

Reflection in Action: Environmental Education Professional Development with Two Cohorts

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Abstract

This article shares lessons learned from a 2-year environmental education professional development initiative with two cohorts. Each cohort consisted of school-based teams of elementary teachers. The professional development included a series of five workshops aimed at integrating environmental education across the curriculum, and each teacher team developed and implemented a school-based project to put these ideas into practice. The project team modified their approach between Cohorts 1 and 2 based on strengths and shortcomings of the first experience. Key takeaways to inform future professional development efforts include ensuring the timeframe of the project allows teachers to build momentum in their work, recruiting teams of teachers with diverse classroom experiences, and including presenters who can offer tangible and actionable ideas to use in the classroom.

Introduction

Over the past several decades, environmental education (EE) has gained attention both inside traditional classrooms and in informal settings. Recent national efforts, such as the widespread adoption of the *Next Generation Science Standards* (NGSS), demand that K–12 teachers integrate ideas around engineering, problem-solving, and design-based teaching into science instruction. Yet, for the most meaningful and impactful instruction in these areas, authentic problem-solving contexts are necessary. For authentic problem-solving contexts to emerge, interdisciplinary perspectives are needed. Environmental issues provide relevant topics that require a multidisciplinary approach to engage students in meaningful learning. Although research demonstrates that teachers often value the importance of environmental education in formal K–12 settings, teachers sometimes lack the content knowledge or pedagogical skills required to teach these topics effectively (Desjean-Perotta et al., 2008; Powers, 2004).

In an effort to aid teachers in incorporating EE across the curriculum, we developed a comprehensive professional development (PD) project targeted at school-based teams of teachers. We implemented the PD with two cohorts of teachers over 2 years. In this article, we share lessons learned across the project's duration and identify strategies for future PD efforts.

Environmental Education in Elementary Schools

Ensuring that teachers understand the value and importance of EE, regardless of their content area, is vital to the success of EE in the classroom. Yavetz et al. (2014) found that the majority of preservice teachers found EE relevant to their teaching and acknowledged the relevance of EE in their future teaching careers. Although teachers' valuing EE is critical, we suggest that teacher knowledge of the environment and EE is even more important. Multiple studies found that preservice teachers lack the specialized content and pedagogical knowledge necessary to effectively integrate EE into their classrooms (Álvarez-García et al., 2015; Crim et al., 2017; Desjean-Perrotta et al., 2008; Moseley et al., 2010; Yavetz et al., 2014). Furthermore, many teachers also hold misconceptions about the environment (Crim et al., 2017). Teacher preparation programs are faced with a multitude of demands and responsibilities; therefore, they often lack opportunities to address EE across the curriculum. As a result, teachers often struggle to implement EE into their own classrooms (Álvarez-García et al., 2015; Ashmann & Franzen, 2017; Powers, 2004).

In order to address current and preservice teachers' lack of EE content knowledge, ongoing high-quality PD is needed. Moseley et al. (2010) found that after a short PD event, there were slight changes in educators' perception of their relationship to the environment. They suggested that with longer, more sustained PD, teachers could gain a greater understanding of the environment as a series of interconnected relationships between humans, the natural world, and the designed world rather than viewing the environment as an object. Regarding how PD is offered, many studies suggest that it should be situated in classroom practice and related to the standards and grade-level content teachers are expected to implement in their classrooms. PD should foster confidence in EE teaching and should be sustained over time. These factors can result in more environmentally literate teachers (Banilower et al., 2007; Dymont et al., 2014; Moseley et al., 2010). Banilower et al. (2007) found that when teachers are exposed to high-quality science PD, there is a positive correlation between teacher attitudes toward science instruction and perception of their own preparedness to teach science. Furthermore, high-quality PD led to increases in instructional time devoted to science and teaching. Although PD has been shown to be a key factor in creating more environmentally literate teachers, finding high-quality, sustained PD in EE can be difficult (Holdsworth et al., 2008).

The literature on teacher PD generally supports the idea that collaboration among teachers has numerous benefits, including a positive effect on student learning, increased job satisfaction among teachers, and a greater likelihood of impacting changes in practice (Schliefer et al., 2017). Typically, this collaboration is studied at the school level, and links between stronger student outcomes and schools with strong collaborative cultures have been found in large-scale studies (Bryk et al., 2010). This is particularly apparent when collaboration includes teachers looking at student work together to spark discussion and reflection (Ronfeldt et al., 2015). Teachers who engage in collaboration report greater job satisfaction when the collaboration is authentic rather than artificially created or mandated

without structure or support. The reported benefits include sharing information about students, less isolation, curriculum development, and having an accountability partner (Datnow, 2011; Johnson, 2015). Teachers who engage in collaborative groups also report more change and innovation in their instructional practices than teachers who have had more traditional professional development (European Commission, 2014; Parise & Spillane, 2010).

About Our Project

EcoTeachers: Protecting Water and Connecting Minds was a 2-year US EPA-funded PD project focused on integrating environmental education across the elementary curriculum. Although we offered ideas related to environmental education broadly, our key focus was water-related issues. The professional development consisted of a series of five, 4-hour workshops held on our college campus, a small, highly selective, primarily undergraduate institution in the northeastern United States.

We held the sessions at the college in the evening after the school day. The school-based teams consisted of three to six teachers. Each participant earned 20 professional development hours and received a stipend of \$200 upon completion of the workshop series. Each workshop in the series followed a similar format. We began with a short community-building activity (i.e., icebreakers) that allowed teachers to engage with their school-based teammates and teachers from other school teams. We then engaged the teachers in content and activities related to the session's focus. Next, a guest lecturer provided additional content and examples of successful methods and strategies from their personal teaching experiences. Finally, the teachers worked in their teams to develop their school-based project. We allocated each school a subaward of \$2,275 for their unique project. We also created a shared Google Drive folder with materials from workshops, planning tools for the project, and links to resources.

Workshop 1: An introduction to environmental education. We began with an icebreaker “scavenger hunt” activity to introduce the teachers to one another and the project team in an effort to build a community of learners. Next, we introduced a problem-based learning activity related to a current event on our campus that had been in the local news. The lakes on campus experienced multiple harmful algal blooms. We read the news stories and explored the lakes through visual observation,^[1] including the people around the lakes (some of whom were fishing), the signage (in English only), and the water itself. We returned to the classroom and discussed ways in which this topic could be introduced in their own schools and classrooms. Teacher-generated ideas included creating signage in multiple languages, developing integrated units on lake ecosystems, and nonfiction reading assignments for their students to engage with authentic scientific data as reported through news outlets and state agencies. We then described the overall EcoTeachers project goals and provided a minilecture on integrating EE across the curriculum. To conclude, a local fifth-grade teacher

visited the class and shared effective EE practices from her own classroom, such as organizing school-wide TerraCycle waste collection (and integrating this into mathematics instruction) and managing a butterfly garden and raising butterflies indoors and outdoors.

Workshop 2: Integrating environmental education into English Language Arts and Mathematics. This workshop also began with an icebreaker trivia activity to engage participants. Next, the activities focused on how to connect and integrate EE into English Language Arts and Mathematics instruction in alignment with the Common Core State Standards (CCSS). Specific lesson strategies were modeled, such as using a paper clip model to numerically compare reservoirs of water on Earth's surface and a water filtration design challenge. Each activity was augmented with a list of many strategies for modification, such as extension activities in writing and mathematics. The participants were provided with a list of leveled readings and given time to peruse a large collection of children's books related to water and EE. Then, a guest speaker from an informal learning environment (a floating classroom and laboratory) shared ideas for field trips. Finally, the project team presented information regarding the criteria for their school-based project, and teachers were given time to brainstorm potential project ideas.

Workshop 3: Integrating environmental education into science and social studies instruction with a focus on the NGSS and the National Council of the Social Studies' C3 Framework. After a short icebreaker, the first presenter, a biology professor, provided background knowledge on the water cycle and addressed several common student misconceptions related to it. He challenged teachers to use deep content knowledge when teaching the topic because it is often taught using a cursory approach. The group then took a walk to the nearby lake on campus to make observations on pollutants and other impacts on the water quality. Upon returning to the classroom, the next presenter, a social studies methods instructor from the college, created random groups with members from each school. The groups completed an activity demonstrating the impact of pollutants on watersheds using washable markers, maps, and water. The presenter then connected this activity to the National Council for the Social Studies C3 Framework, an inquiry process that encourages students to take action on important issues. Next, a gifted and talented teacher from a local school shared tools and strategies for teaching students to use evidence to support reasoning. This complemented the science and social studies presentations and gave the participants practical examples from a fellow teacher. All three presenters shared a variety of resources with teachers related to using evidence, the water cycle, teaching issues, and taking action. Lastly, the biology professor highlighted important aspects of the NGSS and provided examples for implementing those standards in the teachers' classrooms. The workshop concluded with time for each of the teams to work on their school-based projects.

Workshop 4: Equity, diversity, and inclusion in environmental education. We began Workshop 4 with a community-building activity to encourage the teachers to interact with each other across schools. We then had a presentation by two students, one from our

Environmental Sustainability Education minor and one from our college's program for adult students with intellectual and developmental disabilities. They presented their research on including recycling within the life skills program. Next, a guest teacher shared her work on integrating EE across diverse populations at her school. We followed her talk with a discussion of Universal Design for Learning (UDL). The presentation gave an overview of UDL with reflective questions prompting the teachers to consider ways to ensure that their projects are physically and academically accessible to all students at their schools. Based on the teacher participant feedback from previous workshop sessions, we realized that the teachers needed more time during workshops to work on their projects. Therefore, we spent an hour of the session with school teams working on their projects with support from workshop leaders. We also provided a checklist for teachers to refer to regarding progress on their projects.

Workshop 5: Using the arts and technology to enhance environmental education. This workshop began with a minilecture recapping strategies for using technology to enhance environmental education (drawing attention to digital resources shared in earlier workshops and a carbon footprint calculator). Next, a guest lecturer from the Department of Music at our institution highlighted connections between music and EE. The group watched clips of *Landfillharmonic*, a documentary about a children's orchestra whose instruments are composed exclusively of upcycled materials in Paraguay. The group also listened to pieces of "naturescapes," or musical pieces comprised of recorded sounds from nature. The guest lecturer also asked the group to listen to a piece composed for string quartet with a pitch that changed throughout the song based on trends in with global climate data. The workshop concluded with each school-based team presenting their school's project plans to the group.

The purpose of this article is to (1) identify the challenges and strengths in the implementation of the PD with the first cohort, (2) explain how the PD model was modified for the second cohort, and (3) share some of our takeaways from the past 3 years.

Data Sources

Project Team

The project team included the PI, an elementary science educator, two full-time faculty members from the Department of Elementary and Early Childhood Education (an early childhood educator and a social studies educator, both with expertise in environmental education), an adjunct faculty member and former elementary school teacher with content area expertise in mathematics and language arts, and a biologist who works in teacher preparation.

School Teams

Four school teams participated in Cohort 1 (Table 1), and 6 school teams participated in Cohort 2 (Table 2). Pseudonyms are used to refer to all participating schools. Pseudonyms are used to refer to all participating schools.

Table 1

Individual Schools and Their Characteristics for Cohort 1

School name and team description	School demographics	School-based project
Brown Forest Elementary School - Small suburban public elementary school serving children in grades preK-3 - Team consisted of one kindergarten teacher and two first grade teachers, all of whom were early on in their careers (less than 5 years of experience) - The teachers reported some difficulty in communicating with their principal about project activities and struggled to solidify plans around their school-based project - Under a previous administration, the school earned a National Wildlife Federation Green Ribbon Schools Award, and established a partnership with a sister school in Taiwan - School sits next to a stream and has a student-centered club called the Streamkeepers who seek to monitor flora and fauna living in and around the pond, monitor water quality, and observe seasonal changes. - School also has an interior courtyard named the "SNAP Space" focused on Science, Nature, Art, and Pondering that incorporates picnic tables and white boards in an outdoor classroom and a working greenhouse.	Economically disadvantaged: 17% Race/ethnicity: - White: 39% - Hispanic: 13% - Black or African-American: 15% - Asian: 29% - American Indian or Alaskan Native: 1% - Two or more races: 4%	*Purchased one refillable water bottle station and water testing kits (pH and dissolved solids) *Teachers incorporated the water testing materials into their science curricula. They measured and compared water and dissolved solids in their local stream, tap water, and filtered water from the new stations.
Buck's Tower Elementary School - Public elementary school that serves preK-5 students in an affluent suburban community - Team included a third grade teacher, a fifth grade teacher, a wellness/PE teacher, and two second grade teachers. The teachers represented many parts of the school community and a range of experiences from several years to several decades - School includes a magnet STEM academy for students in grades 4-5 and a host of outdoor learning assets including several spaces that can be used as outdoor classrooms, a forested trail, and a greenhouse - The principal was an active team member/advisor and attended several of the workshops alongside the teachers - The school recently earned a green flag from the World Wildlife Federation's Green Schools program and has dedicated much time and attention to fundraising to support additional outdoor learning spaces such as a stage and koi pond.	Economically disadvantaged: 2% Race/ethnicity: - White: 75% - Hispanic: 6% - Black or African-American: 3% - Asian: 10% - Two or more races: 6%	*Installed a pond into their existing outdoor instructional area to enhance instruction on ecosystems and water cycles *Paid special attention to sound in the garden and included a small waterfall.
Price Charter School - Public charter school serving children in grades K-8 in an urban setting across three campuses (lower, intermediate, and upper schools) - Team represented several grade levels from kindergarten through fifth grade - The school lacks outdoor space; recess is held in the parking lot - Each of the three campuses is held in a different setting ranging from a repurposed municipal building to an older Catholic school.	Economically disadvantaged: 80% Race/ethnicity: - White: 5% - Hispanic: 65% - Black or African-American: 27% - Asian: 3% - Two or more races: 0%	* purchased two refillable water bottle stations for their two buildings *the teachers incorporated the counters on these stations into their mathematics instruction.
Pathway Elementary School - Public urban-rim elementary school serving children in grades preK-5 - Team included a kindergarten teacher, two second grade teachers, a third grade teacher, and the school's media specialist. Each of the teachers had more than five years of classroom experience. - Though the principal did not attend any of the workshops, she met frequently with the team during planning and faculty meetings to discuss project progress. - The school setting includes a courtyard with a pond, several greenhouses, raised garden beds, and a weather station.	Economically disadvantaged: 59% Race/ethnicity: - White: 17% - Hispanic: 17% - Black or African-American: 57% - Asian: 3% - Two or more races: 6%	*contracted a landscape architect to improve drainage in the school's courtyard *teachers elicited feedback from all children in the school on how to improve the courtyard. The landscape architect used that feedback to present his plan to the children *teachers created instructional plans for using the courtyard as a source of observation and data collection around how water drainage influences living and nonliving features of the school's courtyard

Surveys

At the conclusion of each workshop, we sent teachers an anonymous open-ended online survey that asked them to identify strengths, shortcomings, and suggestions for improvement. After each workshop, the research assistant summarized all responses and provided feedback to the PD facilitators.

Table 2

Individual Schools and Their Characteristics for Cohort 2

School name and team description	School demographics	School-based project
Apple Elementary School - Part of the same urban-rim district as Pathway, but located in a more suburban part of the town, serves children in grades preK-5 - Team included two first grade teachers, two second grade teachers, one third grade teacher, and one reading specialist. The teachers in the group ranged from several years to several decades of experience - School has a robust garden learning program. They host an annual garden festival, and one second grade teacher in the group coordinates an afterschool garden club for children that meets throughout the school year.	Economically disadvantaged: 42% Race/ethnicity: - White: 30% - Hispanic: 19% - Black or African-American: 41% - Asian: 8% - Two or more races: 3%	*Apple redesigned a space in their courtyard gardens to include raised beds for growing vegetables and a water saving drip irrigation system with a timer *goal was to improve the school garden with a focus on the responsible use of water resources *team created lesson plans appropriate for each grade level to ensure content related to the responsible use of water was included in work at each grade level
Maple Elementary School - Urban school serving children preK-5 - Team included a technology teacher, an autism specialist, a second grade, fourth grade, and first grade teacher, all with five or more years' experience teaching - School has a large outdoor area with space for a garden as well as a large open space outside the main office with access to windows that would be suitable for indoor planting	Economically disadvantaged: 77% Race/ethnicity: - White: 2% - Hispanic: 71% - Black or African-American: 25% - Asian: 1% - Two or more races: 1%	*revitalized an existing outdoor learning area through repairing and creating irrigation systems for raised garden beds and a pollinator garden *team also created a mobile indoor/outdoor garden learning station with hydroponic growing systems
Harvey Elementary School - Located in an affluent suburb, serves children grades preK-5 - Team included a mathematics specialist, a STEM specialist, a first grade teacher and a fifth grade teacher, all with extensive classroom experience - School boasts several outdoor learning spaces, a STEM lab, and multiple indoor hydroponic gardens. The school has been recognized for its efforts related to environmental education by local and state groups and has recently begun growing some of the food used in the school's cafeteria	Economically disadvantaged: 3% Race/ethnicity: - White: 83% - Hispanic: 6% - Black or African-American: 2% - Asian: 2% - Two or more races: 6%	*improved their school's learning garden to address socio-emotional learning and the concept of leaving rain where it falls. Re-structured existing gutters to capture rain in rain barrels and created a useful drip irrigation system *integrated mathematics by using geometric shapes to construct raised garden beds
Tall Grass Elementary School - Small, neighborhood K-5 elementary school in the same school affluent suburban district as Harvey and Buck's Tower - Team included a PE/Wellness teacher, a STEM specialist, an art teacher, and a third grade teacher, all of whom had many years of classroom experience - School's principal, who just began in this post, occasionally joined her staff at the workshops - School grounds have access to open fields and several places suitable to outdoor learning, but there are issues around flooding and draining. A bird blind was recently installed on a trail outside the school - A student green team meets before school - The school's STEM specialist focuses closely on using environmental issues to spark design-based instruction.	Economically disadvantaged: 1% Race/ethnicity: - White: 85% - Hispanic: 5% - Black or African-American: 1% - Asian: 5% - Two or more races: 4%	*built green infrastructure solutions to the school's stormwater runoff problem (frequent flooding of school yards) *installed a rain garden to capture excess stormwater and ensure it flows directly into sewers and local waterways *identified places where STEM specialists and classroom teachers could use the outdoor area as a learning context
Victory View School - Suburban school serving children grades 4-8, located about an hour's drive from our institution - Team included a STEM specialist, a science teacher, social studies teacher, fourth grade teacher, and gifted and talented teacher. Several in the group were in their first few years in the career while the others had decades in the classroom - School's gifted and talented teacher has led efforts around environmental sustainability over the past several years and secured grants to fund the purchase of hydroponic gardens - School also has an active green team that often engages in ecojustice projects such as using grocery store bags to knit mats for the homeless.	Economically disadvantaged: 0% Race/ethnicity: - White: 63% - Hispanic: 0% - Black or African-American: 8% - Asian: 18% - Two or more races: 2%	*purchased tower garden systems to integrate instruction on hydroponic systems and gardening in the classroom across multiple grade levels *integrated practices discussed throughout the workshop series, such as using the arts in environmental education and using plants and water cycles as writing prompts in English-Language Arts.
Lakewood Elementary School - Suburban preK-3 school in the same district as Bear Forest - Team consisted of three experienced teachers: one kindergarten teacher, one PreK teacher, and one media specialist - School has a robust garden based learning program that includes monthly lessons for students in grades K-3 from a local farm educator and a "Fresh Fruit Friday" program providing snacks for the children - Student led green team meets monthly in the school library. - Teacher team was focused on expanding their work to include the youngest children; 3-5 year-olds enrolled in their inclusive PreK program, in their environmental efforts.	Economically disadvantaged: 20% Race/ethnicity: - White: 46% - Hispanic: 14% - Black or African-American: 12% - Asian: 21% - Two or more races: 7%	*augmented their existing garden learning program to include instruction on using rainwater for irrigation *expanded the reach of their school's garden education program to include lessons at the Pre-K level *connected the outdoor garden learning to indoor classroom settings through the purchase of hydroponic garden kits for their classrooms.

Field Notes and Reflections

Workshop facilitators kept notes and held debriefing discussions after each session. Notes focused on the strengths and shortcomings of the session itself, observations of participants, and discussions between and among facilitators and participants. These discussions, coupled with the summary of survey responses, allowed for week-to-week adjustments, such as those related to format, timing, and support provided to teachers.

Site Visits

The project team members visited each school (at the school's invitation) after the completion of the workshops. Some schools requested that the project team sit in on a team meeting or planning session, whereas others requested that we observe a lesson in action. Extensive field notes and photographs were taken at each site visit. These visits were purposefully structured and scheduled by the school partner in an effort to emphasize the collaborative nature of our relationship—the project team was not telling the teachers what they wanted to see on the site visits; rather, they were invited to observe, discuss, and interact at the teachers' discretion. In many cases, there were invitations for multiple site visits.

Learning from Cohort 1

During the summer following Cohort 1 (summer 2018), the project team met and modified the model for Cohort 2 (spring 2019).

Cohort 1: An Overview of Our Experience

We recruited Cohort 1 schools and teachers relatively quickly; we were awarded funding during the summer of 2017 and scheduled workshops to begin that fall. The workshops took place over the course of a 2.5 month period. We recruited four school-based teams that represented a range of demographic and socioeconomic communities within a 10-mile radius of our campus. The existing EE efforts at each of the schools varied considerably. Descriptions of individual schools and their characteristics can be found in Table 1. Knowing that a key element of the PD was for each team to develop their own school-based initiative, we purposefully planned the workshops to have a 2-week break between each meeting and an even longer break (4 weeks) between Workshops 4 and 5 to allow teams to work together to complete plans.

We decided to start Workshop 1 with a place-based investigation of a phenomenon: toxic algal blooms in lakes on our campus. After this introductory activity, we focused more directly on describing the project's aims and purpose and providing an overview of our vision of environmental education followed by a guest lecture from a teacher who shared her experiences integrating environmental education across the curriculum. We waited until Workshop 2 to introduce the school-based projects because we did not want to overwhelm the group at the first meeting. We discussed parameters around the projects (e.g., needing the principal's approval, identifying connections to curriculum, and using the school's preferred vendors when purchasing items). We also suggested that teams work together to identify a key person responsible for each element of their project. During Workshops 2–4, after covering the focus topics and a visit from a guest lecturer, the groups had dedicated time to work on their individual school-based plans, troubleshoot concerns, and gather feedback from peers and colleagues. Workshop 5 followed a similar plan, but teacher teams presented their projects instead of working on them.

The Cohort 1 school teams varied quite a bit and seemed to fall into two groups. The first group, consisting of the Buck's Tower and Pathway teams, faced fewer challenges in all aspects of the PD experience. The teams from Buck's Tower and Pathway both included teachers with a range of experience, from early in their careers through seasoned 25+year veterans. They also included classroom teachers from multiple grade levels as well as a "specials" teacher, a PE/Wellness teacher from Buck's Tower and a media specialist from Pathway. Interestingly, these schools were the most different in terms of demographics and socioeconomic status of students. Both teams easily selected a project to focus on, connected with school administrators to secure appropriate permissions, and delegated tasks to team members in a way that allowed the team to work effectively. The Buck's Tower team elected to use the funding to add a pond to their school's outdoor learning space, whereas the Pathway team opted to install a better drainage system and additional plants in their school's interior courtyard to make the space more usable.

The second group included the two other school teams, Price Charter and Brown Forest. These teams faced obstacles from the very beginning of the experience. The team from Price Charter included teachers from multiple grade levels; however, these individuals worked in three separate buildings. The teachers were relatively early on in their careers and often had difficulties coordinating with one another and their school's administration. The Brown Forest team consisted of just three teachers, all of whom were untenured and in their first few years of teaching. All three taught in either kindergarten or first grade. As a result, they did not have a clear sense of what their colleagues across grade levels and administrators would agree to support with respect to a school-based project. Teams from both of these schools struggled to narrow down their final projects, perhaps due to a lack of administrative support or being unable to connect as a team between workshops. In the end, both decided on installing water bottle filling stations, and both encountered further challenges when planning for the installation.

Lessons Learned from Cohort 1

After analyzing the survey data and field notes from Cohort 1, we found four crucial aspects of professional development: timing, content, teams, and community.

Timing considerations. When considering the cohort holistically, it became clear that spacing the workshops 2 weeks apart over the course of 4 months was a hindrance for all the teams. Instead of allowing them to meet on their own to work on school-based projects, the 2-week gaps resulted in teachers losing momentum and needing time in the workshops to refresh their thinking and reorient themselves to their projects.

Connection to or quality of content considerations. We also learned that some of the guest lectures were more helpful than others, especially from the perspective of the teachers. One guest lecturer was a music educator who shared some examples of using music as a mechanism for teaching about environmental issues and was unanimously

praised, especially because she offered tangible examples that could be applied to their own schools and projects. Some others who discussed potential field trips or partnership ideas were not as well received. Survey responses indicated that there was little interest in these presentations and that field trips were challenging to plan and schedule in their schools.

Diversity within teams considerations. We learned that the more diverse school-based teams, those with teachers across many grade levels and a “specials” teacher, were the most successful. These teams tended to have a more consistent vision of the wants and needs of their colleagues and were able to make decisions earlier about the direction of their projects. They also reported more frequent communication with their school principals (Buck’s Tower’s principal even attended several of the workshops), suggesting that their teams had strong support systems at school.

Community considerations. When the teachers arrived at each session, they naturally sat with their own teams. Although we began with an icebreaker, and they often chatted with the other teams, we did not provide significant time for them to interact with each other. We learned from feedback after one session in which the presenter created random groups that the teachers wanted more time to connect with the teachers from the other schools.

Modifications After Cohort 1

After the first cohort was complete, we made several modifications to the way in which we recruited teams and planned workshops.

- *Meet more regularly to build momentum.* We modified the schedule so that we met weekly for Workshops 1 through 4 then took just 1 week off between Workshops 4 and 5.
- *Use Cohort 1 teachers as guest lecturers.* Because the guest lecturers for the first cohort had mixed responses, we changed the way we made decisions about who to invite as speakers in order to include more guest lecturers who could offer tangible strategies and actions. The Cohort 1 teachers were building on their own school-based projects and could offer specific examples and ideas for the second cohort to use when planning their own. We kept the music educator for Workshop 5 because she was so well received by the entire group.
- *Recruit diverse teacher teams.* When meeting with potential school partners, we let them know that the strongest teams during the first cohort included teachers of varying grade levels, amounts of experience, and roles within their schools. We also emphasized the importance of frequent communication with school leaders and administrators in developing and enacting a successful project.
- *Build community.* We included more time during the workshops for teachers to interact across teams, including providing feedback to each other on their project plans. In addition, we aimed to create a community across cohorts, thereby building a network of environmental educators across the state.

Applying What We Learned: Cohort 2

The workshops for our second project cohort took place during January–February 2019. We held Workshops 1–4 on four consecutive Thursday evenings, and Workshop 5 was held 2 weeks later. Six schools sent teams to attend the workshops, and these teams varied in size from three to six participants. We kept the same session topics. To begin Workshop 1, we used a jigsaw approach, sharing stories about a variety of water-related issues from regional news media sources to provide an overview of the wide range of environmental concerns connected to water. As with Cohort 1, we followed this activity with an overview of the project’s aims and goals and our vision of environmental education across the curriculum. An important change we made with Cohort 2 was to introduce the school-based project early. We had a team from Cohort 1 come and share their project to provide a successful, concrete example for the new cohort. We continued a similar model for Workshops 2–4 in which we covered the focus topics, followed up with a guest lecture from a Cohort 1 team, and then allowed time for the teams to work on school-based projects and give one another feedback. Workshop 5 coincided with the opening of a new exhibit at our institution’s art gallery, titled *Springs Eternal*, which included works by several artists directly related to water, so we included a visit to the art gallery as well as a guest lecture from our music education colleague. At the gallery, we set up a mobile printmaking station for participants to create a print to commemorate their experience. The workshop concluded in the same manner as Cohort 1, with school-based project presentations and a celebration.

Cohort 2 consisted of six public schools, five of which were located within 10 miles of our campus. The sixth was about an hour’s drive away. The schools varied quite a bit in terms of grade levels. For example, Victory View is a school serving grades 4–8, and Lakewood Elementary School is a pre-K–3 school. There was also a wide range of demographics. Maple Elementary School is located in an urban area where nearly 80% of students come from economically disadvantaged homes, and Harvey Elementary School is located in an affluent suburb where fewer than 3% of students are economically disadvantaged. Each school sent teachers with varied teaching experiences, ranging from those in the first 5 years of their careers to those with decades of experience. Along with the more traditional single-grade classroom teachers, each school also sent one or more teachers who worked with a range of students, including media specialists, reading specialists, STEM teachers, and art teachers.

The second cohort developed and implemented their school-based projects more quickly than Cohort 1. Based on survey and observational data, we attribute this to the changes in the timing of the workshops, examples provided by Cohort 1 teachers, and the makeup of the teams. However, there were challenges. Teachers from Maple Elementary School struggled to secure approval from their district’s business office and administrators. It took nearly 6 months after the workshops to rectify these problems. Teachers at Victory View

School also had some difficulty working with their school's facilities office in determining what they were and were not allowed to build and who would be responsible for construction and maintenance. After initially planning to install refillable water bottle stations, the team elected instead to purchase a hydroponic garden system that would be easier to maintain by the team's teachers. This choice was driven, in part, by a fellow teacher participant at another school who has been using the hydroponic garden systems for several years in her teaching. She was able to provide some guidance and collaborative planning to help the Victory View team establish their plans.

Creating a Model for Content-Rich and High-Impact EE Professional Development

We continued visits to schools from both cohorts, which allowed us to see continued development over time. We saw exciting developments in many of the Cohort 1 schools. The Pathway team reworked their school's garden club after implementing their school-based project. They renamed it the "Environmental STEM Club," which resulted in quadrupled membership. The club worked to continue to fundraise and work in the school's courtyard, adding art installations and additional garden spaces used by all the school's teachers. Teachers began to use the courtyard space for lessons in writing and science as well, providing opportunities for students to closely observe nature in their day-to-day activities. The Buck's Tower group also continued to build on their school's project over time. This school was already engaged in a number of initiatives related to environmental education, and they went on to earn a Green Flag from the World Wildlife Federation in 2019. They found that the pond they installed for their school-based project quickly became full of falling leaves, and hiring someone to clean it was cost-prohibitive. This created a teachable moment for the school's faculty. The school's STEM specialist created a classroom-based design challenge project for third graders in an effort to solve this problem. The third-grade classes were challenged to build a cover for the pond that would allow access for frogs while preventing leaves from covering the surface. This design challenge was created with a universal design for learning approach and allowed for inclusive practices in EE to be celebrated. A new cover, designed and built in partnership with students, was installed in fall 2020. Finally, the Bear Forest school had a change of administration, and their new principal was more motivated to build on the team's existing water bottle refilling station, which had not yet been installed. Inspired by a first-grade student's observation, the entire school engaged in an investigation of single-use water bottles in the building. These are just a handful of examples of EE in action that we were able to observe; however, they provide strong evidence that the EE strategies provided at the workshops were used to integrate EE across multiple content areas.

Though they were not quite as far along as the Cohort 1 schools, we have also seen progress on the projects started by the Cohort 2 schools. For example, the Victory View team has continued searching for funding to continue their hydroponic garden systems and has included additional EE activities such as a "trashion" show in which students reused waste to create clothing. The planning of this activity integrated science- and social-studies-based

explorations of waste reduction in the fashion industry in an interdisciplinary way. The Harvey Elementary School team reworked its plans to incorporate more socioemotional learning after some tragic losses in their school's community, allowing their school's garden to become a space for quiet meditation and art-making, integrating strategies introduced during Workshop 5 of our PD. The Lakewood Elementary School team expanded the school's entire EE curriculum to integrate the youngest children at the prekindergarten level into their garden-based learning activities with child-sized tools. One teacher from the Tall Grass Elementary School team developed an interdisciplinary unit on air pollution in China covering social studies, science, and mathematics using strategies suggested at the workshops. These projects demonstrated that momentum was building around EE, especially regarding their school-based projects.

Limitations

This PD initiative was limited in scope because we worked with teams of teachers from just 10 schools in a specific geographic area. The successes and struggles of each team could also be attributed to myriad other factors related to teachers, schools, communities, and curricula.

Next Steps

We found that having a two-cohort model allowed us to refine our practice for more successful professional development. We also learned why the one-hit-wonder approach to professional development is so limiting. Central to the PD experience was the community we built with the teachers and the schools and the generous reciprocity of knowledge and experience within and between school teams (Datnow, 2011; Johnson, 2015). Although the workshop series is now complete, we continue to maintain a working relationship with teachers from all 10 schools and will support them in building upon their recent successes. The combination of the teachers coming to the campus with follow-up at the school, as well as having Cohort 1 teachers share their projects, enabled a sense of pride in and ownership of their professional development experience. This also provided a mechanism for ongoing long-term PD, a factor often cited in the literature as contributing to successful PD efforts (Dymeyt et al., 2014; Mosely et al., 2010). Our goal is to expand this community to include more teachers and schools throughout the state. Our next steps include future PD efforts focused on specific EE topics, climate change and marine science, with actionable lesson plans and activities for teachers to implement soon after completing the PD.

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[1] Prior to all activities, teachers were given safety precautions. For Workshop 2, safety precautions included wearing closed-toed shoes while walking to the lake, not touching the lake water with bare hands, and using safety goggles during the water filtration activity.

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