywhere prompts during their beach trips. All three families were middle-class families with two college-educated parents and two or three young children ages 2 to 9. The families were recruited at a local science center, through e-mail listservs and informal networks. Each family was given 20 Anytime, Anywhere prompt cards to use during their beach trip, and researchers asked them to use whichever cards they found interesting. The researchers were not present during the beach trip; instead, the researchers gave one child and one adult from each family wearable GoPro cameras to video record their family/beach activities. Between 45 and 90 minutes of video recording was obtained from each camera. Researchers also interviewed families after their beach trips regarding their activities and ideas about science.

The researchers used qualitative methods to analyze data from videos and interviews. Analysis showed that children and adults used the prompts to engage in exploring natural phenomena at the beach. Three common themes of science learning and exploration emerged across the case studies: Families used the activity prompts to engage in (1) asking questions and generating ideas about natural processes, (2) generating hypotheses about unknown and surprising phenomena, and (3) spontaneous experimentation to test

ideas. Different families used different prompts, and they used those prompts to varying degrees and frequencies. All families engaged in collaborative science learning about a range of natural, local phenomena, within the context of everyday family time.

Based on their data analysis, the researchers made several design recommendations for improving the activity. First, they urged that the activity prompts be situated in specific, local phenomena, rather than abstract generalized phenomena or principles. This specificity will help participants make specific observations, draw on their prior knowledge, and seek evidence relevant to the local context. Second, they suggested using prompts for which no one knows the correct answer, as it tends to encourage more talk and collaboration, and reduces the potential for any single person with the “correct answer” to discount others’ ideas. Third, they called for prompts that encourage participants to ponder multiple competing ideas, thus creating space for communication and collaboration during family time.

THE BOTTOM LINE:

Everyday and leisure activities are great contexts for engaging families with young children in science learning. Rather than family science activities that emphasize fact-based knowledge and “correct” answers, those that encourage adults and children to engage with scientific processes and practices—through asking questions, exploring phenomena, testing hypothesis, and spontaneous experimentation—can be substantially more engaging. Activities should draw on families’ everyday experiences, support open-ended explorations of scientific phenomena, and encourage playful interaction. In addition, situating the activity in specific local and natural phenomena, encouraging communication, and supporting collaboration can lead to more meaningful family engagement with science.

Luce, M. R., Goldman, S., & Veal, T. (2017). Designing for family science explorations anytime, anywhere. *Science Education*, 101(2), 251–277.