ENVIRONMENTAL EDUCATION

RESEARCH BULLETIN

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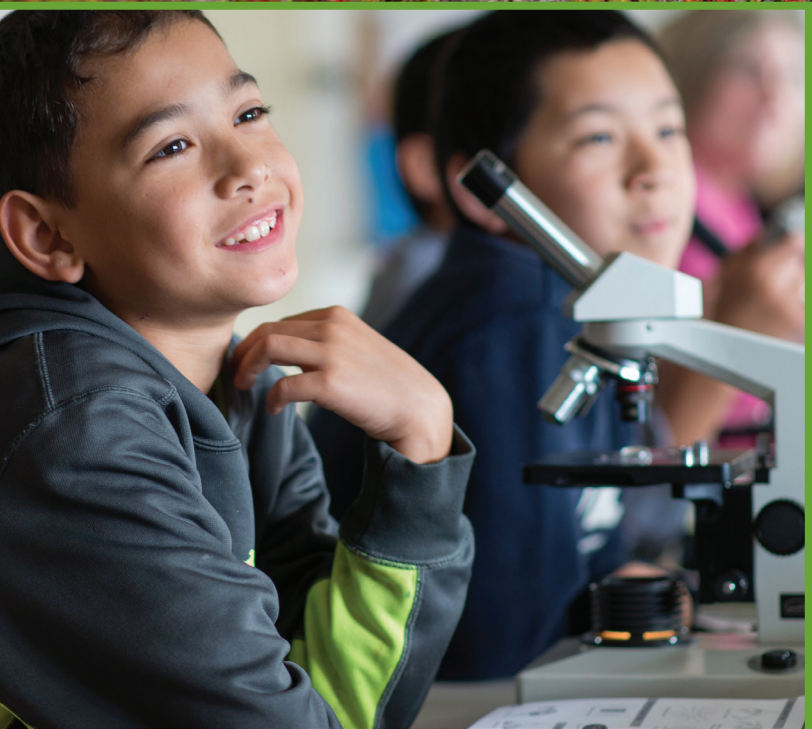

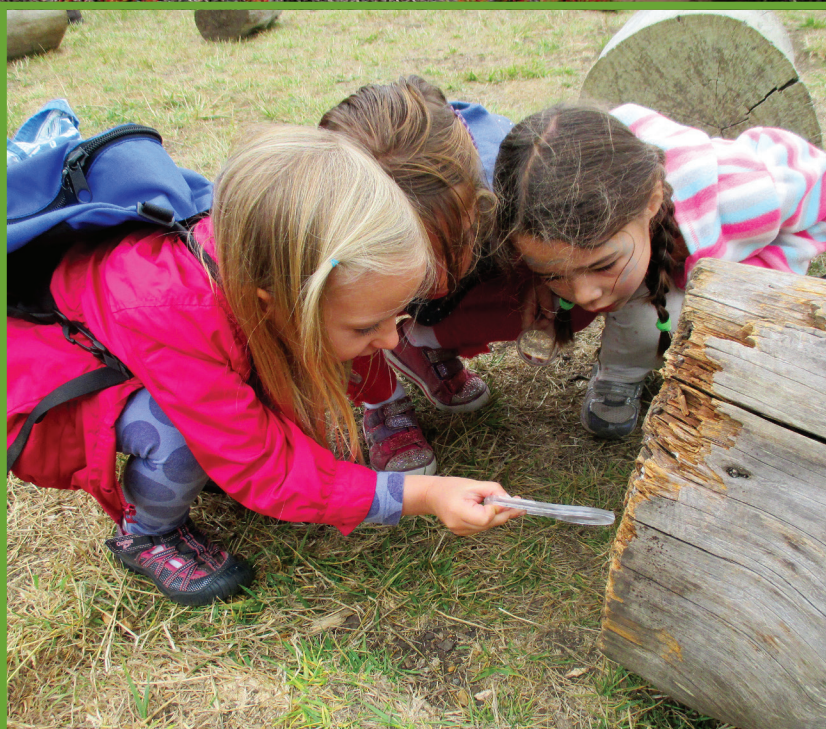

ABOUT THE RESEARCH BULLETIN

The *Environmental Education Research Bulletin* is a project of ChangeScale in partnership with Dr. Nicole Ardoin at Stanford University. The bulletin is designed to inform environmental and sustainability educators about recent relevant research, with a primary emphasis on informal, field, and residential settings, as well as stewardship behavior, conservation, and related topics. Although other environmental educators and those in related fields might also find this bulletin useful, it does not—nor is it intended to—cover all aspects of environmental education. This Research Bulletin, as well as past issues, is available online through the ChangeScale website: www.changescale.org. Please send questions and feedback to eeresearchbulletins@changescale.org.

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INTRODUCTION

Dear Colleagues,

In partnership, ChangeScale and Stanford University researchers are pleased to share this seventh issue of the *Environmental Education Research Bulletin.* The most talented environmental educators we know are conducting place-based programs, collaborating with communities, and using hands-on strategies to make critical links between enhancing environmental awareness, building skills, and supporting informed action. Yet rarely do these committed professionals have time to keep up on the latest research, whose beneficial findings may enhance the effectiveness of environmental education programming. To that end, these bulletins aim to help bridge the research-and-practice gap by summarizing recently reported research. In turn, we hope that practitioners may be inspired to infuse their work with research findings.

This issue includes synopses of peer-reviewed journal articles that are particularly relevant for front-line environmental education practitioners. We reviewed issues (published between January to June 2014) of a number of environmental education-related journals, including: *Journal of Environmental Education, Environmental Education Research, Applied Environmental Education and Communications, Australian Journal of Environmental Education, Canadian Journal of Environmental Education, Journal of Experiential Education, International Journal of Science Education, Science Education, Visitor Studies, Journal of Interpretation Research, Environmental Research Letters,* and the *Journal of Environmental Psychology.*

Because we are creating this document for you, we're eager to hear your feedback. Please let us know if there are additional topics you'd like covered or journals you'd suggest that we monitor, or if there's an alternative format that may be helpful. You can send suggestions to researchbulletins@changescale.org. We'll consider your feedback at the beginning of each cycle and try to adapt accordingly.

For another take on these kinds of articles, you may want to check out the research community of the North American Association for Environmental Education (https://naaee.org/eepro/research). You may also be interested in the *Relating Research to Practice* effort of CILS and the Exploratorium, available here: www.exploratorium.edu/education/relating-research-practice.

We wish you all the best in your important efforts to integrate high-quality research into inspiring practice!

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BEHAVIOR

MOTIVATIONS AND CHANGES IN CONSERVATION BEHAVIOR OF ZOO VOLUNTEERS

Docents and volunteers are critical members of environmental education institutions. Volunteers are often treated as experience facilitators to museums, zoos, aquariums, and other informal learning centers, but in this study they are examined as the participants in wildlife conservation programs. Because of the extensive time volunteers spend learning and interpreting about conservation, they are an interesting group to study as they develop their own environmental ethic. This study focused on volunteers at a zoo and sought to understand their experience in terms of their motivations for volunteering and the influence of volunteering on their engagement in wildlife conservation.

Registered volunteers at the Cleveland Metroparks Zoo were given a questionnaire; 356 volunteers responded, representing 91% of the volunteer pool. Of these respondents, 85% were current volunteers and had an average of 7.6 years of volunteer experience at the zoo. The questionnaire asked about their attitudes toward volunteering at the zoo and their motivations for being involved. In addition, participants were asked about changes to their conservation-oriented behaviors since beginning their involvement with the zoo.

For their analysis, the researchers grouped motivations for volunteering according to three categories: motivated by learning about wildlife, motivated by interpreting wildlife, and motivated by new social relationships. Of these three categories, being motivated by a desire to learn more about wildlife was the most common reason volunteers cited regarding their decision to remain in the program and their satisfaction with volunteering.

Volunteers were asked about ten environmental behaviors, such as purchasing organic food or purchasing items that help third-world countries. These behaviors were categorized as conservation behaviors, informal wildlife outreach, displays of social identity centered on wildlife, and learning about wildlife. Within these categories, researchers analyzed whether behaviors started, increased, or decreased, and the relationship between the behavior and the number of years spent as a volunteer.

With regard to environmental behaviors, purchasing organic food and donating more than $100 to a conservation cause were two of the most popular conservation behaviors started by volunteers after they joined the program at the zoo. Voting in a national election and conserving water were behaviors the volunteers had already adopted before working at the zoo, which increased in frequency during their tenure as a volunteer. Many volunteers also reported decreasing the use of pesticides around their homes. The results suggested the more years spent volunteering in a program, the more likely those volunteers are to make behavior changes. Overall, increases in most of the studied environmental behaviors were associated with more years spent in the program.

The questionnaire also asked participants about their outreach behaviors. Their responses showed encouraging others to join the Zoo Society and talking with others about wildlife were two of the most commonly started behaviors and also the most commonly increased behaviors. Encouraging others to join the Zoo Society was the only behavior that had a significant correlation with years spent as a volunteer (i.e., the more years spent as a volunteer, the more likely that person was to encourage others to join the Zoo Society).

Identity-displaying behaviors, in this context, are those that allow the individual to showcase their involvement in wildlife conservation. Regarding these behaviors, volunteers started using skills developed at the zoo in another setting and began socializing with other zoo volunteers or staff outside the zoo. Other commonly increased behaviors were displaying wildlife art at home or work and wearing wildlife-oriented clothing. Socializing with others outside the zoo was also positively correlated with years as a volunteer.

Volunteers were also asked about their behaviors regarding "learning about wildlife." The results showed reading books about conservation behavior and visiting other zoos were two of the most commonly started behaviors. Watching wildlife programs on television and reading books about animal behavior or conservation were some of the most commonly increased behaviors, though all behaviors in this category displayed larger increases than the other categories. Again, it was found that increases in these types of behaviors were associated with more years spent as a volunteer.

THE BOTTOM LINE:

Since volunteering at a zoo is often motivated by an interest in animals, zoos may be able to encourage more complex or difficult environmental behaviors with this group. Zoos can also expand this sphere of influence by training volunteers to promote pro-environmental behaviors within their social circles. Furthermore, because a longer tenure as a volunteer is often associated with starting or increasing environmental behaviors, finding ways to encourage the longevity of participation from volunteers is an important area for zoos to focus their efforts.

Bixler, R. D., Joseph, S. L., & Searles, V. M. (2014). Volunteers as products of a zoo conservation education program. *Journal of Environmental Education,* 45(1), 57–73.

COST OR CARBON? EFFECTS OF LANGUAGE FOR MOTIVATING ENERGY REDUCTION

To meet ambitious global climate change goals, energy reduction is paramount. This study, therefore, focuses on how communicating energy usage encourages the public to conserve energy. Specifically, the authors of this paper investigated whether it is more effective to emphasize financial benefits or environmental benefits from energy reduction, such as reduced carbon dioxide emissions. Determining effective communication regarding energy usage may have greater payoffs beyond reducing energy consumption; it may cause behavioral spillover, where additional environmental behaviors are enacted. With this in mind, the authors investigated different ways to communicate information on energy consumption to see if there is the potential for behavioral spillover. They also investigate how different values—both environmental and financial—influence the potential for pro-environmental behavioral spillover.

Research has noted cross-cultural social values, which are predictive of behavior. For example, altruistic values are linked with sustainable behaviors, while egocentric values lead to behaviors motivated by wealth. These values are contradictions of each other—the enhancement of one could lead to a decrease in the other. While these social values tend to be relatively stable and consistent throughout a lifetime, messages and experiences can prime values and encourage a particular behavior. For example, priming participants with images of money led to less collaborative and helpful behavior. To determine how values are influenced through communication, the study used three different primers, or metrics, for communicating energy usage to their participants: energy used in kilowatt-hours (kWh), cost of energy in pounds (£), or carbon dioxide emitted (CO2). From this communication, they were able to determine any shift in values and the potential for behavioral spillover, with regard to behaviors such as recycling or reducing driving.

Two studies were conducted with randomized groups of undergraduates, 170 total, enrolled in UK universities. Participants of each study completed pre- and post-tests measuring individual values. They also self-reported their daily energy use with an online Home Energy Calculator (HEC), completed a budget allocation task measuring their propensity to behave environmentally, and engaged in a post-study debrief. The HEC provided to each participant measured and communicated energy usage using one of the three primers: kWh, £, or CO2. Using this online simulation, participants reflected on how they could reduce their energy usage by 5% by altering their daily activities. Immediate feedback reflecting these changes in energy usage was communicated to the participant in terms of the three primers. Participants were asked to reflect on why it was important to them to reduce their energy usage: cost savings or environmental impact?

The HEC simulation influenced participants' motivations for reducing their energy depending on how the information was communicated. When energy information was communicated through kWh or cost, participants were more likely to give cost as their reason for reducing their energy usage. Conversely, when CO2 was the metric used, participants claimed they reduced their usage for environmental purposes. Notably, the participants who received information in financial terms were the most likely to claim that energy is not worth saving. There was no significant behavioral spillover effect; however, participants who considered energy in terms of CO2 in the pre-test questionnaire also tended to exhibit more environmental behaviors. Framing energy usage in terms of CO2 may make climate change more salient to the public and encourage additional thoughts about sustainability or environmental behaviors. However, the link between carbon dioxide, energy use, and climate change is abstract. Furthermore, people tend to think of climate change as being someone else's responsibility to address, rather than seeing their own behavior as a meaningful and contributing factor.

The second study further investigated the extent to which the importance of financial issues and climate change influenced participants. In addition to engaging in all the tasks of the first study, participants completed a survey, which measured perceptions on energy use and the environment. Analysis of results demonstrated that framing energy in terms of CO2 led to a greater likelihood that people would consider climate change as a motivation to save energy. Additionally, when this connection was made, these participants, as opposed to those who interacted with the cost and kilowatt-hour versions of HEC, exhibited more environmental behavioral spillover. While these results illustrate great potential for communicating energy information through an environmental frame, additional studies communicating consumption in terms of both cost and carbon dioxide are needed.

THE BOTTOM LINE:

What motivates people to reduce their energy usage: cost benefits or environmental reasons? This study suggests that if you emphasize the cost savings of reduced energy usage, people will internalize the idea that cost is the primary reason to make behavioral changes. On the other hand, emphasizing the CO2 emission savings of decreased energy use encourages people to see environmental

reasons as the factor motivating them to make changes. It is important to keep these values in mind while teaching environmental education, as emphasizing environmental values can spill over and create other environmental behavioral changes beyond the one being targeted, such as recycling or driving less.

Spence, A., Leygue, C., Bedwell, B., & O'Malley, C. (2013). Engaging with energy reduction: Does a climate change frame have the potential for achieving sustainable behaviour? *Journal of Environmental Psychology,* 38, 17–28.

EFFECTS OF AGE AND GENDER ON FOSTERING PRO-ENVIRONMENTAL ATTITUDES IN CHILDREN

Although shifting environmental attitudes—particularly among adults—is a slow process, it is critical in fostering pro-environmental behavior. To this end, clarifying environmental attitudes is often addressed in environmental education (EE). In this study, the authors aim to understand how differences in age and gender influence the acquisition of pro-environmental attitudes.

This study took place at German schools with fourth graders (9 to 10 years of age) and sixth graders (11 to 13 years of age). Within each age range, the authors formed two subsamples: students who attended a weeklong, intensive residential EE program, and those who did not. Student participation in these subsamples was based on participating classes; 11 classes participated in the weeklong EE program, while four classes did not. These subsamples allowed the authors to compare how this weeklong EE program influenced environmental attitudes in respect to age and gender.

All participants completed pre- and post-program surveys consisting of 47 questions with 5-point Likert scale responses. Administration of the surveys occurred three times: two weeks before the program (T0), directly after the program (T1), and four to six weeks later (T2). The control group responded to the survey without any program participation. The survey was modified from a 20-item questionnaire called the Two Major Environmental Values (2-MEV) model. This well-tested, reliable, and valid model defines environmental attitudes under two distinct domains: preservation and utilization. Preservation is a biocentric dimension, represented by acts of conservation and protection of the environment. Utilization, on the other hand, is an anthropocentric dimension focusing on the self-interest use of the environment and its natural resources. While these dimensions are unique from each other, they do not occur on a linear spectrum. For example, someone who works to conserve the environment may also have strong utilization attitudes toward the environment. In other words, these dimensions are independent of one another; the questioner measures them as such. Lastly, the survey included questions focusing on knowledge and connectedness to nature.

The weeklong intensive EE program, called "Water in Life–Life in Water," reflected both preservation and utilitarian attitudes. For example, students learned how to lessen their water use and protect water sources, thereby promoting pro-environmental preservation attitudes. Students also learned about their own water usage and how their actions might have a negative impact on water, promoting pro-environmental utilitarian attitudes. Additionally, students engaged in a diverse array of activities, which took into consideration gender-related preferences regarding learner types, learner styles, and content. To that end, the program was designed to equally engage both males and females.

Findings from this study suggest that younger students (ages 9 to 10) had a higher preservation attitude ($M = 4.34$) toward the environment and a lower utilitarian ($M = 2.47$) attitude than older students (ages 11 to 13; preservation: $M = 4.03$, utilitarian: $M = 2.63$). This combination of high preservation and low utilitarian dimensions is defined by the authors as a pro-environmental attitude. Younger students also retained these pro-environmental attitudes over the long term (T0 to T2), as opposed to older students, whose pro-environmental attitudes did not persist. There

were no differences in the findings between males and females for either age group, although this is inconsistent with other research findings suggesting females score higher on preservation attitudes and lower on utilitarian attitudes when compared to males. The authors' results may suggest an effective and gender-equitable design and pedagogy for the EE program, although further research is required.

Additional limitations of the study include the younger students' developmental preference toward socially acceptable behaviors. Whereas 9- and 10-year-olds in this study are still at a "concrete operational" development stage, seeking acceptance from role models such as parents and teachers, the older students, entering adolescence, are gaining autonomy. These developmental differences between the age groups may account for some of the differences in pro-environmental attitudes. Nonetheless, these findings suggest that weeklong, intensive EE programs are more effective at enhancing and maintaining pro-environmental attitudes with younger children.

THE BOTTOM LINE:

Findings from this study suggest environmental education programs are more effective at fostering and maintaining pro-environmental attitudes in younger children. As younger children are more likely to be in a developmental stage focused on social acceptance, this is an important time to establish and foster pro-environmental social norms. However, this is not to say that environmental education programs should not also cater to older students. Students in their adolescence are learning how to gain their independence and autonomy. This developmental learning can coincide with environmental education and be fostered through environmental activism, which fosters students' empowerment and leadership skills.

Liefländer, A. K., & Bogner, F. X. (2014). The effects of children's age and sex on acquiring pro-environmental attitudes through environmental education. *Journal of Environmental Education,* 45(2), 105–117.

EVALUATION

EVALUATING RESIDENTIAL ENVIRONMENTAL EDUCATION

Over 200 residential environmental education centers (REECs) exist in the United States, offering students immersive experiences in nature. Like many other informal education outlets, REECs struggle with evaluating student learning outcomes in their programs due to a lack of time, money, and expertise.

This study presents an updated analysis of evaluation practices in REECs and compares this analysis with findings from a similar study conducted by Chenery and Hammerman, published in the *Journal of Environmental Education* in 1985. For this research, the authors adapted the survey used in the Chenery and Hammerman paper, including questions about evaluation practices and demographics. The authors included eight additional questions about overall satisfaction, barriers, and needs regarding evaluation. The survey was delivered electronically to program directors; 205 REECs received the survey and 114 responded.

In terms of demographics, most of the responding centers were from rural areas (78%), self-funded (80%), and focused on science education (97%). When asked about evaluation, 85% of directors said that they participated in developing program evaluations and 78% of directors said they were involved in conducting evaluation. In addition to the directors, full-time staff also participated often in the development and execution of evaluations, whereas independent researchers were rarely involved.

Evaluations at REECs mostly included teacher surveys (91%) and program observation (82%). Student surveys and discussions were used by fewer than half of the responding institutions. Primarily, evaluations included measures of teacher and student satisfaction, as well as operations and logistics. Of the respondents, 71% said their current evaluation practices met their needs, while 61% stated their evaluations met the needs of stakeholders (e.g., teachers, students, parents, and administrators).

When asked about barriers to conducting evaluation, respondents said that limited funding, time, and knowledge of evaluation practices were their primary obstacles. Respondents said that it was difficult

to meaningfully engage students in evaluation and that they were challenged to find enough time to properly administer evaluation tools, especially without detracting from time spent outdoors. Additionally, desired outcomes and needs varied depending on the individual requirements of schools and teachers, so adapting evaluation approaches to these myriad situations was difficult.

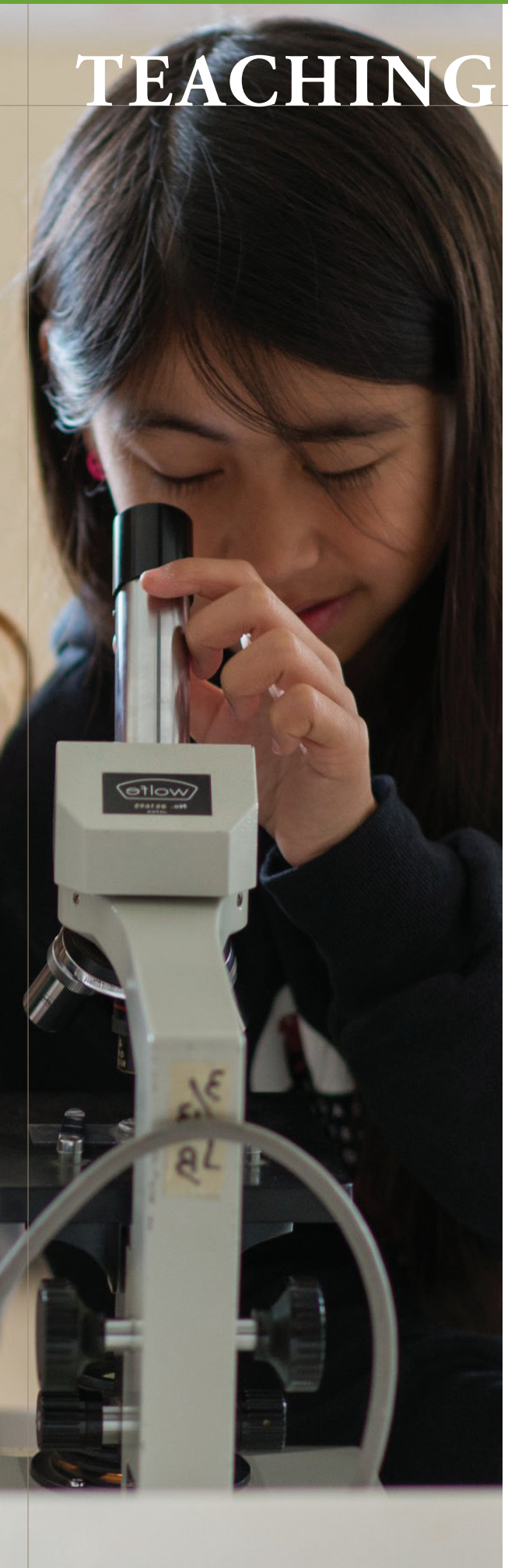
Directors were also asked to describe evaluation needs in their programs. Most respondents said they were interested in developing evaluation tools that could indicate shifts in student attitudes or behavior toward the environment, or the impact of the program on academic achievement. Respondents also indicated they desired more rigorous evaluation tools that provided a deeper level of information on the student experience. Lastly, directors said they would generally like their staff to have more capacity in evaluation. Participants in this study seemed to have conflicting visions of the ideal evaluation, with some wanting in-depth and comprehensive information about the experience, while others desired fast and easy-to-implement instruments.

Compared with Chenery and Hammerman's 1985 study, fewer evaluations gathered data from students, but teachers were more often involved in the evaluation process in the current version of the study. In both studies, evaluation was primarily done at the end of an experience. Both studies showed similar challenges to conducting evaluation, though acceptance of the importance of evaluation now appears to be growing.

THE BOTTOM LINE:

Environmental education professionals often struggle with the skills necessary to conduct evaluation, which makes the task daunting and difficult. By training staff members in evaluation practices and developing an institutional culture of evaluation, some of the other barriers to evaluation, such as a lack of time and money, may be mitigated. Educators who are trained in evaluation and see its importance to institutional growth may be better equipped to devise innovative approaches to evaluation that fit the specific needs of their institution and its available resources.

Bourke, N., Buskist, C., & Herron, J. (2014). Residential environmental education center program evaluation: An ongoing challenge. *Applied Environmental Education & Communication,* 13(2), 83–90.



TEACHING METHODS

FAMILY LEARNING PROCESSES IN INFORMAL CONTEXTS

Families are the most common group visiting informal EE centers. Children's learning in informal environmental education contexts, therefore, is likely to be affected by their interactions with their families. However, few studies have examined the way that families interact and collectively learn in informal EE contexts. This study examined how families interact and coordinate thinking in conversations and activities at a nature center. The authors specifically sought to address two questions about the processes families use in learning: (1) how do families use prior experiences and knowledge in relating to EE topics, and (2) how do family members interact with each other during conversations about EE topics to enable children in learning?

To understand family interactions and learning in informal EE settings, the authors video-recorded, surveyed, and interviewed participants attending 20 "Meet the Birds of Prey" shows at the Shaver's Creek Environmental Center in Petersburg, Pennsylvania. The show features eagles, hawks, and owls brought out of their cages by trained center volunteers. Audience members get a chance to see these birds up close and ask questions about them. The authors also asked family participants to draw images together of a raptor and its habitat. This allowed the authors to examine the social interactions between family members when working on a collaborative task. Overall, 203 participants were surveyed, and 23 individuals were interviewed. Video recordings of the family members interacting with the show and completing the drawing task were transcribed and analyzed. This analysis was focused on the various techniques used within families for negotiating and developing meaning and ensuring all group members contributed.

Through their analysis, the authors found that prior family experiences, particularly experiences in the outdoors, with media, and at other informal education venues, were important for family learning. Often, one family member would bring up a memory of a prior family experience, such as a visit to a zoo or a sighting of a hawk in their backyard, to engage other family members in learning discussions. This sharing of prior knowledge enabled individual learning to become social learning within the family, which helped families create common ground to work together on their drawings of the raptor.

The authors also found that several families used specific ways of structuring conversations that allowed for disagreements to be addressed, all family members to be valued in conversations, and collaborative ideas to develop. For example, when drawing the raptor, parents often encouraged children to contribute by double-checking children's reasoning behind why they chose to portray something in the picture, and asking for children's consent before drawing something new. The authors also found that parents were often concerned with emphasizing family harmony, so much so that they would, in some cases, relinquish their insistence on scientific accuracy in learning. Finally, the authors found that parents structured conversations so that family members were building off each other's sentences, a process that enabled the creation of collaborative ideas that built on the different family members' ecological knowledge.

Based on these findings, the authors offer several suggestions for educators, curriculum developers, and researchers seeking to maximize family learning in informal EE settings. First, they suggest that educators can incorporate prompts into EE programs that may elicit families' prior experiences in outdoor settings, in other EE settings, or with the media or books. Second, the authors suggest that future work may examine how environmental educators can help families engage in the types of conversations that enable students to become active participants in collaborative learning. In conclusion, the authors suggest that understanding the learning processes within families is essential for informal EE, given that families are the most prevalent group in such contexts.

THE BOTTOM LINE:

Understanding the processes used by families for learning in informal environmental education (EE) contexts is important for maximizing children's learning. Families often use prior experiences to create common ground to enable collaborative learning to occur. In addition, families can structure their conversations in certain ways to enable children to become valued participants in the learning environment. Informal EE programs may benefit by providing prompts that elicit families' prior experiences in the outdoors, with media, or with other informal EE environments. Environmental educators may also facilitate children's learning by suggesting that families engage in discursive patterns of dialogue so that students can participate as contributors of knowledge in the family learning process.

Zimmerman, H. T., & McClain, L. R. (2014). Intergenerational learning at a nature center: Families using prior experiences and participation frameworks to understand raptors. *Environmental Education Research,* 20(2), 177–201.

HELPING MUSEUM DOCENTS SHIFT TO STUDENT-CENTERED PEDAGOGY

Museums hold great potential to expand and enhance learning that occurs in schools. However, most school trips rarely take advantage of the unique learning opportunities afforded by museums. Instead, when working with school groups, museum docents often adopt the role of traditional educators and rely on familiar, didactic, teacher-centered pedagogies. Furthermore, most museums do not offer their docents professional development that would support the docents' continual growth.

This study examined how the educational practice and conceptions of learning of several docents at a natural history museum (NHM) evolved through the professional experience of implementing a student-centered, inquiry-based school trip program. The researchers sought to answer two main research questions: (1) How do docents at an NHM think and talk about learning in the museum? (2) How does involvement in iterative implementation of a new, inquiry-based school trip program about climate change influence the way docents think and talk about learning in the museum?

As part of a four-year collaboration to develop a climate science learning experience for middle school students from a local public school district in a midsize Rust Belt city, the university research team worked with NHM staff and the school district to design a curriculum that was then iteratively implemented by museum docents. The

pedagogical design of the school trip program sought to balance scaffolding with free-choice learning and was quite different from the traditional school trip format, which had been highly docent-centered and transmission focused.

During the new trips, docents would start by briefly modeling scientific observation at an exhibit. From there, students were encouraged to record their own observations and analyses of other exhibits, while docents would circulate to engage students in conversation, answer questions, and present driving questions. Three principles guided this new program: learner autonomy, conversation and reflection, and deep investigation. Docents participated in an iterative implementation process of the new program in which they tried successive versions of the program with students. After each implementation, docents would reflect upon the experience with the project team and other docents. Eight docents participated in the study. Data sources included four observations of school trips, debrief meetings following each school trip, and interviews with each of the docents at the end of the implementation period. The authors detailed case studies for four of the eight participating docents.

Although individual docents differed in their professional growth, they all displayed changes in practice with the implementation of the new curriculum. Steve, a docent who had been strongly attached to teacher-centered pedagogy, grew to embrace the principle of learning through conversation, as he witnessed its positive impacts on learning. Another docent, Elizabeth, who also typically clung to teacher-centered pedagogy, found that she was "loosening" her tours to include more student interaction and conversation. Paul, who was eager to try new techniques, embraced the new pedagogy and found it quite effective for middle school students. Although Lucy expressed discomfort with the inquiry-based format, she increasingly incorporated the principles of student autonomy and conversation into her tours. Furthermore, with the debrief meetings, all docents actively reflected on the process of their professional growth and contributed to growing a community of practice among themselves. The in-depth debrief sessions following school trips allowed the docents to engage in reflective discussions where they shared examples of how to scaffold student learning using the three guiding principles of student autonomy, conversation, and driving questions.

This study portrays the beginning of a community of practice among docents. Such a community, with its professional vocabulary and pedagogy unique to a museum setting, could help practitioners challenge the dominant, teacher-centered notions of teaching and learning. As it did in this study, a community of practice within a museum could provide docents with the opportunity to share and grow strategies for engaging audiences, while also supporting these museum educators with ongoing professional development through conversation and reflective practice. In this study, the reflective, iterative implementation process allowed the docents to connect their own learning and training to practice. Enhancing communities of practice within museums could be an important step toward expanding high-quality science education for all students.

THE BOTTOM LINE:

Museums and informal learning environments offer the best learning opportunities when educators, such as docents, relinquish teacher-centered pedagogy for a student-driven, inquiry-based one. This study offers three guiding principles for implementing this new teaching style: learner autonomy, conversation and reflection, and deep investigation. In this framework, the educator's role is one of listening, reflecting, and asking driving questions to encourage the student to go deeper in their investigation. Creating communities of practice—where educators have an opportunity to engage in reflection and discussion with colleagues—helps educators to work together to challenge the traditions of teacher-centered, didactic pedagogy. These communities of practice allow for educators to share successes and difficulties, and to continue refining best practices for teaching.

Allen, L. B., & Crowley, K. J. (2014). Challenging beliefs, practices, and content: How museum educators change. *Science Education*, 98(1), 84–105.

USING DRAMA TO TEACH GLOBAL CITIZENSHIP AND ENVIRONMENTAL EDUCATION

Drama is a powerful tool for exploring and enacting various relationships, values, attitudes, and human identity. *Global Storylines*, an education for sustainable development (ESD) and global citizenship education (GCE) initiative in Scotland, uses the power of drama to explore themes relating to ESD and GCE. Using a research-in-action methodology, participating teachers were trained to implement *Global Storylines* dramas and collect data. From analysis of the results, the author argues that educational drama provides a powerful pedagogical asset for ESD and GCE.

Sixteen participating teachers from eight primary schools implemented yearlong *Global Storylines* projects in their classes. They collected classroom observations, samples of students' written and oral responses, analytical field notes, and reflections. For each *Global Storylines* topic, students and teachers created stories of communities, closely reflecting actual communities, and grappled with various issues and challenges. Storylines were trialed with two age groups. The first group were 6- to 8-year-olds, using a story called *The Village and the Giant* that focused on how to build the best community possible and what to do when someone or something—in this case, a giant—acts in a destructive, antisocial manner. The second group included 9- to 11-year-olds and *The Water Source* story, which focused on responsibilities and decisions of sharing limited natural resources (e.g., water) with those who have none.

Global Storylines did not provide a prewritten script for students to read from; instead, teachers and students together created the story based on the title and basic premise. In this way, the creation of the drama became the learning medium. At the beginning of the process, students researched key questions they had to gain understanding of the people, geography, and history of the given community. Each student then took ownership of one community member (e.g., a scientist, cook, plumber, and engineer) and "walked in the shoes" of their character by creatively improvising a series of episodes relating to the storyline and various ESD and GCE topics. Each teacher was the facilitator, or director, of the process. They held the line of the story together and provided prompts for each episode, such as a stranger arriving in town with news that the water source has dried up. Logs from teachers provided thorough accounts of the ESD and GCE learning experiences.

Teachers noted the powerful and unique pedagogy provided through educational drama. This included whole class improvisation with occasional "stop the drama" call-outs from the teacher to provide out-of-role debriefs and opportunities to look at conflict resolution. Another activity explored opposite perspectives, such as whether or not to take in drought-stricken refugees. A strategy called "still image" was also used to isolate a moment in the drama and explore the internal thoughts and external actions of the characters. These teaching strategies provided students with an in-depth understanding and appreciation for complex situations. By promoting active participation from all the students in the class, these strategies also provided a means for everyone's voice to be heard and considered.

In their logs, the teachers reported students' increased interest in learning about other global communities and environmental issues. Fourteen of the 16 teachers mentioned students continuing their learning experiences outside of school with Internet searches and discussions with their families about environmental and global citizenship issues. Furthermore, all teachers noted student engagement with critical thinking, such as analyzing and deliberating ideas and synthesizing and evaluating solutions. These critical thinking skills are foundational to ESD and GCE. Teachers found the process to be particularly useful in the development of ESD- and GCE-related values, such as concern and empathy for environmental and social justice issues.

Students grappled with these storylines by making connections through cross-curricular learning. They gathered information through drama lessons, reading, technology, music, science, and geography. They became immersed in the fictional context, but made connections to "real world" current events. Students also developed relationships as they learned how to communicate and collaborate with one other and with their teachers who, at times, would be in character and participate in this democratic learning experience. These relationships between the learning context and the fictional storyline, and the relationships between participants—students and teacher alike—along with the unique pedagogy of educational drama, provided a rich engagement and exploration of ESD- and GCE-related values, topics, and themes.

THE BOTTOM LINE:

Educational drama provides a powerful and unique pedagogy for students to engage with and explore environmental and global citizenship topics. Through this process, students develop critical skills, perspectives, and values necessary for navigating complex and multifaceted issues. Global citizenship and environmental themed drama can be utilized in the classroom by asking small groups of students to research given topics, discuss various ways to resolve the issues, and improvise mini scenarios in front of the class, with each student representing a different stakeholder in the issue. Pausing these scenarios at various moments provides time to have whole-class discussions about how various characters may feel or the consequences of different actions.

McNaughton, M. (2014). From acting to action: Developing global citizenship through *Global Storylines* data. *Journal of Environmental Education,* 45(1), 16–36.

PEER EDUCATION FOR SUSTAINABLE ACTION

Youth peers tend to influence each other significantly, in both positive and negative ways. Peer education builds upon this powerful influence by providing youth the opportunity to teach and learn from each other. Peer education may be a valuable strategy for educators hoping to foster the values and skills necessary for youth to take sustainable actions. In contrast to pro-environmental behavior changes, sustainable actions are defined as self-initiated, intentional acts that operate at a community or global scale (e.g., starting a recycling program or joining an environmental group). This study implemented a yearlong peer education program, *MindShift*, to understand the benefits and challenges of using peer education to foster sustainable actions.

MindShift is a yearlong peer education program developed in Halifax, Nova Scotia (Canada). It aims to develop sustainability knowledge and environmental values, attitudes, and behaviors of high school students. *MindShift* was implemented with six teams of 10th-to-12th graders; three of those teams were selected for this study. A teacher advisor supported each team. In total, 23 students participated in the study. The students—referred to as "youth leaders" or "peer educators"—started the year by learning to prepare and offer dramatic, interactive, one-hour-long sustainability presentations to 10th-grade science classes. In total, the groups presented to 36 science classes. As the year progressed, the groups' focus turned to planning school-wide educational activities and events. Two of the three teams planned two school-wide events. The third team disbanded in the second term due to scheduling conflicts.

To collect data, peer educators participated in interviews and focus groups at the beginning and end of the year. During these meetings, students were asked to share and interpret their experience with the program. Additionally,

pre- and post-program written questionnaires were used to gain further insight about changes in the students' environmental values, personal empowerment, and pro-environmental behavior. The researchers also conducted field observation of team activities throughout the year, taking notes on team dynamics and leadership, and making personal reflections.

The data collected during the interviews and focus groups was transcribed, analyzed, and categorized into six types of learning or growth: skills for action, pro-environmental behavior, sense of empowerment, pro-environmental attitudes and values, knowledge of sustainability, and interpersonal relationships. Many students mentioned changes they had made to their personal environmental behavior. These changes began small, such as turning off lights and unplugging electronics, but became larger, requiring more of a commitment, such as eating less meat or biking instead of driving. On average, participants reported five different personal environmental behaviors taken up as a result of the program, such as taking shorter showers, turning off the lights, and choosing local foods. These self-reported behavioral shifts were also significant as participants considered them to be new "permanent habits."

Participants also spoke of the social-emotional and cognitive growth they experienced. For example, they felt a sense of empowerment and gained confidence as they learned the skills and knowledge required to understand complex issues, communicate ideas, work as a team, and make decisions. All 23 peer educators reported an increase in skills needed to take action, such as organization, facilitation, and initiative.

Another significant theme was that of growing pro-environmental attitudes and values. Peer leaders spoke of a significant shift in perspective and a new sense of concern for global ecological problems. An unexpected theme resulting from the interviews was the positive effect the *MindShift* program had on their interpersonal relationships. Students spoke of making new friends and building a new community of people with shared ideas and interests. In addition to these changes, 12 out of the 23 participants spoke of taking further action outside of the program, including sharing information or advice with family and friends, presenting at other schools, and organizing events and activities.

Given the success of this program, the authors asked: What specific characteristics of peer education led to this learning and growth? In response to this question, they discussed four positive characteristics of peer education: peer support, the ability to contribute and participate in meaningful work, participating in leadership roles, and having a sense of ownership toward the initiative. These characteristics allowed youth to have fun and feel supported by their peers and make decisions and take responsibility for the progress of a program they felt was meaningful, while also allowing them to try out and practice different leadership skills.

Overall, *MindShift* created a transformative experience for youth; however, it is important to note that each peer leadership team was unique, experiencing distinct successes and challenges. Developing positive peer interactions appeared to be the most critical step in building successful collaborative, supportive, and productive teams.

THE BOTTOM LINE:

Peer education—where students learn from each other—is a holistic learning process that can foster creative and systems-level thinking, develop leadership skills, and allow students to gain a sense of empowerment and confidence. These skills are vital for students to take action toward sustainability. There are a number of ways to implement peer education, such as having students give presentations to other groups of students, or having them organize educational activities and events. Successful implementation of peer education requires developing students' sense of ownership and leadership, including letting each student contribute to the project, and creating a safe, supportive environment for students to share and learn with their peers.

de Vreede, C., Warner, A., & Pitter, R. (2014). Facilitating youth to take sustainability actions: The potential of peer education. *Journal of Environmental Education*, 45(1), 37–56.

FACTORS THAT MOTIVATE CHILDREN IN SCIENCE

Children's motivation and interest in science often declines as they approach adolescence; this is why understanding the factors that influence children's motivation in science is critical for fostering continued science engagement. The authors of this paper investigated differences in children's motivation to study science based on three factors: the context of the learning environment (formal or informal); the manner of the students' interaction with the material (e.g., textbook learning, hands-on experimentation, or debate); and the topic of science being studied (e.g., biology, earth science, or physics).

The study consisted of 252 fifth and sixth graders who participated in an 89-item online survey. The survey was conducted in Pittsburgh, Pennsylvania, science classrooms, and also science classrooms and class museum visits happening in the San Francisco Bay Area. The survey was developed through adapting and extending existing surveys on motivation.

The first part of the survey consisted of a list of 35 science topics. These topics were selected from five science domains: astronomy, earth science, biology, engineering, and physical science. Each domain was broken down to seven topics studied under that domain. For example, the astronomy domain was represented by the following topics: planets, space travel, telescopes, distant galaxies, the moon, the sun, and black holes. Using this smaller grain size allowed the authors to more effectively measure if different scientific topics are motivating factors for children to engage in science. Students selected a minimum of two topics they were interested in learning about, plus a favorite topic. There was no maximum; they could choose all 35 topics if they wished. The favorite topic was automatically inserted into some of the questions in the survey to measure the magnitude of motivation.

The next part of the survey asked questions about students' motivation and preference toward science depending on context, manner of interaction, and topic. Questions integrated these three different factors. For example, the question, "If I started a class project on climate change, I think I could do a really good job," measured learning in a formal context (a science classroom), a specific manner of interaction (a hands-on project), and a topic (earth science). As for manners of interaction, the author identified three types: (1) consuming new knowledge, such as through reading, studying, or lectures; (2) analyzing, including how children think about material they have already learned; and (3) action, in which there are hands-on activities. Although children often interact with material in all of these ways when doing science, these distinctions were made in order to understand the influences of the specific interactions. Students answered questions using a Likert scale, with the five points on the scale correlating to the following five options: YES!; yes; maybe; no; and NO!

The results of the study suggest science content has a great impact on the motivation and interest of children. Specifically, children demonstrated a keen interest in specific topics, as opposed to traditional domains of science. Topics within the earth science domain, for example, were some of the least favored, although "oceans" (also within the earth science domain) was one of the most popular topics selected. Furthermore, students reported interest in a range of topics that were not categorized by traditional domains, but instead picked topics spanning all five science domains. This highlights the importance of specifying science topics when trying to understand children's sentiments and engagement in science. These results also suggest that children may be interested in particular opportunities which studying these topics provide, such as using technology, measuring, or working outside.

Context and manner of interaction appeared much less influential in motivating children in science. These are rather surprising results, given that informal and hands-on activities provide more opportunities for autonomy and choice, factors which are known to increase intrinsic

motivation. It may be that these children did not have many informal education experiences to draw upon; it may also demonstrate that context and the way in which children interact with science content, in itself, is not enough to motivate them toward science.

THE BOTTOM LINE:

This study found that students have a strong motivation to study specific topics (e.g., satellites or sharks), which may not correlate to a broad interest in a traditional domain of science (e.g., astronomy or biology). In order to keep students motivated to study science—or possibly any subject—it is critical to ask about and discover the specific topics most interesting to them, and to allow students to explore all the various aspects of those topics. If a student or class is interested in frogs, for example, you could choose that as the focus of study, incorporating a variety of traditional disciplines in the inquiry, such as biology, ecology, water pollution, stories about frogs in literature and film, art, and more. One of the outcomes of this topic-driven approach is a more interdisciplinary method of teaching science.

Bathgate, M., Schunn, C. D., & Correnti, R. (2014). Children's motivation toward science across contexts, manner of interaction, and topic. *Science Education,* 98(2), 189–215.

REVIEWING TECHNOLOGY USE IN CLASSROOM ENVIRONMENTAL EDUCATION

A wide variety of information and communication technologies (ICT) and digital tools have been introduced into environmental education, both inside and outside of the classroom. This review presents a range of examples of how ICT has been used by classroom environmental educators. The authors also explore whether ICT is helping meet the goals of environmental education and present suggestions for teachers and researchers exploring ICT use in environmental education (EE) curriculum.

The review begins by outlining the goals of EE, using the objectives put forward by the United Nations Educational Scientific and Cultural Organization (UNESCO) based on international conferences held on environmental education in 1975 and 1977. Four of these objectives are to help individuals and social groups acquire the following:

- *Awareness* of and sensitivity to the global environment and its allied problems
- *Attitude*—a set of values and feelings of concern for the environment, as well as the motivation to actively participate in environmental improvement and protection
- *Skills* for identifying and solving environmental problems
- *Participation*—an opportunity to be actively involved at all levels in working toward resolution of environmental problems

Two additional objectives for EE are that the teaching includes:

- An international and local dimension
- An interdisciplinary approach

Next, the authors explored whether the ICT tools seem to be helping meet these goals by gathering a variety of examples from peer-reviewed articles. The criteria for choosing these articles were: (1) they discussed a learning activity employing ICT in some form, and (2) the learning activities were either clearly defined as EE or could be used by EE. Of the articles collected, the researchers chose 16 to examine more closely. These 16 examples met at least four of the six criteria outlined by UNESCO. These 16 examples covered both indoor and outdoor uses of ICT for environmental education and had a range of target audiences from elementary to higher education. In the review, the authors present a table that shows how each example of ICT either meets or does not meet each of the six UNESCO goals outlined above.

The authors began by examining the use of ICT inside the classroom. They point out that ICT offers a potential

alternative to field trips and outdoor learning experiences. Specifically, these programs can provide access to places at times when they are otherwise inaccessible. Although these first-hand experiences are ideal, financial, time, and security concerns all can present difficulties for teachers. Virtual field trips could provide opportunities for students to explore beyond the limits of their classrooms and their place in time. For example, students could virtually explore the world of dinosaurs, or an imagined future. ICT can also potentially help teachers teach EE topics that are abstract or distant from students' everyday lives. The authors examined 12 examples of ICT for use inside the classroom: virtual museum, e-Junior, virtual ecological pond, and QA, designed for grades 1–6; Google Earth, River City, and Under Control, designed for middle school children; acid ocean virtual lab, for high school; and, for higher education, virtual field trip, video podcasts, Appropedia, and EVFL. These examples range from teaching marine ecology (virtual museum), to the history of the 50 worst oil spills (Google Earth), to soil degradation and environmental destruction linked to human civilization (virtual field trip).

Next, the authors explored ICT that has been used to enhance outdoor learning experiences, using portable computers or mobile phones. They found the two main advantages of these devices, with regard to EE, are the ability to generate scientific data and the ability to simulate an environmental investigation while in the field. The authors examined four examples of ICT used outdoors: Sense project, ED, Timelab 2100, and using mobile phones for environmental awareness. Most of these ICTs were designed for use in high school or higher education.

Based on their review of each of these 16 ICT examples (12 indoor and four outdoor), the authors discuss several key findings relating to overall affordances and constraints associated with ICT tools currently available for EE. One key finding was that there are a number of tools and applications available for teachers. However, there is a lack of research examining how each of these tools is used and what it implies for student learning. The authors conclude that there seems to be much more interest in designing the tools than in analyzing how their use contributes to student learning and understanding of environmental issues.

With regard to the six goals of EE outlined by UNESCO highlighted above, the researchers found several patterns. All of the tools seem to have the potential to raise awareness and to help acquire an attitude of concern for the environment. All the tools available also use an interdisciplinary approach. Most, but not all, of the activities seem to evoke skills for identifying and solving environmental problems. They found few of the tools seemed to include both international and local dimensions, which is important for developing both a holistic view of global problems and a sense of concrete and local implications. In addition, very few of the activities seemed to have the potential for fostering participation of students in working toward resolutions of environmental problems.

Another key finding was that teachers often lack the technical support or computer skills to address issues that arise when using the ICT software. The authors point out that most of these ICT tools are tested with expert researchers present to address technical problems, and little research exists on how easy these tools are for a regular teacher to implement.

Finally, the authors raise questions about the merit and value of using ICT to teach EE. While there are several possible benefits, there is also a possibility that the entertainment value and software itself can detract from students' focus on the material. A concern exists that these tools could encourage teachers and students to stay indoors and participate in virtual field trips, even though actual outdoor experiences could be feasible. In this way, ICT could contribute to students' alienation from nature instead of promoting a sense of connection. Ideally, ICT will be used in moderation, and as a complement to actual outdoor experiences in EE.

THE BOTTOM LINE:
Many information and communication technologies (ICTs) have been developed for use in teaching environmental education (EE); some of these tools, such as virtual field trips, are designed for classroom use, while others are designed for collecting data and extending interactive learning in outdoor settings. Although most of these tools have merit for promoting environmental awareness, attitudes, skills, and interdisciplinary thinking, only a few of them incorporate both local and international dimensions and encourage student participation toward resolution of environmental problems. Experimenting with these tools when teaching EE may produce useful and insightful outcomes, particularly when faced with constraints that make outdoor experiences and field trips difficult to actualize.

Fauville, G., Lantz-Andersson, A., & Saljo, R. (2014). ICT tools in environmental education: Reviewing two newcomers to schools. *Environmental Education Research,* 20(2), 248–283.

INCREASING ADULT ENGAGEMENT IN CITIZEN SCIENCE

Citizen science projects engage participants as active members of scientific research. They offer opportunities for education, as well as the potential for enabling the collection of robust data sets that may otherwise be infeasible for the professional scientific community to gather alone. The Lost Lady Bug Project builds upon this understanding and engages adult participants in research about ever-changing ladybug populations across North America. Through this project, the authors of this study investigated the dual purpose of citizen science projects to motivate, engage, and increase learning among citizen science volunteers, while also advancing scientific research. Through evaluation and testing of various learning outcomes, the authors of this paper suggest these educational and scientific goals are mutually supported. They also identify some of the challenges of citizen science while proposing goals for improvements.

The study consisted of online pre- and post-tests assessing knowledge, skills, and attitude gains. The tests were administered through different means—the pre-test through an online pop-up on the project's website (49 participants total), and the post-test through emails to the participant database (353 participants total). The pre-test survey consisted of 10 forced-choice questions (i.e., there were no "no opinion" or "I don't know" answer selections) regarding ladybug biology, as well as eight attitude statements about citizen science. The post-test survey included identical questions to the pre-test survey, as well as additional measures of self-reported learning, motivation, and use of the website as a learning resource. As participants were a self-selected sample, which increases the potential of bias, the authors of the paper interpreted the results conservatively.

Respondents from the Lost Lady Bug Project reported gains in knowledge, skills, motivation, and attitudes. The 10 forced-choice questions measured knowledge about ladybugs and included topics on biodiversity, regional differences in ladybug populations, invasive versus native species, and the ecological benefits of ladybugs. The mean knowledge score of these questions on the pre-test was 6.65, which increased to 7.99 on the post-test, suggesting a greater awareness and understanding about ladybugs, the diversity of the species, and ecological problems they face. Rating motivational statements demonstrated that respondents mainly enjoyed contributing to a scientific study (80%) and learning about ladybugs (71%). Other important motivational factors to note included contributing to conservation (69%) and being in nature (56%). These findings suggest an interest in the scientific process, demonstrating the great potential of citizen science projects to engage the public in science.

Respondents' motivation to contribute to scientific research also aligns with their perception that scientists value their work and deem it important. However, they reported low confidence about their individual ability to contribute to science. This low confidence was remedied somewhat through experience; Lost Lady Bug Project participants with multiple years of involvement reported

more positive attitudes regarding their contribution than those with only one year of involvement. This suggests a relationship between ongoing participation and sense of value of one's contribution. More research in this area is needed in order to understand the relationship and then structure citizen science programs accordingly.

The results of the study also highlight some important trends about the benefits and limitations of citizen science. For example, while nearly all participants reported using the provided online resources to read about ladybugs (94%), far fewer reported using online resources to learn more in-depth information about the data collected. For example, 63% reported using the interactive map showing locations of reported ladybug populations, and only 54% reported looking at the list of submitted ladybug data. These results suggest a limit to the type of science practices citizen science participants are willing to engage in. Along the same line, respondents reported wanting additional resources to improve their ladybug identification skills, again demonstrating participants' interest in their role as data collectors, as opposed to data interpreters.

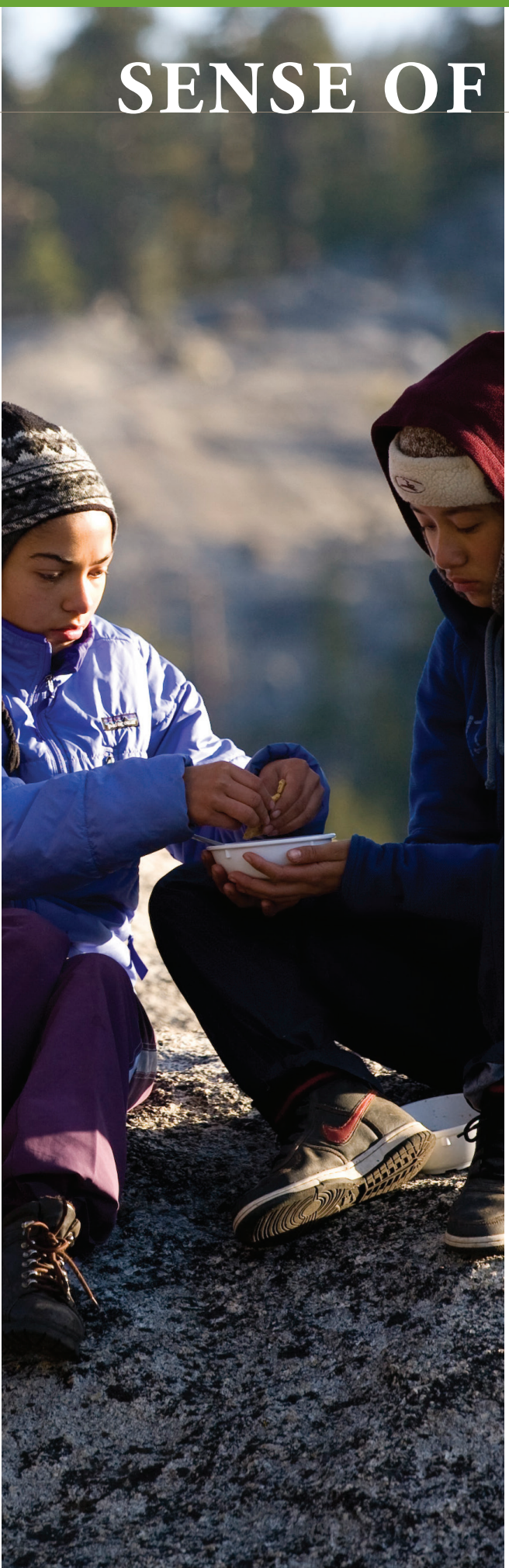
The findings of this study align with current citizen science research and demonstrate a strong feedback loop between the goals of science and education: participants engage in scientific processes, and increase their understanding, interest, and motivation in science, while also contributing scientific data. Similar research on ladybug citizen science projects suggests that it is a more effective and cost-effective means for data collection, as compared to traditional data collection methods. Furthermore, these citizen science projects have led to several scientific discoveries already, such as the existence of rare ladybug populations, changes in ladybug size resulting from environmental factors, and the sudden decline of native ladybug populations in some areas.

Based on the importance of citizen science participant contributions, it is important to find ways to increase participant engagement. To that end, staff of the Lost Lady Bug Project noted the participation of "super-spotters," participants who engage in the project at higher levels than average. These super-spotters may provide insight regarding how to develop skills and motivation with other participants. These understandings align with two project goals: (1) encourage minimum-level participants to expand their contributions, and (2) attract more super-spotters. Current work on these goals includes a ladder-like engagement and development plan where participant involvement is supported by increasingly higher-level tasks. The first task, for example, may be to make a first submission of data to the citizen science database; the second, to plan and conduct a planned ladybug search; and third, to replicate the search over time.

THE BOTTOM LINE:

Citizen science projects have shown to be an effective and powerful means to engage the public in scientific practices. Additionally, citizen scientists make meaningful and important contributions to the field of science. This dual benefit makes clear the importance of further engagement in citizen science projects by involving more high-skilled participants while also developing the skills of all participants. Connecting local citizen scientists with each other, or creating online forums for citizen scientists to communicate and share knowledge with each other, can help foster a learning community. These connections could also provide opportunities for more experienced citizen scientists to mentor and engage beginner participants.

Sickler, J., Cherry, T. M., Allee, L., Smyth, R. R., & Losey, J. (2014). Scientific value and educational goals: Balancing priorities and increasing adult engagement in a citizen science project. *Applied Environmental Education & Communication*, 45(1), 16–36.



SENSE OF PLACE

INCORPORATING INDIGENOUS PERSPECTIVES IN PLACE-BASED EDUCATION

Although place-based literature acknowledges the complex relationships between land and culture, the multicultural and historical context of the land—particularly with regard to indigenous cultures—is often left out. Without understanding and incorporating these indigenous perspectives, educators run the risk of perpetuating conceptual developments and experiences of place that do not account for the histories of land-culture relationships that preceded settlement. Recognizing that Western intellectual tradition often denies or erases indigenous points of reference, this paper's authors uncover ways in which settler colonialism is embedded in place-based education and explore lessons learned from an indigenous land and community-based education project.

The authors represent heritage from six different nations (Ojibwe, Lakota, Choctaw, Little Shell Band of Chippewa-Cree, Miami, and Navajo), each with various histories that typify experiences of indigenous people across North America. In their paper, they trace the emergence of settler colonialism and consider its subsequent impacts in environmental learning contexts. They then draw lessons learned from a six-year community-based research project, which they led together in Chicago. This project was inspired by indigenous elders who began walking the perimeter of the Great Lakes almost 15 years ago to raise awareness for the impacts to the health of the lakes (see www.motherearthwaterwalk.com). The research project centered on the ecosystems and environmental degradation of the Great Lakes, which are home to many indigenous nations.

Because many educational research traditions are inadequate for understanding the complexities of learning and development, the research team used a design-based research method that refines theory and practice throughout the process. The first step involved bringing together a range of community members to be decision-makers in the design and implementation of place-based science learning. Following the design process, a local community organization was created to initiate youth and family programs held at the American Indian Center of Chicago. Programming was initially held during the summer, but then was expanded to year-round on Saturdays.

Three themes that emerged from the design process guided program implementation: (1) knowing Chicago as the lands of indigenous ancestors and, specifically, visiting old village sites; (2) knowing Chicago as wetlands, where many medicinal and edible plants grew and continue to grow; and (3) understanding the impacts of invasive species on these lands. The authors organized the pedagogy around "knowing" and "coming to know" through building relationships with land. From this experience, the authors offer insights for reconceiving place-based education in a multicultural, historical context.

The authors found that constructions of land as no longer indigenous are consistently implicated in teaching and learning about the natural world. Based on their reckoning of settler colonialism and its impacts in learning contexts, as well as their experience through the community-based research project, the authors suggest that pedagogies that acknowledge indigenous people's lifestyles and incorporate indigenous perspectives of the land can inspire stewardship. One key theme that emerged from the research project, for example, was "remaking relatives:" the notion that people need to treat land as a relative, rather than as a material object; in this way, land is protected for long-term use and conservation. Learning about people's relationships with "plant relatives" over time, for example, enabled project participants to come to know a place through a lens focused on its current state. This focus on plant relatives enabled participants to move beyond an anthropocentric view of nature to one more family-focused. Uncovering how people—both indigenous and Western—have valued and related to a species, such as a plant, over a long history could facilitate this type of learning. The authors suggest that this type of place-based knowledge creation that integrates indigenous culture could enable deeper engagement and cultivation of relationships with the land, as participants became increasingly interested in expanding their learning about plant relatives to land, water, and other aspects of the environment.

Another theme that emerged from their research project was the significance of "naming" and the ways in which naming may construct knowledge systems in teaching and learning environments. Naming, in place-based education or environmental education, may often create the turning point at which references between Western and indigenous ways of knowing and fostering understanding diverge. For example, using the term "invasive species" can sever a whole history of human relationships to a species. Because the "invasive" may be new to the current population in a particular place, it may not be perceived as a "relative" of the people in that place today. It is, however, a relative of humans at a broader scale. Learning about a longer continuum of relationships between people and an "invasive" plant, for example, seemed to create an openness and eagerness for the research project participants to learn more about changes in the environment over time. The authors refer to this learning process as "storying the land from long views of time and experience" or "(re)storying." They argue that by making the history of the land and changes in the land visible over time, the land becomes "the first teacher," and learning environments emerge from there.

THE BOTTOM LINE:

Taking a long view of the relationships between people and plants in a given place may facilitate a stewardship perspective that goes beyond an anthropocentric view of nature. Coming to know how people have connected to a particular plant, over time, for example, is one way to cultivate place-based learning that incorporates indigenous perspectives on relationships with land. For indigenous scholars, focusing on relationships between people and land is not new; however, these relational pedagogical approaches need to make their way into place-based education and other environmental learning contexts. (Re)storying lands to include indigenous people as original inhabitants can help people move beyond narratives of acquiring territories and resources and bring about social change for stewardship.

Bang, M., Curley, L., Kessel, A., Marin, A., Suzukovich III, E. S., & Strack, G. (2014). Muskrat theories, tobacco in the streets, and living Chicago as Indigenous land. *Environmental Education Research*, 20(1), 37–55.

PROFESSIONAL DEVELOPMENT

LACK OF ENVIRONMENTAL EDUCATION IN TEACHER TRAINING PROGRAMS

Teachers play a pivotal role in environmental education, but what are their own perceptions about the environment? The environment is not only an ecological entity, it is a construct influenced by social, cultural, and political domains. How it is perceived and defined influences how environmental education (EE) is taught and how we evaluate environmental issues. Mounting evidence indicates that lack of EE in teacher education is one of the obstacles to successful implementation of EE in schools. This study explores the environmental perceptions of preservice teachers at both the beginning and the end of their teacher education programs. It investigates perceptions of the environment and how these perceptions are related to the subject area they will teach, as well as human interrelationships with the environment. Results from this study provide insights as to whether graduates are well informed to teach EE and what might be done to bolster their environmental literacy.

To understand the environmental perceptions of preservice teachers, 215 undergraduate students from three teacher-education programs in Israel participated in pre- and post-tests both at the beginning and the end of their four-year bachelor and teaching certificate programs. The average age of the study participants at the beginning of the study was 24 years old, and the majority of participants were female (87%). These preservice teachers were assigned to one of two categories: The first included participants learning to teach subjects affiliated with the environment, such as environmental studies, life science, agriculture, and geography. The second category included participants planning to teach other subjects, such as history, literature, mathematics, art, and physical education.

The pre- and post-tests asked participants the same two open-ended questions: (1) “When you hear the word ‘environment,’ you think of …”; and (2) “In your opinion, how do environmental topics relate to the teaching area you chose to major in? Explain.” The pre-test was administered in the first month of the first academic year in the program, and the post-test was administered with the same students during the last month of their third (and final) academic year.

Through analysis of the responses from the first question, the authors identified a number of themes, reflecting a variety of common perceptions about what the environment is. Once these themes were identified, the authors noted how many responses made reference to each theme. Some responses contained references to many themes, whereas others made reference to only a few. The authors noted that 60% of the responses to this first question were comprised of lists of components or characteristics of the environment, and the rest were phrased in complete sentences.

The first theme identified was a romantic perception of the environment, meaning that nature is referred to in aesthetic terms, referring to a pristine paradise and refuge from the modern world (e.g., flowing rivers, serenity, pure water, a world isolated from technology). About a quarter of responses (25.6%) made reference to this romantic perception at the beginning of the program. By the end of the program, the number of responses that made reference to the romantic perception showed a significant increase (to 30.6%).

Environmental quality was another theme identified. The authors divided this theme into two categories: (1) responses that mentioned the adverse effects of human activity on the environment, such as pollution, soot, and environmental damage; and (2) responses that mentioned the need to protect the environment. At the beginning of the program, 40.2% and 20.1%, respectively, mentioned these two categories. By the end of the program, there was a significant decrease, to 36.0% and 15.2%, respectively. In other words, concern for environmental quality seemed to decrease over the course of the teacher-training program.

Another way the authors considered the responses was through the lens of various dimensions, specifically biophysical, social, economic, and political. The biophysical dimension refers to the environment as comprised of various living and nonliving objects, such as animals, fungi, oceans, rocks, and so on. This was, by far, the most common theme noted in the responses, with over half of responses referencing biophysical dimensions in the pre- and post-tests. The social, economic, and political dimensions of the environment are also considered critical for a holistic understanding of the environment. However, only a few respondents (fewer than 4%) mentioned any of these aspects in their responses both before and after the program.

Another theme the authors identified was a self-centered perspective. These responses expressed the environment from the point of view that it is something surrounding oneself, or that "I" am in the center of the environment. This perspective was exemplified in sayings such as, "the environment is everything outside of my body." About 20% of the responses touched on this theme in both the pre- and post-test.

The final theme the authors discussed was different variations of the human-nature relationship. About 15% of responses mentioned humans as part of the environment. Fewer than 2% of responses mentioned humans as separate from the environment, and about 5% of the responses described humans and the environment as interdependent. All of these response rates showed no significant change from before to after the program.

Regarding the second question, nearly all the preservice teachers (95%) reported that environmental topics were relevant to their area of teaching. The reasons given for why environmental topics are relevant fell into one or more of these categories: (1) the environment is a universal issue that all are a part of (about 5% of both pre- and post- responses); (2) concern for the environment is an educational value and needs to be taught (33% pre; 22% post); (3) teaching about the environment is the responsibility of educators (22% pre; 15% post); and (4) as teachers, they need to be role models and demonstrate environmental behaviors (about 4% both pre- and post-program). In terms of how to put this into practice in their classrooms, respondents noted that their specific subject areas could be taught through an environmental lens or that they could use their teaching to promote environmental values. Overall, responses to this second question highlighted the interest that pre-

service teachers have in teaching environmental topics. However, between the beginning and end of the program, there was an overall decrease in the number of responses that articulated why teaching about the environment is important or how to incorporate this topic in their teaching. This indicates a lack of preparation offered by their teacher-training program.

Finally, the authors also examined differences in the responses between pre-service teachers planning to teach in environment-affiliated fields (EAF) versus those planning to teach in non-environment-affiliated fields (NEAF). In terms of responses to the first question about how they view the environment, differences between these two cohorts were relatively minor and nonsignificant, both before and after the teacher-training program. With regard to the second question about incorporating the environment in their teaching, the biggest difference was that EAF students were much more likely to report that they see their teaching area as a framework for integrating environmental content. This was not surprising given that they plan to teach in environment-affiliated fields. Overall, the authors concluded that students in EAF and NEAF both seemed to be equally unprepared to teach environmental topics after the three-year teacher training program.

THE BOTTOM LINE:

Although most teachers may feel a desire to incorporate environmental topics into their teaching, teacher-training programs may not be adequately preparing them to do so. Teacher-training programs should focus on developing a holistic and multidimensional view of the environment; this holistic view includes understanding that people and the environment are interdependent. In addition, teachers should understand that teaching about the environment means more than learning about the living and nonliving objects (animals, rocks, plants, and so on), but also includes social, economic, and political dimensions. It would also be valuable for teacher training programs to discuss why environmental education is relevant to any field of teaching (not just science) and also provide teachers with strategies for how to implement environmental education perspectives in their classrooms.

Yavetz, B., Goldman, D., & Pe'er, S. (2014). How do preservice teachers perceive 'environment' and its relevance to their area of teaching? *Environmental Education Research*, 20(3), 354–371.

OTHER RESEARCH

INSIGHTS FROM TWO DECADES OF CLIMATE CHANGE COMMUNICATION RESEARCH

Because climate change will have consequences for many people around the planet, efforts to educate the public about its causes and effects are steadily rising. In the face of these increasing efforts, there is a need for better information on how learners of climate science understand climate-related issues, how media discourse frames climate change, what barriers exist to public engagement in climate change, and how these barriers could be overcome. This paper provides educators with insight into the growing fields of climate change communication and public understanding of climate change through a literature review of 92 studies. Through this review and discussion of recurrent themes in the literature, the authors aim to inform future design of climate change communication and education, particularly in informal settings.

The review explored: (1) factors that influence how climate change communication is understood and received by an audience; (2) goals of climate change communication to a lay public; (3) barriers to public engagement in climate change and possible solutions; and (4) the relevance of key messages in the literature for nonformal climate change education. The author primarily focused the analyses of barriers on the content of climate change communication, visualizations, framing, and audience segmentation into target groups. The review encompassed peer-reviewed articles published between 2000 and 2011, because the bulk of research in the nascent fields of climate change communication and education has been conducted in the 2000s. Search terms for articles listed in two databases (Academic Search Premier and Scopus) included climate change, global warming, communication, public, public understanding, and public engagement. With a few exceptions, the studies included in the final dataset were primarily from developed countries.

In terms of how climate change education is received and understood, the author found a clear distinction between public understanding and public engagement, as well as a shift from communication goals centered on understanding to those centered on engagement over

time. Climate change communication that targets public understanding relies upon the information deficit model, the idea that basic education about climate change can alleviate the lack of trust or interest in climate change. In contrast, communication designed for public engagement actively brings the public into the learning process with minds, hearts, and hands. Caring about the issue, feeling motivated, and having the ability to take action were all found to be critical to public engagement in climate change.

The results contextualize public climate change education and communication by summarizing media coverage and studies of the public's understanding of climate change. The reviewed studies document a tendency in media for sensationalism and alarmism that can be counterproductive for engaging people. How media frames the issue influences how people understand and interpret it. Highlighting the core issues and actors, and offering solutions, could be more productive for media communication to trigger engagement. Despite an increase in public awareness of climate change, some studies reported a decline in concern in the U.S. and U.K. in recent years. Citizens may see government bodies as the main responsible bodies, as individuals balance everyday-life challenges with the societal issues climate change may cause and question their own abilities to affect change. Public discourse on climate change remains characterized by uncertainty and debate, with various perspectives offered on how people can best contribute to mitigation and adaptation.

The primary goal for climate change communication was consistent across the studies examined and centered on identifying strategies that support sustainability and reduce climate impact. Various studies offered more specific goals within this umbrella, such as focusing on lifestyle change, political influence, and participation in climate science and policy dialogue, or reduction in household energy use.

The review of the climate change communication literature also revealed many barriers to public engagement. The greatest barriers were a lack of scientific literacy and "the bigger-than-self" dilemma, in which individuals doubt that there are actions they can take to make a difference. The author offers a number of potential solutions to these barriers, such as using awareness-raising messaging that empowers individuals, as opposed to fear-based messages, and suggests that climate change communication and nonformal education needs to address several barriers at once.

THE BOTTOM LINE:

Climate change communication has evolved in recent years to focus on engaging the public to care about the issue, feel motivated, and have an ability to act. There are many barriers, however, to engaging individuals in climate change. Climate change communication research indicates the importance of using messaging that focuses on empowerment, rather than fear; solutions rather than catastrophic consequences; and local impacts rather than more-distant, iconic impacts, such as glacial retreat. Using computer visualizations may help people better understand future impacts in relation to their current actions. Reframing climate change, not as an environmental issue, but as a human health issue or security issue—and carefully tailoring communication to groups based on values, attitudes, and beliefs—may also help enhance public engagement.

Wibeck, V. (2014). Enhancing learning, communication and public engagement about climate change – some lessons from recent literature. *Environmental Education Research*, 20(3), 387–411.

EXAMINING PRECONCEIVED IDEAS OF SHARKS TO DESIGN BETTER ZOO EXHIBITS

Sharks are commonly perceived as aggressive, violent, and dangerous—a view often propagated by media. Zoos and aquariums try to counter this antagonistic vision by exposing visitors to a more accurate depiction of sharks and their role in the marine ecosystem. This is approached

through interpretation and positive experiences with live animals. To improve the quality of these learning experiences, the institution where this study took place, Zoomarine, performed an evaluation of its programs and visitors. Their first goal was to understand what information and attitudes participants are bringing to their visit: specifically, how their young and adolescent visitors think about sharks. The second goal was to develop teaching strategies based on this information.

The researchers collected data in two phases. The first phase was an exploratory study and included 235 museum visitors aged 8 to 16. These participants were asked to draw a shark using their memory and conception of the animal, without the addition of hints or prompts. Participation was voluntary, and there were no time limitations. These drawings were coded and analyzed by a single researcher, according to four categories: anatomy, behavior, physiology, and classification. Each aspect of the drawing (such as anatomy and behavior) was subsequently coded to one of three levels of complexity: initial, intermediate, and reference.

Based on the results of the first phase of the study, the authors designed a second phase to acquire more information about participants' ideas and experiences related to sharks. Five visitors of different ages (between 8- to 14-years old) were selected and asked to participate in a semi-structured interview about their work, particularly regarding their knowledge and representation of shark biology, anatomy, and ecology, and the environments in which sharks live.

Based on the analysis of the drawings collected in the first phase of the study, the authors identified five categories and 19 subcategories that represented various aspects of the drawing content. Based on the second phase of the study, which included drawings and interviews, the authors identified additional features, for a total of 13 categories and 33 subcategories. These categories and subcategories included: anatomy (subcategories: gill slits, fins, mouth, human expression, plus six more); community (biological diversity, ecological connectivity); environment (distribution, natural habitat, and two others); trophic relations (diet, predation); population (sharks); conservation (ecological importance, status); behavior (activity, aggressiveness); senses (vision, smell, hearing); physiology (breathing); classification (class); movement (migration, mobility); reproduction (reproductive capacity and strategy); and longevity.

For the purposes of analysis and discussion, the authors focused on four of the categories: anatomy, behavior, physiology, and classification. For each of these categories, the authors identified three levels of understanding: initial, intermediate, and reference. These levels allowed the authors to better analyze the drawing and interview data. The authors also describe these levels as a framework that could be used by future educators.

To illustrate the authors' analytic process, in the anatomy category, all three levels of understanding were identified. At the initial level, the features identified were considerably different from scientific understanding. Initial level drawings, for example, had shark heads detached from the rest of the body, human facial expressions, or rectangular teeth. The intermediate level included drawings and verbal explanations representing a somewhat more comprehensive or factual understanding, such as the presence of both caudal and dorsal fins, though with no reference to their use. The reference level drawings included features such as correctly proportioned heads, the inclusion of a pectoral fin, and descriptions of cartilaginous skeletons, among other features.

The authors followed a similar analytic process for the behavior, physiology, and classification categories. Based on this analysis, the authors discerned that most visitors had very little understanding of shark behavior. Not a single participant expressed or drew what the authors deemed reference-level behavior traits, such as hunting primarily at dawn or dusk. Instead, most references to shark behavior incorrectly described sharks as naturally aggressive, or attempting to hunt and attack humans (initial-level understanding).

A similar lack of understanding was found for the category of shark physiology. The authors noted that there are several approachable concepts related to shark physiology, such as skeletons made of cartilage and huge livers that help with buoyancy, among others. However, the only physiological process addressed by the study participants was related to gas exchange. Participants either described sharks incorrectly as air-breathers with lungs (initial level) or correctly described the way sharks extract oxygen from water passing over their gills (reference level).

Finally, with regard to the classification category, participants either categorized sharks incorrectly as mammals (initial level) or correctly as fish (reference level).

Based on these findings, the authors suggest the primary barriers to gaining a more advanced understanding of sharks include the negative reputation of sharks and an anthropocentric view, centered on a perceived relationship between sharks and humans. Another aspect of this anthropocentric view was marked by human characteristics being incorrectly assigned to sharks. One suggestion for overcoming these barriers includes focusing shark education on simple characteristics to alleviate common misconceptions about sharks and their role in the ocean ecosystem. Another suggestion is to ask questions directly related to how sharks are different from humans, such as: "Do sharks breathe underwater?" or "Why aren't sharks mammals?" These types of questions can be used to help visitors move toward progressively higher levels of understanding.

THE BOTTOM LINE:

When designing effective educational materials, understanding the preconceived notions of students or other visitors to a zoo or museum is essential. One method for discerning these preconceived notions is to allow students or visitors to draw their understanding of a subject, without additional prompting. Semi-structured interviews can provide additional insight into student understanding. This data can then be used to identify areas of misunderstanding and to focus educational efforts. Determining different levels of understanding of a subject, from initial to reference level, can also provide valuable information for formulating educational goals.

Correia das Neves, J. P., & Monteiro, R. C. R. (2014). How full is your luggage? Background knowledge of zoo visitors regarding sharks. *Environmental Education Research*, 20(3), 291–312.

THE EXTENT OF TRANSMISSION OF ENVIRONMENTAL CONCERN FROM PARENT TO CHILD

Previous research has found that many social and political attitudes are highly developed by the end of high school and tend to remain relatively stable throughout the rest of life. The influences that shape the development of environmental concern among youth and adolescents, therefore, are particularly important for environmental educators to understand. Environmental concern is the values and beliefs one has toward the environment and nature. Intuition would posit that parents play an important role in fostering environmental concern among their children; however, this role has not been well documented. This study asked: "To what extent, and how, is environmental concern transmitted from parent to child?"

The researchers investigated three different models for the transmission of environmental concern between parents and children: direct transmission, indirect transmission, and gender-specific transmission. Direct transmission is the overall transmission of values from parent to child; the hypothesis based on this model is that the level of environmental concern will be related between parents and children. Indirect transmission refers to the family context and communication patterns within a family. This model posits that if families talk about the environment at home, children are more likely to have a higher degree of environmental concern. Finally, gender-specific transmission means that the influence of parents on their children regarding environmental concern is different depending on the gender of the parent and child. Based on their literature review, the authors of this study hypothesized that mothers would

have a stronger impact than fathers on the environmental concern of both their sons and daughters.

To investigate these questions, the authors used data from the Parent-Child Socialization Study (PCSS) (Hooghe et al., 2012). The PCSS was given to Dutch adolescents and their parents, and data were collected on social and political attitudes, family situations, and parent–child relationships. Sixty-one Dutch secondary schools were randomly selected for the study, and all pupils in their third year of secondary school (average age of 15) completed the questionnaire during class hours. The students were given similar questionnaires for their parents to complete. In total, 3,426 adolescents (54% male), 2,305 mothers, and 2,092 fathers participated in the survey. Because of the nature of question regarding gender-specific transmission, single-parent families were not included in the analysis.

The questionnaire measured environmental concern through five items that asked about the level of importance and involvement in aspects of the environment, which could be answered on a five-point scale from 1 (totally disagree) to 5 (totally agree). To measure indirect transmission, this question was asked: "How many times have you talked about environmental pollution with your parents? With your mother? With your father?" These questions were answered on a four-point scale, from 1 (never) to 4 (often). Gender (male or female) was another variable that was included in the analysis. The researchers also took into account the education level of the parents, since research has shown that individuals with higher levels of education tend to be more concerned about the environment.

The results showed that parents were significantly more concerned about the environment than their children, indicating a generation gap. No significant differences were found between the environmental concern of mothers and fathers, or sons and daughters. In general, it was found that adolescents talk a little more with their mother than with their father about the environment.

The results indicated a significant positive correlation between the environmental concern of parents and their children. Overall, the environmental concern of mother and father combined accounted for about 10% of the total variance in the environmental concern of the child. This effect was stronger for girls than for boys, suggesting that girls' environmental concern is more influenced by parents.

With regard to the role of indirect transmission through conversation about the environment in the household, the researchers found that this did seem to have a strong influence on the environmental concern of the adolescents. Specifically, the more often a child discusses environmental issues with parents, the more likely they are to have high environmental concern. This affect seemed to be similar for talking with either parent. The frequency of communication about the environment was also higher in families where the parents are more concerned.

Finally, the researchers investigated the effects of gender-specific transmission. Contrary to their prediction, the authors found that mothers and fathers appear to have the same influence on both girls and boys, and they could discern no gender patterns among the results.

While the intergenerational transmission does appear to have an influence, these results also showed that a large part of the variance in environmental concern of adolescents (about 90%) remains unexplained. Peers, media, formal environmental education, and other factors may all play important roles.

THE BOTTOM LINE:

The environmental concern of parents has a significant positive effect on that of their children. Moreover, in families where environmental issues are discussed, children are more likely to develop a sense of concern for these issues. As a teacher, this knowledge can be used to encourage children and parents to discuss environmental issues at home, through questions or take-home activities. Involving parents

in environmental education activities is also valuable, since it creates reasons for more discussion about these issues at home. Since overall, parents were found to have a greater sense of environmental concern than their children, parents may also serve to continue educating and influencing their children in positive ways long after the environmental education experience has taken place.

Meeusen, C. (2014). The intergenerational transmission of environmental concern: The influence of parents and communication patterns within the family. *Journal of Environmental Education*, 45(2), 77–90.