Environmental Education Research

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ISSN: (Print) (Online) Journal homepage: https://www.tandfonline.com/loi/ceer20

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To cite this article: B. Troy Frensley, M. J. Stern, R. B. Powell & M. J. Blackwell (2022) Exploring the links between teaching approaches and student outcomes at a residential setting, Environmental Education Research, 28:6, 826-844, DOI: 10.1080/13504622.2022.2044454

To link to this article: https://doi.org/10.1080/13504622.2022.2044454

Published online: 06 Mar 2022.

ENVIRONMENTAL EDUCATION RESEARCH
2022, VOL. 28, NO. 6, 826–844
https://doi.org/10.1080/13504622.2022.2044454

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Exploring the links between teaching approaches and student outcomes at a residential setting

B. Troy Frensley[a], M. J. Stern[b], R. B. Powell[c] and M. J. Blackwell[d]

[a]Department of Environmental Sciences, University of North Carolina Wilmington, Wilmington, NC, USA; [b]Forest Resources and Environmental Conservation, Virginia Polytechnic Institute and State University, Blacksburg, VA, USA; [c]Department of Parks, Recreation, and Tourism Management and Department of Forestry and Natural Resources, Clemson University, Clemson, SC, USA; [d]North Cascades Institute, Sedro-Woolley, WA, USA

ABSTRACT

In this case study, we used a mixed-methods approach to identify the characteristics of environmental education (EE) lessons most positively associated with students' environmental literacy outcomes at one residential EE center in the U.S. Students attending residential EE programs spend multiple days participating in numerous lessons, activities, and experiences, resulting in perhaps more opportunities to enhance students' knowledge, attitudes, skills, and behavioral intentions related to environmental literacy. To explore what teaching approaches were most effective at enhancing immediate student outcomes and to provide insights for practitioners, we observed 80 lessons, tracked 20 observable teaching approaches, and administered questionnaires to measure students' self-reported changes in environmental literacy outcomes. Correlation analyses revealed four variables related to enhanced student outcomes: affective messaging, environmental issue-focus, relevance, and effective time management. Two variables, fact-based teaching and data collection, were negatively correlated with student outcomes. Linear regression analysis with these six variables resulted in a model explaining 34% of the variance in the environmental literacy outcome. We discuss these findings and share examples of each practice from our qualitative observations. We also discuss broader applications of our mixed methods approach for the field.

ARTICLE HISTORY
Received 12 April 2021
Accepted 14 February 2022

KEYWORDS
Environmental literacy; environmental education; best practices; pedagogy; observation; evaluation

Introduction

Since the Tblisi Declaration in 1977, the field of environmental education (EE) has focused on addressing the complex relationships between humans and the environment, with a goal of developing environmentally literate citizens (Ardoin, Biedenweg, and O'Connor 2015; Farmer, Knapp, and Benton 2007; North American Association for Environmental Education (NAAEE) 2019; 2021l; Stern, Powell, and Hill 2014). Environmentally literate people are equipped with the knowledge, attitudes, dispositions, and competencies needed to effectively recognize, analyze, and address important environmental issues in their communities and beyond (Hollweg et al. 2011; NAAEE 2019; UNESCO. 1977). Decades of evaluation research have shown that EE

CONTACT B. Troy Frensley frensleyb@uncw.edu Department of Environmental Sciences, University of North Carolina Wilmington, 601 South College Rd. Wilmington, Wilmington, NC 28403, USA.
Supplemental data for this article is available online at https://doi.org/10.1080/13504622.2022.2044454 .

programs, whether single-day or overnight, can achieve positive outcomes related to environmental literacy (Ardoin, Biedenweg, and O'Connor 2015; Ardoin et al. 2018; Dettman-Easler and Pease 1999; Mullenbach, Andrejewski, and Mowen 2019; Rickinson 2001; Stern, Powell, and Ardoin 2008; 2010; Stern, Powell, and Hill 2014; Thomas et al. 2019).

Despite strong evidence that EE programs can achieve positive outcomes, research rarely focuses on determining which characteristics of the EE experience are most strongly related to measured outcomes (Ardoin, Biedenweg, and O'Connor 2015; Bourke, Buskist, and Herron 2014; NSF 2008; Stern, Powell, and Hill 2014). Currently the design of many EE programs is based on guidelines, such as the North American Association for Environmental Education (NAAEE) *Guidelines for Excellence in Environmental Education Series*, which is drawn from the synthesis of research and theory in not only environmental education but also fields such as informal science learning, developmental psychology, educational psychology, and others. This series is a part of the National Project for Excellence in Environmental Education and consists of six publications that set the standards for high-quality EE and include: nonformal EE programs (NAAEE 2009); environmental education materials (NAAEE 2021); and K-12 environmental education (NAAEE 2019). These resources can be seen by practitioners as indispensable tools for developing and delivering their EE programming. However, a systematic literature review by Stern, Powell, and Hill (2014) seeking to find evidence linking these practices to better programmatic outcomes found that any links appear to be largely circumstantial. This may be due, in part, to research design and the immense number of confounding factors (e.g. socio-cultural, geo-political, diverse audiences, diverse educators, learning context, etc.) that can influence learning and subsequent learning outcomes for diverse audiences. As such, it may be helpful to move from broad principles and guidelines to exploring the efficacy of specific pedagogies and lesson characteristics that may influence immediate learning outcomes in unique contexts. Therefore this case study seeks to begin to fill this gap by identifying specific teaching approaches within 2–4 h long EE lessons that are positively associated with enhanced student environmental literacy outcomes at one residential EE center in the U.S. Specifically, this study sought to answer the following question: what teaching approaches during EE lessons provided at one residential center resulted in enhanced self-reported environmental literacy outcomes? The EE lessons were part of a five-day residential EE program experience for middle school students and we investigated a range of teaching approaches through observations and linked them to students' self-reported changes in environmental literacy using questionnaires.

Literature review: Teaching approaches

Some prior case studies and systematic literature reviews have sought to identify specific teaching approaches that may influence broad elements of student's environmental literacy such as: knowledge (e.g. students factual, conceptual, or socio-ecological knowledge related to the environment, issues, solutions, etc.; Ballantyne and Packer 2009; Mason and Santi 1998; Monroe et al. 2019; Stern, Powell, and Hill 2014); attitudes (e.g. students' feelings about nature, the environment, or a particular issue; [Ballantyne and Packer 2009; Emmons 1997; Monroe et al. 2019; Stern, Powell, and Hill 2014); skills (e.g. student's learned something they can use; Stern, Powell, and Hill 2014; behavioral intentions (e.g. things students could do to protect the environment; Ballantyne and Packer 2009; Monroe et al. 2019; Stern, Powell, and Hill 2014); and behaviors (e.g. student's pro-environmental behaviors, or behaviors focused on their home or community; Monroe et al. 2019; Stern, Powell, and Hill 2014).

These case studies cover many diverse articles focused on a wide range of contexts and learners such as: elementary and middle school students attending a range of EE outdoor programs (some single-day and some residential) in Australia (Ballantyne and Packer 2009), high school students attending a five-day EE field program in Belize (Emmons 1997); and elementary

students in a classroom setting discussing the greenhouse effect in Italy (Mason and Santi 1998). However, despite the range of contexts, when one looks across these works, consistent trends about effective teaching approaches in EE begin to emerge (see Table 1):

Methods

To investigate which teaching approaches used in the EE lessons during the five-day NorthBay residential program lead to better outcomes, we developed an observational protocol in which researchers recorded the quality and extent of use of 26 teaching approaches during 81 EE lessons at the NorthBay Adventure (NorthBay) residential program. Students completed a short survey following each observed lesson to self-report any immediate post-lesson changes in outcomes related to environmental literacy.

Study site

NorthBay is located in the small town of Northeast, Maryland, which is approximately 100 miles (160 km) northeast of Washington, D.C. NorthBay offers weeklong (five-day) residential programs for visiting middle school students from urban areas (Baltimore, Maryland, Washington D.C., and Philadelphia, Pennsylvania) and suburban and rural areas across the state of Maryland. The NorthBay campus is located on the shore of the Chesapeake Bay and spans over 90 acres of beach, wetlands, and forested habitat. NorthBay's programming combines elements of environmental education, informal STEM education, positive youth development, multimedia presentations and performances, and adventure activities ([please see Stern, Powell, and Ardoin 2010 and Stern et al. 2018 for more details]). NorthBay's EE curriculum has been developed in conjunction with the Maryland State Department of Education and incorporates Hungerford et al. (2003) 'investigating and evaluating environmental issues and actions' (IEEIA) model and the 'better environmental education, teaching, learning, and expertise sharing' (BEETLES) project model (BEETLES 2014). The IEEIA model focuses on developing student skills through the investigation of complex environmental issues in their community and making data-driven decisions about these issues to arrive at potential solutions. The BEETLES project model encourages outdoor learning and empowering students to investigate the world around them through engaging directly with nature, and learning through collaboration and discussion. NorthBay combines these approaches during their lessons to link key concepts, knowledge, and skills to students' lives at home as they investigate complex environmental issues on the NorthBay campus. The culminating lesson each week consists of students developing an 'action plan' of

Table 1. Effective teaching approaches from prior EE-related literature.

Effective teaching approach	Prior EE-related literature
Direct experiences in the natural environment	Ballantyne and Packer 2009; Emmons 1997; Stern, Powell, and Hill 2014
Multi-sensory engagement in the natural environment	Ballantyne and Packer 2009
Role models who model aspects of environmental literacy such as pro-environmental attitudes or behaviors	Emmons 1997; Stern, Powell, and Hill 2014
Student discussions that welcome multiple perspectives and even previous misconceptions	Mason and Santi 1998; Emmons 1997; Monroe et al. 2019
Investigation of real-world problems or issues that are rooted in a real place	Ballantyne and Packer 2009; Monroe et al. 2019; Stern, Powell, and Hill 2014
Promoting relevance to student's lives at home and their community or school	Ballantyne and Packer 2009; Stern, Powell, and Hill 2014
Cooperative group work that promotes collaboration	Stern, Powell, and Hill 2014
Affective-based messaging, often related to attitudes towards the environment	Stern, Powell, and Hill 2014
Student-centered experiences including student reflection	Stern, Powell, and Hill 2014

how they will use what they have learned to address challenges in their communities or at school.

Each week (Monday–Friday) during the school year, NorthBay provides programming for up to 400 students from one or more schools. Students are subdivided into smaller same-gender groups, typically with fewer than 30 students, who share a cabin and complete group activities together. Occasionally these student groups are comprised of students from more than one school due to logistical circumstances, rather than the expressed intention of mixing students from different schools. These student groups are matched with one NorthBay environmental educator who delivers all of their two hour lessons and they also stay with this group during mealtimes, leisure activities, free exploration, and evening cabin reflections. NorthBay's team of environmental educators represents a range of races, ages, genders, personalities, and prior experiences that also enhance the NorthBay experience.

More broadly, the NorthBay experience consists of daytime activities, in which two two-hour EE lessons are the focus. Outside of the formal lessons NorthBay provides a myriad of adventure activities, such as zip lines and a high ropes course during their stay which are focused on team-building, character development and leadership skills. After dinner each evening all students attend a multimedia live show. These evening programs seek to couple the environmental literacy lessons of the day with highly personalized programming focused on positive youth development and enhancing attitudes towards school.

The two-hour EE lessons during the daytime are the focus of this study and only take place during two hours each morning and two hours afternoon on Tuesday, Wednesday, and Thursday (six lessons in total each week). The morning and afternoon EE lessons are separated by lunchtime and are discrete, different lessons. These lessons occur in a variety of habitats across the campus or on a boat in the waters of the upper Chesapeake Bay. Students may participate in 14 different EE lessons covering a range of topics. Across these lessons, students commonly make observations, collect data, work collaboratively, and investigate environmental issues. NorthBay's environmental educators aim to link lessons learned and new perspectives back to students' home environments through group discussions, reflection, and journaling. The final EE lesson each week is an 'action' lesson where students complete a service learning project on campus (e.g. beach cleanup) and develop an action plan as a group for when they return home to positively address issues related to their environment, their school, or their community.

While we recognize the entire NorthBay experience, not just these EE lessons, contributes to the overall outcomes for each student, the focus of this study is on the primary environmental education and environmental literacy lessons at NorthBay, Moreover, due to the comparative nature of the study design, we sought to identify the characteristics of these lessons that were associated with enhancing immediate post-lesson environmental literacy outcomes for students.

Pilot testing

Two researchers conducted all observational field work. Four weeks of pilot testing aided in the development and refinement of the study methods and enhanced the reliability of observational measurement by the two field researchers. Both researchers observed eight NorthBay educators conducting 18 unique EE lessons together during the pilot period. Extensive discussions with the broader team and regular consultation of the literature allowed for refinement of the independent variable definitions and observation techniques. For each observational measure, we sought to maximize the potential for variability while maintaining reliability/consistency. Once the definitions and scoring for each variable were finalized, the two researchers continued to observe lessons together at the study site until an acceptable interrater reliability was obtained for observational measures. The average intraclass correlation coefficient (ICC) measure was 0.928 with a 95% confidence interval from 0.889 to 0.957 ($F(40, 440) = 15.512$, $p < .001$), which is above the recommended threshold of 0.9 for a high degree of reliability (Field 2013).[1]

We also pilot tested student questionnaires during these four weeks with the goal of developing a questionnaire that could be completed by students in approximately five minutes following each lesson. Limiting the survey to five minutes or less was important so that it didn't take the students too long to complete and disrupt the transition from one activity or location to the next following the end of the lesson (Powell et al. 2019). We discussed the questionnaires with students to ensure they understood the content and instructions. We eliminated or revised questions that were confusing to the students, as well as those that exhibited little to no variability over the four weeks of pilot testing.

Sampling

Nine weeks, from February 2015 to November 2015, were purposefully selected to mirror the overall student demographics attending NorthBay each year. Of the 17 schools that attended during this period, 12 were suburban, three were urban, and two were from rural districts (National Center for Education Statistics 2017). Data related to urbanity was obtained at the school level from the National Center for Educational Statistics (NCES). Three of the schools were private schools (one rural and two suburban); the rest were public schools. Of these 14 public schools, 11 were classified as Title 1. Schools with a Title 1 classification in the United States have high numbers or high percentages of children from low-income families and receive additional federal funding to help ensure each child can successfully meet state academic standards (United States Department of Education 2018).

In this study, two student groups were chosen each week in an effort to observe a diverse range of students and NorthBay educators. Each of the two field researchers observed the same student group and every EE lesson that group participated in during the week. Six of the 15 observed groups were comprised of students from more than one school. In total, 17 NorthBay educators were observed teaching 15 student groups.[2] Student group sizes ranged from 11 to 29 students. Eight were female and seven were male groups, each matched with a NorthBay educator of the same gender.

Data collection

Data collection consisted of observing all EE lessons that the 15 different student groups received during their weeklong visit to NorthBay and conducting student surveys immediately following each lesson (Table 2). In total, 81 lessons were observed. Seven student groups received six lessons during their weeklong visit, seven student groups received five lessons during their week, and one student group received four lessons during their week due to weather-related and logistical complications.

The observation method we use was adapted from prior research in the fields of environmental interpretation (Stern and Powell 2013), EE (Ballantyne, Packer, and Everett 2005; Ballantyne and Packer 2009), and formal education (e.g. Pianta and Hamre 2009). One researcher observed each lesson, maintaining an unobtrusive presence and recording notes regarding each teaching approach. Each measure of a teaching approach represented the extent and quality of the

Table 2. Weekly data collection schedule at the NorthBay program.

	Monday	Tuesday	Wednesday	Thursday	Friday
Two-hour morning EE lesson	Students arrive	Lesson #1 Observation & Survey	Lesson #3 Observation & Survey	Lesson #5 Observation & Survey	Students depart
Two-hour afternoon EE lesson		Lesson #2 Observation & Survey	Lesson #4 Observation & Survey	Lesson #6 Observation & Survey	

teaching approach observed during the entire two-hour lesson experience (e.g. Pianta and Hamre 2009). Immediately following each lesson, we asked students to complete a short questionnaire containing environmental literacy items. Qualitative notes were also recorded throughout the lesson to provide additional details and examples of the teaching approach in practice.

Measurement

Student outcomes: Survey to measure environmental literacy

We developed a questionnaire that asked students to rate how much the EE lesson influenced their knowledge, attitudes/dispositions, skills, and behavioral intentions related to environmental literacy. Each dimension and the corresponding items were based on established definitions of the subcomponents of environmental literacy (Hollweg et al. 2011, McBeth et al. 2011, McBride et al. 2013, etc.). As noted earlier during pilot testing, we sought to create an efficient survey instrument that could measure changes in these dimensions of environmental literacy given the logistical time constraints we faced in administering surveys on-site (Table 3). Response categories were comprised of a five-point Likert-type scale: (1) not at all; (2) a little; (3) somewhat; (4) a lot; (5) a huge amount. We conducted confirmatory factor analysis on individual student survey responses ($N = 1{,}298$) and confirmed that six survey items comprised a statistically valid environmental literacy index for use in this study (Satorra Bentler (S-B) $\chi^2/df = 0.17$; S-B CFI = 0.97; S-B RMSEA = 0.06; S-B TLI = 0.96; SRMR = 0.04; and Cronbach's alpha = 0.90). A composite mean score of all six survey items (equally weighted) for each lesson was then computed. Two additional conversely worded items served as a validity check: 'I disliked the lesson' and 'I enjoyed the lesson'. Surveys of students who agreed with both items were discarded.

Independent variables: Teaching approaches

The observation variables used in this study were based on prior literature in EE (e.g. Ballantyne and Packer 2009, Emmons 1997; Mason and Santi 1998; North American Association for Environmental Education (NAAEE)) 2009; Stern, Powell, and Hill 2014) and also in the fields of environmental interpretation (e.g. Ham 1992; Skibins, Powell, and Stern 2012; Stern and Powell 2013; Powell and Stern 2013a; 2013b) and informal science education (e.g. Bell et al. 2009; Fenichel and Schweingruber 2010). Table 4 provides a complete list of observed independent variables along with definitions and supporting literature for each. Similar to Stronge et al. (2007) and Stern and Powell (2013), we used a four-point Likert-type scale to measure each. A score of one indicated a complete absence of the characteristic, while a score of four indicated that the characteristic was a central component of the program (see Online Supplemental Materials for more detail).

Analyses

Data cleaning

Any student surveys missing more than 50% of data (Tabachnick and Fidell 2007) or containing responses failing the inversely worded validity check (agreement on both 'I disliked the lesson'

Table 3. Student survey items comprising environmental literacy outcome index.

Survey question	Environmental literacy outcome
This lesson made me appreciate nature more than I did before.	Attitude/Disposition
This lesson taught me something that will be useful to me after I leave.	Knowledge/Skills
This lesson made me feel I can make a difference in my community at home.	Disposition/Behavioral intention
This lesson made me want to spend more time in nature after I leave here.	Disposition
This lesson made me want to learn more about environmental issues.	Knowledge/Behavioral intention
This lesson made me want to do something to take care of the environment.	Disposition/Behavioral intention

Table 4. Observation variables.

Teaching approaches	
Group reflection (Hungerford and Volk 1990; Stern and Powell 2013; Stern, Powell, and Hill 2014)	Degree to which the reflection is group-based (e.g. discussion).
Individual reflection (Hungerford and Volk 1990; Stern and Powell 2013; Stern, Powell, and Hill 2014)	Degree to which the reflection is individual-based (e.g. journal writing).
Affective messaging (Jacobson 1999; Lewis 2005; Moscardo 1999; Stern and Powell 2013; Tilden 1957)	Degree to which the lesson communicated emotion *(in terms of quantity, not quality).*
Play-based learning (Liefländer and Bogner 2014)	Degree to which the lesson actively engages students in games or competition as an intentional teaching technique.
Holistic storytelling (Beck and Cable 2002; Larsen 2003; Stern and Powell 2013; Tilden 1957)	Degree to which the lesson presented a holistic story as opposed to disconnected pieces of information *(students can be characters in the story).*
Sensory focus (Ballantyne and Packer 2009; Beck and Cable 2002; Emmons 1997; Tilden 1957; Ward and Wilkinson 2006)	Degree to which students are encouraged to explicitly use their senses in a unique way to explore a concept, solve a problem, or connect to their environment.
Cooperative group learning (Mason and Santi 1998; Rickinson 2001)	Degree to which the lesson content requires students to work with others, either through group deliberation/discussion and/or active participation/investigation.
Relevance (Ardoin, Clark, and Kelsey 2013; Ballantyne and Packer 2009; Beck and Cable; Emmons 1997; Ham 1992; Jacobson 1999; Stern and Powell 2020; Stern, Powell, and Hill 2014; Monroe et al. 2019; Tilden 1957)	Degree to which the lesson content references or makes explicit connections to the students' experience outside the realm of the instruction.
Role modeling (Ardoin, Clark, and Kelsey 2013; Chawla & Derr 2012; Rickinson 2001; Stern et al. 2018)	Degree to which the educator demonstrates and shares their interests and "likes" about the topic and uses stories, actions, or models to create the impression that a desirable behavior is the norm.
Environmental issue (Ballantyne and Packer 2009; Rickinson 2001; Stern, Powell, and Hill 2014)	Degree to which the lesson focuses on real-world environmental problems/issues, their consequences, and potential solutions.
Fact-based (Jacobson 1999; Lewis 2005; Stern and Powell 2013; Tilden 1957; Ward and Wilkinson 2006)	Degree to which the lesson communicated "factual" information as opposed to other forms of delivery, such as storytelling, discussion, or emotional messaging.
Guided inquiry (Jacobson 1999; Lewis 2005; Stern, Powell, and Hill 2014; Ward and Wilkinson 2006)	Degree to which educator asks questions and facilitates students' pursuit of answers.
Data collection (Hungerford and Volk 1990; Stern, Powell, and Hill 2014)	Degree to which students carried out research techniques to address research questions. Data collection may be field-based or lab-based.
Hands-on learning (Ballantyne and Packer 2009; Emmons 1997; Stern, Powell, and Hill 2014)	Degree to which students were actively involved (e.g. touching or interacting with nature, props, etc.) during the lesson; not just passive receivers of verbal or visual communication (e.g. physical involvement).
Free exploration (Ardoin, Clark, and Kelsey 2013; Ballantyne and Packer 2009; Stern, Wright, and Powell 2012)	Degree to which students were encouraged to explore the environment for reasons other than scientific data collection (*may be teacher or student-led*).
Quality of introduction (Stern and Powell 2013)	Degree to which the introduction oriented the students to the lesson's content (and/or primary message) and captured student's attention.
Quality of conclusion (Ham 1992; Jacobson 1999; Stern and Powell 2013; Stern, Powell, and Hill 2014)	Degree to which lesson connected the introduction and lesson-content into a conclusion in an organized or cohesive way (e.g. lesson "came full circle").

(*Continued*)

Table 4. Observation variables.

Teaching approaches	
Transitions (Beck and Cable 2002; Brochu and Merriman 2002; Ham 1992; Jacobson 1999; Stern and Powell 2013)	Degree to which educator incorporated transitions during shifts in location or content to keep the students engaged and did not detract from the lesson's sequence (*quality not quantity focused*).
Class management (Bohn, Roehrig, and Pressley 2004; Henderlong and Lepper 2002; Regnier, Gross, and Zimmerman 1992; Wong and Wong 2005)	Degree to which the educator effectively managed disruptions or off-task behavior.
Time management (Baker, Robinson, and Kolb 2012; Enfield 2001; Wurdinger 2005; Stern and Powell 2013)	The degree to which the students were able to complete all intended parts of the lesson in an organized and cohesive way, not just disconnected parts of the lesson (e.g. experience without reflection, etc.)
Teaching approaches removed from analysis	
Multiple viewpoints (Emmons 1997; Monroe et al. 2019; Stern, Powell, and Hill 2014)	Degree to which the lesson explicitly acknowledged multiple perspectives or uncertainty *(often in controversial messaging; when an argument was made, was a counter-argument provided?).*
Quality of questions (Hungerford and Volk 1990; Stern, Powell, and Hill 2014)	Degree to which the educator's questions were probing and encouraged critical thinking, problem solving, student-led solutions/discussion, and complexity (instead of one or two word answers, memorization, or educator giving students the answer).
Investigation (Hungerford and Volk 1990; Stern, Powell, and Hill 2014)	Degree to which students took part in active testing of a hypothesis (e.g. investigation) during the lesson (*May be field-based, lab-based, or class based*).
Teacher-led investigation *(subset of investigation)*	Degree to which the investigation is teacher-led (e.g. educator told students what to investigate.
Student-led investigation *(subset of investigation)*	Degree to which the investigation is student-led (e.g. students in charge of own investigation.
Student-led learning (Ballantyne and Packer 2009; Stern, Powell, and Hill 2014)	Degree to which students are in charge of their own experience during the lesson instead of following detailed directions from an educator.

and 'I enjoyed the lesson') were removed. This screening process resulted in the removal of 77 student surveys, reducing the sample size to 1,392 individual student surveys from 81 lessons. Data were also screened for multivariate outliers using Mahalanobis Distance (Tabachnick and Fidell 2007). This resulted in the removal of an additional 94 student respondents. This reduced our sample to 1,298 student surveys from 81 lessons.

The unit of analysis was the lesson, as we investigated teaching approaches used in lessons and there influence on student outcomes. Therefore we aggregated individual student scores measured at the end of each lesson by taking the mean of all student scores. Before doing so, we examined the intraclass correlation coefficients (ICC(1)) and (ICC(2)) of students' responses on the environmental literacy outcome index to determine validity of this aggregation. We observed an ICC(1) score of 0.27 and ICC(2) score of 0.87, suggesting a large group effect on student responses and justifying the aggregation of the data to the group level (Bliese 2000; Bryk and Raudenbush 1992; Fleiss 1986; Woehr et al. 2015). The ICC(1) value is well above the 0.10 threshold for a medium effect, nearing a large effect, which suggests that a significant amount of variance in outcomes occurred at the group level and not at the individual level (Bliese 1998; 2000; Bryk and Raudenbush 1992). The ICC(2) value is also well above the threshold of 0.75 suggesting a high degree of group level reliability (Fleiss 1986).

Lesson-level student mean scores were then checked for skewness and kurtosis. All lessons except for one were below the threshold for concern (± 0.6; Schumacker and Lomax 2004). Data were then screened again for multivariate outliers using Mahalanobis Distance at the lesson level. This same lesson was confirmed as an outlier and was subsequently removed from the sample (Tabachnick and Fidell 2007). This resulted a final sample size of 80 lessons.

Six teaching approaches were removed due to a lack of variability: multiple viewpoints, investigation-focused approaches (and the two subcategories of this variable), student-led approaches, and quality of questions (see Table 4). This reduced the total number of the independent variables from 26 to 20.

Linking teaching approaches to environmental literacy outcomes

To account for school culture or other unobserved variables at the group level, we used group mean centering to remove the variance caused by group membership (Bell et al. 2018; Enders and Tofighi 2007). Group means were computed by subtracting each group's lesson environmental literacy outcome index score from that same group's weeklong average environmental literacy score. In effect, the resulting measure gauges divergence of each lesson from each group's overall mean.

We conducted a bivariate correlation analysis between each observational variable and the group-mean-centered environmental literacy outcome index scores. The Spearman's rho statistic was used due to the ordinal nature of the variables (Field 2013). We also conducted a bivariate correlation using the Pearson statistic to explore the relationships between the 20 independent variables. We then performed a linear regression only with those variables that were statistically correlated ($p < 0.05$) with the outcome to further explore the relationships. We used only these variables in the regression equation due to power limitations of the small sample size. Qualitative observation notes were categorized and used to provide descriptions of key teaching approaches.

Results

Descriptive statistics and spearman correlations with the environmental literacy

Table 5 displays the descriptive statistics for the teaching approaches and the correlation statistics between each item and the group-mean-centered environmental literacy outcome index.

Table 5. Means and standard deviations of observed lesson characteristics, Spearman's rho correlation values with the group-mean-centered environmental literacy index.

Variable	M (SD)	Spearman r
Environmental issue	2.60 (0.94)	**.390****
Affective messaging	1.82 (0.90)	**.298****
Data collection	2.81 (1.23)	**−.291****
Fact-based	2.49 (0.77)	**−.270****
Relevance	2.44 (0.90)	.286*
Time management	3.39 (0.71)	.224*
Role modeling	1.59 (0.88)	.198
Group reflection	2.61 (0.83)	.189
Quality of conclusion	2.19 (0.91)	.184
Individual reflection	1.99 (0.88)	.149
Holistic Storytelling	1.53 (0.82)	.125
Free exploration	1.84 (1.02)	.108
Class management	3.11 (0.61)	.080
Hands-on learning	3.15 (0.98)	.065
Cooperative group learning	2.43 (1.17)	.057
Guided inquiry	3.04 (0.72)	.007
Transitions	1.74 (0.91)	−.028
Play-based learning	1.81 (0.99)	−.029
Quality of introduction	2.26 (0.74)	−.055
Sensory-based learning	1.70 (0.94)	−.189

*Notes: *p < .05; **p < 0.01*

Four teaching approaches were positively correlated with the environmental literacy outcome ($p < 0.05$): environmental issue-based, affective messaging, relevance, and time management. Two teaching approaches were negatively correlated with the environmental literacy outcome ($p < 0.01$): data collection and fact-based.

Pearson correlations between teaching approaches

Further exploration of the independent variables revealed that data collection was positively correlated with fact-based teaching and negatively correlated with affective messaging ($r = 0.48$ and −0.31, respectively, $p < 0.01$). Further, issue-based approaches were positively correlated with relevance ($r = 0.42$, $p < 0.01$). These findings suggest that issue-based approaches and relevance were often observed together. Similarly, data collection was commonly fact-based and rarely connected to affective messaging.

Regression analysis

Table 6 displays the results of the linear regression analysis of the six teaching approaches that were significantly correlated with the student environmental literacy outcome. Three variables were statistically significant in the regression model. Issue-based approaches and time

Table 6. Linear regression model for the six teaching approaches variables correlated with the student environmental literacy outcome ($F = 6.81$; $p < 0.01$; $R^2 = 0.39$; Adjusted $R^2 = 0.34$).

	Standardized β	t	p
Constant		−2.94	.005
Issue-based	.448	3.91	.000
Affective messaging	.179	1.65	.104
Data collection	−.275	−2.30	.025
Fact-based	.036	.322	.748
Relevance	.002	0.02	.988
Time management	.213	2.17	.034

management were positively related to the outcome and data collection was negatively related. The model explained approximately 34% of the variance in the outcome.

Descriptions of promising teaching approaches

In our analyses, four lesson characteristics were most consistently positively associated with students' environmental literacy outcomes during the lessons at NorthBay: environmental issue-based approaches; affective messaging; relevance; and effective time management. We provide descriptions of these practices from our qualitative notes taken during observations (Table 7). We also similarly provide examples of the two teaching approaches that were negatively associated with student outcomes (Table 7) in this study.

Discussion

This study sought to understand what teaching approaches were most effective at enhancing immediate environmental literacy outcomes for the students participating in these EE lessons at the NorthBay residential program. Four teaching approaches (issue-based; affective messaging; relevance; and time management) were positively correlated with student environmental literacy outcomes and two teaching approaches (data collection and fact-based) were negatively correlated with the outcome. In a linear regression model issue-based approaches and time management were positively related to the outcome and data collection was negatively related and accounted for 34% of the observed variance in environmental literacy outcomes.

Environmental issues & relevance

The importance of real-world issue-based approaches (e.g. real place, real issues, real tasks and work students can do in the field, etc.), has been widely supported in the literature (Ballantyne and Packer 2009; Cheeseman and Wright 2019; Gardner and Stern 2002; Jacobson, McDuff, and Monroe 2006; Monroe et al. 2019; Rickinson 2001; Smith-Sebasto and Walker 2005; Stern and Powell 2013; Stern, Powell, and Hill 2014) and is also considered a best practice of effective EE (North American Association for Environmental Education (NAAEE) 2009; North American Association for Environmental Education (NAAEE) 2019). The IEEIA model, which NorthBay uses as a foundation for their EE programming, is rooted in investigating real-world environmental issues and has been shown in numerous evaluation studies to positively impact student outcomes (Culen and Volk 2000; Hungerford and Volk 1990; Hungerford et al. 2003; Volk and Cheak 2003). Further issue-based teaching approaches and relevance were correlated with each other in our study, which reflects NorthBay's approach to teaching environmental issues. NorthBay uses key themes each day to link ecological concepts and complex issues to students' lives at home in the constructivist spirit. For example, one day's theme was 'degraded conditions.' Students investigated different degraded environmental conditions in the ecosystems of NorthBay's campus and were prompted to consider degraded conditions in their communities at home (e.g. social, economic, environmental, etc.). This intertwining of issue-based approaches and content relevant to students' home lives appears to have been an effective feature of the lessons at NorthBay.

Affective messaging

NorthBay educators who sincerely conveyed their love for the resource and expressed care and concern for the environment and their students tended to achieve more positive outcomes. A

Table 7. Observations of what the teaching approaches positively and negatively associated with students' environmental literacy outcomes looked like in practice.

	Examples of Teaching Approaches Leading to Enhanced Student Outcomes
Environmental issue	The educator engaged the students in a discussion about food waste, the lengthy journey from farm to table to trash, and the implications of these steps on the environment. Students then gathered all of the food waste and compost, weighed each, and recorded the data. While doing this, the educator told the students to think about every meal they ate, the steps that go into making their food, and what happens to it when thrown away. The students shared their thoughts about positive ways they can reduce their waste and impact(s) on the environment.
Affective messaging	The educator frequently conveyed the importance of loving a place or species. During a lesson on fungus, the educator says, "Today, I am going to teach you about fungi in all of their diversity. I know you think they are weird, but I am going to teach you to love them." The educator focused less on facts and data in the first 20 min of the lesson and more on why fungi are so special, giving students an opportunity to find fungi, draw them, name them, and come up with stories about how these fungi live their lives and why they are important. Afterwards, the educator discussed facts and more details on the importance of fungi in these woods and continued to reference these emotions throughout.
Relevance	Students completed a game that required them to work together to "stay alive" on an island. The students discussed the concept of a filter in the environment, such as a wetland, and then the educator spoke about how the people in our lives could be filters too. The educator engaged the students in a discussion about being a positive filter, who the filters were in their lives, if they were a positive filter to someone else, and whether or not they were a positive filter during the game. The educator did a masterful job of making a seemingly irrelevant game extremely relevant for these students and broached complex issues such as protecting the environment and building a stronger community at home.
Time management	The educator allowed the right amount of time to complete each activity/part of the two-hour lesson. The pace wasn't too slow where students appeared bored or too fast where there wasn't enough time to fully complete each activity. The educator allowed for more time at the end of the lesson than any other educator observed allowing for a dedicated 15 min for a strong conclusion and student reflection that was relevant and linked the content covered in the lesson to students' home lives. Enough time was allowed such that in this conclusion the educator linked the ecological concepts covered in the lesson (e.g. degraded conditions and how wetlands are filters) to the experiences they had with bullying in their own life. The students and educator discussed ways to be positive filters for the species living in this ecosystem so a degraded condition doesn't develop. The conversation continued to ways to be a positive filter (a.k.a., a role model) and identify negative filters in the students' lives at home so they are not harmed and had strong affective messaging. The time management allowed students the opportunity to reflect in the moment on what they learned, how it was relevant to them, and ways they could become positive filters for the natural environments and/or their community at home.
	Example of teaching approach leading to lower student outcomes
Data collection & fact-based	After a wonderful exploration in the woods where students climbed trees, took pictures of the trees and each other climbing, and walking around the woods to start the lesson, the educator spent the remaining 90 min focusing on facts, data collection, and analysis about trees. Students were led into an inside classroom where the educator wrote facts about trees and definitions on the whiteboard and showed students how to use equipment to collect data on trees (e.g. DBH, identification, etc.). Near the end of this classroom time, 90% of the students were clearly detached (e.g. looking down, doodling in their journals, fidgeting, etc.) and the educator asked the students to stay focused because there were more facts that needed to be covered. The educator walked the students back into the woods, divided them into groups to collect data on a tree, handed them the equipment and told them to get to work. The students struggled to remember how to collect the data and were observed being disruptive (e.g. using measurement tools as swords, tying each other up with measuring tape, etc.) and making comments like, "can we do something else?" and "I ain't worried about trees." At one point, the educator told the students, "…if you can just get through this lesson, we will be good, [this is the] longest data collection all week." The educator gathered the students together in an outdoor classroom where they went through their data and consulted formulas and tables to calculate the monetary value of their tree. A discussion about the value of trees, and forests, concluded the lesson and was focused on the monetary value of wood which tied in the student's data collection and analysis.

similar finding was recently observed by O'Hare et al. (2020) with a nationwide sample of middle school EE students. Students appeared more inclined to consider and share their feelings and emotions about key issues affecting the natural environment and their lives at home if the

educator shared affective messaging of their own. Conveying emotions alongside the delivery of facts or the collection and analysis of data may help these activities seem less sterile and more relevant for students. Many argue that the affective domain is a critical entry point for building environmental literacy and pro-environmental behavior (Iozzi 1989a; 1989b; Hungerford and Volk 1990; Reis and Roth 2009), and research provides some empirical support for this as well (Altmeyer and Dreesmann 2021; Stern and Powell 2013; Stern, Powell, and Hill 2014). Placing a greater emphasis on emotions (e.g. attitudes and values) has also been linked to promoting emotional development, nature affinity, and pro-environmental attitudes and behaviors in addition to its influence on environmental literacy for the youth in this study (Ballantyne and Packer 2009; Bergman 2016; Cheng and Monroe 2012; Kals, Schumacher, and Montada 1999; Hungerford and Volk 1990; Nisbet, Zelenski, and Murphy 2009).

Time management

Good time management enables an educator to complete all lesson components and underpins effective teaching. While effective time management does not guarantee positive learning outcomes, poor time management assuredly erodes learning outcomes. In our observations, poor time management was most often the result of poor pacing or inefficient movement of the student group from one activity to another. Some educators appeared to only notice they were running behind near the very end of their lessons. This caused them to move too quickly through the remaining work, which often involved data analysis, reflection, and conclusion. Some educators omitted some of these key programmatic elements entirely because they ran out of time. Having time for meaningful student reflection and a strong conclusion may be essential for students to make sense of their experience and be able to apply what they have learned either later during the lesson or program, or when they return home (Cincera, Johnson, and Kroufek 2020; Kolb 2015; Lee, Stern, and Powell 2020; Stern, Powell, and Hill 2014). These instances tended to lead toward less positive environmental literacy outcomes in this study and lend support to other empirical evidence that attention to good pacing can have meaningful impacts on program outcomes (Stern and Powell 2013).

Data collection and fact-based teaching

We found that programs at NorthBay that focused on data collection tended to yield less positive environmental literacy outcomes. Further exploration of the data revealed that these programs were also typically focused on fact-based teaching and did not use affective messaging or the other techniques described above. Delivering facts and information are obviously important to any program, but this study adds evidence that over-emphasizing facts at the expense of emotional connections can diminish returns. Guidance from the fields of EE and interpretation suggest that facts must be linked to larger concepts, issues, or themes that provide meaningful connections to the students to achieve more meaningful outcomes (Ham 1992; Monroe et al. 2019; North American Association for Environmental Education (NAAEE) 2009; North American Association for Environmental Education (NAAEE) 2019; Tilden 1957).

Limitations of the study

Our mixed-methods case study approach precluded our ability to perform more complex multivariate analyses (Maas and Hox 2005) and statistically account for interactions between the variables we observed. This study also took place at a single site on the east coast of the United

States. The NorthBay program operates in a distinct context that is likely different from other residential programs in the United States, and perhaps greatly different to the contexts in which international programs operate. As such, if this study were conducted at other residential centers with different characteristics and contexts, the results may be different. This study was also conducted prior to the COVID-19 pandemic, and if conducted today, the study may yield different results. We urge similar studies in diverse contexts to explore which teaching approaches might be most effective for different audiences in different contexts, particularly as programs navigate changing contexts, modalities, and conditions with the global pandemic. Our findings align with prior studies to some extent (e.g. Ballantyne and Packer 2009; Hungerford and Volk 1990; Rickinson 2001; Stern, Powell, and Hill 2014). Yet, we expect that other practices might emerge in different settings. As such, we want to strongly caution readers against inferring that the statistically insignificant teaching approaches found in this study are unimportant. Some characteristics exhibited little variation, and other characteristics associated with setting, individuals' pre-dispositions, or other unmeasured approaches may have also influenced outcomes.

This study gathered student data through immediate post-experience surveys, which limits our understanding of longer-term outcomes. As such, we cannot make any claims related to the longer-term impacts of these lessons (see Stern, Powell, and Ardoin 2008 for a separate study on longer-term student outcomes associated with the NorthBay program). The strength of this approach lies in its comparative nature between lessons, which enabled the identification of specific lesson characteristics most predictive of immediate environmental literacy outcomes. Focusing on these EE lessons in this way allowed for the isolation of specific characteristics of the lessons that were associated with enhanced immediate environmental literacy outcomes, which was our chief goal. We aimed to provide insights for residential EE practitioners, who may consider what aspects of this case study are relevant to their specific context. We focused on these EE lessons because they were, by design, the primary EE components of the entire NorthBay experience. However, we did not incorporate other important elements of the NorthBay program (E.g., adventure activities, live evening shows, free exploration, etc.) into this study, which may certainly have influenced the students learning and outcomes. As with any survey research, there may have been some social desirability bias (Podsakoff et al. 2003) although the repeated surveys may have minimized the effects of any social desirability bias across the sample. Moreover, by group-mean-centering the data, our analytical techniques would have controlled for any consistent upward or downward bias within a specific group of students.

Conclusion

This study adds to the EE-related literature by investigating the relationships between specific EE lesson characteristics and environmental literacy for these students attending the NorthBay residential EE program. We identified four lesson characteristics that were most consistently associated with higher student environmental literacy scores at NorthBay: environmental issue-based approaches, affective messaging, relevance, and effective time management. Two characteristics were negatively associated with outcomes: data collection and fact-based approaches. The results suggest that high quality EE incorporates not only real-world and relevant issues, but also moves beyond the mere sharing of information toward giving students the time and context to feel something about an issue, place, or even each other.

This study also makes some methodological contributions to the field of EE. We have refined a method (e.g. Stern and Powell 2013; Powell and Stern 2013a; 2013b) for linking lesson characteristics with student outcomes through observation and questionnaire responses. While we conducted this study at only one site, these methods could apply across a much wider array of programs, where characteristics of lessons and EE experiences could be observed and surveys used to compare their effectiveness. These techniques have since been expanded in other recent

efforts (e.g. Powell et al. 2019). We also provide a simple and statistically validated short questionnaire for measuring environmental literacy that might be useful to practitioners and other researchers to build upon when facing time constraints. Future researchers could also take into account the full suite of classes, experiences, and activities occurring at residential programs rather than isolating specific components as we have done here. More broadly, future researchers may also wish to examine other important factors, such as the influence of socio-cultural-political contexts on learning and ultimately student outcomes.

Disclosure statement

The authors have no potential conflict of interest to report. This study was reviewed and approved by the author(s) Institutional Review Board (#15-915).

Notes

1. ICC estimates and their 95% confidence intervals were calculated based on average measures using absolute-agreement and a two-way mixed-effects model.
2. Two additional backup educators were observed on rare occasions due to the primary educator being unable to teach a particular lesson.

Notes on contributors

B. Troy Frensley is an assistant professor in the Department of Environmental Sciences where he teaches courses in environmental education and interpretation, global environmental issues, human dimensions of natural resource management, and environmental nonprofit organizations. His research focuses on environmental education; environmental interpretation; program evaluation; motivation and engagement; and citizen/community science.

Marc J. Stern is a professor in the Department of Forest Resources and Environmental Conservation where he teaches courses in environmental education and interpretation, social science research methods, and the human dimensions of natural resource management. His research focuses on human behavior within the contexts of natural resource planning and management, protected areas, and environmental education and interpretation.

Robert B. Powell is the George B. Hartzog, Jr. Endowed Professor in the Department of Parks, Recreation, and Tourism Management at Clemson University. He is also the Director of the Institute for Parks, which is an interdisciplinary institute focused on providing research, training, and outreach to support park and protected area management. His research and outreach program focuses on environmental education and interpretation, ecotourism, and protected area management.

Michael J. Blackwell is the Director of Education at the North Cascades Institute and has over thirty years of experience working in community-based non-profit organizations, academia, and the private sector. He has a master's degree in educational psychology, and is passionate about holistic human learning and curriculum design.

ORCID

B. Troy Frensley http://orcid.org/0000-0002-4670-5503
M. J. Stern http://orcid.org/0000-0002-0294-8941
R. B. Powell http://orcid.org/0000-0003-2775-2571

References

Altmeyer, S., and D. Dreesmann. 2021. "The Tree Was There First" – Using an Everyday Ecological Dilemma to Explore the Personal Orientations of Secondary School Students in Environmental Decision-Making." *Environmental Education Research* 27 (1): 67–87. doi:10.1080/13504622.2020.1853062.

Ardoin, N. M., K. Biedenweg, and K. O'Connor. 2015. "Evaluation in Residential Environmental Education: An Applied Literature Review of Intermediary Outcomes." *Applied Environmental Education & Communication* 14 (1): 43–56. doi:10.1080/1533015X.2015.1013225.

Ardoin, N. M., A. W. Bowers, N. W. Roth, and N. Holthuis. 2018. "Environmental Education and K-12 Student Outcomes: A Review and Analysis of Research." *The Journal of Environmental Education* 49 (1): 1–17. doi:10.1080/00958964.2017.1366155.

Ardoin, N. M., C. Clark, and E. Kelsey. 2013. "An Exploration of Future Trends in Environmental Education Research." *Environmental Education Research* 19 (4): 499–520. doi:10.1080/13504622.2012.709823.

Baker, M. A., J. S. Robinson, and D. A. Kolb. 2012. "Aligning Kolb's Experiential Learning Theory with a Comprehensive Agricultural Education Model." *Journal of Agricultural Education* 53 (4): 1–16. doi:10.5032/jae.2012.04001.

Ballantyne, R., and J. Packer. 2009. "Introducing a Fifth Pedagogy: Experience Based Strategies for Facilitating Learning in Natural Environments." *Environmental Education Research* 15 (2): 243–262. doi:10.1080/13504620802711282.

Ballantyne, R., J. Packer, and M. Everett. 2005. "Measuring Environmental Education Program Impacts and Learning in the Field: Using an Action Research Cycle to Develop a Tool for Use with Young Scientists." *Australian Journal of Environmental Education* 21: 23–38. doi:10.1017/S0814062600000926.

Beck, L., and T. T. Cable. 2002. *Interpretation for the 21st Century: Fifteen Guiding Principles for Interpreting Nature and Culture*. 2nd ed. Champaign: Sagamore

Beetles: Science and Teaching for Field Instructors (Beetles: Science and Teaching for Field Instructors). 2014. http://beetlesproject.org/index.html

Bell, A., K. Jones, and M. Fairbrother. 2018. "Understanding and Misunderstanding Group Mean Centering: A Commentary on Kelley et al.'s Dangerous Practice." *Quality & Quantity* 52 (5): 2031–2036. doi:10.1007/s11135-017-0593-5.

Bergman, B. G. 2016. "Assessing Impacts of Locally Designed Environmental Education Projects on Students' Environmental Attitudes, Awareness, and Intention to Act." *Environmental Education Research* 22 (4): 480–503. doi:10.1080/13504622.2014.999225.

Bliese, P. D. 1998. "Group Size, ICC Values, and Group-Level Correlations: A Simulation." *Organizational Research Methods* 1 (4): 355–373. doi:10.1177/109442819814001.

Bliese, P. D. 2000. "Within-Group Agreement, Non-Independence, and Reliability: Implications for Data Aggregation and Analysis." In *Multilevel Theory, Research, and Methods in Organizations*, edited by K. J. Klein and S. W. J. Kozlowski, 349–381. San Francisco, CA: Jossey-Bass.

Bohn, C. M., A. D. Roehrig, and M. Pressley. 2004. "The First Days of School in the Classrooms of Two More Effective and Four Less Effective Primary-Grades Teachers." *The Elementary School Journal* 104 (4): 269–287. doi:10.1086/499753.

Bourke, N., C. Buskist, and J. Herron. 2014. "Residential Environmental Education Center Program Evaluation: An Ongoing Challenge." *Applied Environmental Education & Communication* 13 (2): 83–90. doi:10.1080/1533015X.2014.944632.

Brochu, L., and T. Merriman. 2002. *Personal Interpretation: Connecting Your Audience to Heritage Resources*. Fort Collins, CO: InterpPress.

Bryk, A. S., and S. W. Raudenbush. 1992. *Hierarchical Linear Models: Applications and Data Analysis Methods*. Newbury Park, CA: Sage.

Cheeseman, A., and T. Wright. 2019. "Examining Environmental Learning Experiences at an Earth Education Summer Camp." *Environmental Education Research* 25 (3): 375–387. doi:10.1080/13504622.2018.1509301.

Cheng, J. C. H., and M. C. Monroe. 2012. "Connection to Nature: Children's Affective Attitude toward Nature." *Environment and Behavior* 44 (1): 31–49. doi:10.1177/0013916510385082.

Cincera, J., B. Johnson, and R. Kroufek. 2020. "Outdoor Environmental Education Programme Leaders' Theories of Experiential Learning." *Cambridge Journal of Education* 50 (6): 729–745. doi:10.1080/0305764X.2020.1770693.

Culen, G. R., and T. L. Volk. 2000. "Effects of an Extended Case Study on Environmental Behavior and Associated Variables in Seventh- and Eighth-Grade Students." *The Journal of Environmental Education* 31 (2): 9–15. doi:10.1080/00958960009598633.

Dettman-Easler, D., and J. L. Pease. 1999. "Evaluating the Effectiveness of Residential Environmental Education Programs in Fostering Positive Attitudes toward Wildlife." *The Journal of Environmental Education* 31 (1): 33–39. doi:10.1080/00958969909598630.

Emmons, K., M. 1997. "Perceptions of the Environment While Exploring the Outdoors: A Case Study in Belize." *Environmental Education Research* 3 (3): 327–344. doi:10.1080/1350462970030306.

Enders, C. K., and D. Tofighi. 2007. "Centering Predictor Variables in Cross-Sectional Multilevel Models: A New Look at an Old Issue." *Psychological Methods* 12 (2): 121–138. doi:10.1037/1082-989X.12.2.121.

Enfield, R. P. 2001. *Connections between 4-H and John Dewey's Philosophy of Education. FOCUS*. Davis: 4-H Center for Youth Development, University of California, Winter.

Farmer, J., D. Knapp, and G. M. Benton. 2007. "An Elementary School Environmental Education Field Trip: Long-Term Effects on Ecological and Environmental Knowledge and Attitude Development." *The Journal of Environmental Education* 38 (3): 33–42. doi:10.3200/JOEE.38.3.33-42.

Fenichel, M., and H. A. Schweingruber. 2010. *Surrounded by Science: Learning Science in Informal Environments. Board on Science Education, Center for Education, Division of Behavioral and Social Sciences and Education*. Washington, DC: The National Academies Press.

Field, A. 2013. *Discovering Statistics Using IBM SPSSs Statistics: And Sex and Drugs and Rock 'N' Roll*. 4th ed. Los Angeles: Sage.

Fleiss, J. 1986. *The Design and Analysis of Clinical Experiments*. New York: Wiley.

Gardner, G. T., and P. C. Stern. 2002. *Environmental Problems and Human Behavior*. 2nd ed. Boston, MA: Pearson Custom Publishing.

Ham, S. H. 1992. *Environmental Interpretation: A Practical Guide for People with Big Ideas and Small Budgets*. Golden: Fulcrum

Henderlong, J., and M. R. Lepper. 2002. "The Effects of Praise on Children's Intrinsic Motivation." *Psychological Bulletin* 128 (5): 774–795.

Hollweg, K. S., J. R. Taylor, R. W. Bybee, T. J. Marcinkowski, W. C. McBeth, and P. Zoido. 2011. *Developing a Framework for Assessing Environmental Literacy*. Washington, DC: North American Association for Environmental Education.

Hungerford, H. R., and T. L. Volk. 1990. "Changing Learner Behavior through Environmental Education." *The Journal of Environmental Education* 21 (3): 8–21. doi:10.1080/00958964.1990.10753743.

Hungerford, H. R., T. Volk, J. M. Ramsey, R. A. Litherland, and R. B. Peyton. 2003. *Investigating and Evaluating Environmental Issues and Actions*. Champaign, IL: Stipes Publishing, LLC.

Iozzi, L. A. 1989a. "What Research Says to the Educator. Part One: Environmental Education and the Affective Domain." *The Journal of Environmental Education* 20 (3): 3–9. doi:10.1080/00958964.1989.9942782.

Iozzi, L. A. 1989b. "What Research Says to the Educator. Part Two: Environmental Education and the Affective Domain." *The Journal of Environmental Education* 20 (4): 6–13. doi:10.1080/00958964.1989.9943033.

Jacobson, S. K. 1999. *Communication Skills for Conservation Professionals*. Washington, DC: Island Press.

Jacobson, S. K., M. D. McDuff, and M. C. Monroe. 2006. *Conservation Education and Outreach Techniques*. Oxford: Oxford University Press.

Kals, E., D. Schumacher, and L. Montada. 1999. "Emotional Affinity toward Nature as a Motivational Basis to Protect Nature." *Environment and Behavior* 31 (2): 178–202. doi:10.1177/00139169921972056.

Kolb, D. A. 2015. *Experiential Learning: Experience as the Source of Learning and Development*. 2nd ed. Englewood Cliffs, NJ: Prentice Hall.

Larsen, D. L. 2003. *Meaningful Interpretation: How to Connect Hearts and Minds to Places, Objects, and Other Resources*. Eastern National.

Lee, H., M. J. Stern, and R. B. Powell. 2020. "Assessing the Influence of Preparation and Followup on Student Outcomes Associated with Environmental Education Field Trips." *Environmental Education Research* 26 (7): 989–1007. doi:10.1080/13504622.2020.1765991.

Lewis, W. J. 2005. *Interpreting for Park Visitors*. 9th ed. Fort Washington, PA: Eastern National.

Liefländer, A. K., and F. X. Bogner. 2014. "The Effects of Children's Age and Sex on Acquiring Pro-Environmental Attitudes through Environmental Education." *The Journal of Environmental Education* 45 (2): 105–117. doi:10.1080/00958964.2013.875511.

Maas, Cora J. M., and Joop J. Hox. 2005. "Sufficient Sample Sizes for Multilevel Modeling." *Methodology* 1 (3): 86–92. doi:10.1027/1614-1881.1.3.86.

Mason, L., and M. Santi. 1998. "Discussing the Greenhouse Effect: Children's Collaborative Discourse Reasoning and Conceptual Change." *Environmental Education Research* 4 (1): 67–85. doi:10.1080/1350462980040105.

McBeth, B., H. Hungerford, T. Volk, and K. Cifranick. 2011. National Environmental Literacy Assessment, phase two: Measuring the effectiveness of North American environmental education programs with respect to the parameters of environmental literacy.

McBride, B. B., C. A. Brewer, A. R. Berkowitz, and W. T. Borrie. 2013. "Environmental Literacy, Ecological Literacy, Ecoliteracy: What Do we Mean and How Did we Get Here?" *Ecosphere* 4 (5): art67. doi:10.1890/ES13-00075.1.

Monroe, M. C., R. R. Plate, A. Oxarart, A. Bowers, and W. A. Chaves. 2019. "Identifying Effective Climate Change Education Strategies: A Systematic Review of the Research." *Environmental Education Research* 25 (6): 791–812. doi:10.1080/13504622.2017.1360842.

Moscardo, G. 1999. *Making Visitors Mindful: Principles for Creating Quality Sustainable Visitor Experiences through Effective Communication*. Champaign: Sagamore.

Mullenbach, L. E., R. G. Andrejewski, and A. J. Mowen. 2019. "Connecting Children to Nature through Residential Outdoor Environmental Education." *Environmental Education Research* 25 (3): 365–374. doi:10.1080/13504622.2018.1458215.

National Center for Education Statistics. 2017. *Search for public schools*. https://nces.ed.gov/ccd/schoolsearch/

National Research Council (NRC). 2009. "*Learning Science in Informal Environments: People, Places, and Pursuits*. Committee on Learning Science in Informal Environments." edited by P. Bell, B. Lewenstein, A.W. Shouse, &

M.A. Feder . *Board on Science Education, Center for Education, Division of Behavioral and Social Sciences and Education*. Washington, DC: The National Academies Press.
National Science Foundation (NSF). 2008. "Framework for evaluating impacts of informal science education projects." Retrieved from: http://www.informalscience.org/documents/Eval_Framework.pdf.
Nisbet, E. K., J. M. Zelenski, and S. A. Murphy. 2009. "The Nature Relatedness Scale: Linking Individuals' Connection with Nature to Environmental Concern and Behavior." *Environment and Behavior* 41 (5): 715–740. doi:10.1177/0013916508318748.
North American Association for Environmental Education (NAAEE). 2009. *Guidelines for Excellence: Nonformal EE Programs*. Washington, DC: NAAEE Publications and Membership Office. Retrieved from: https://cdn.naaee.org/sites/default/files/gl_nonformal_complete.pdf.
North American Association for Environmental Education (NAAEE). 2019. *Guidelines for Excellence: K-12 Environmental Education*. Washington, DC: NAAEE Publications and Membership Office. Retrieved from: https://cdn.naaee.org/sites/default/files/eepro/resource/files/k-12_ee_guidelines_for_excellence_2019_3.pdf.
North American Association for Environmental Education (NAAEE). 2021. *Guidelines for Excellence: Environmental Education Materials*. Washington, DC: NAAEE Publications and Membership Office. Retrieved from https://cdn.naaee.org/sites/default/files/eepro/resource/files/guide_2.21.21.small_acc.pdf.
O'Hare, A., R. B. Powell, M. J. Stern, and E. P. Bowers. 2020. "Influence of Educator's Emotional Support Behaviors on Environmental Education Student Outcomes." *Environmental Education Research* 26 (11): 1556–1577. doi:10.1080/13504622.2020.1800593.
Pianta, R. C., and B. K. Hamre. 2009. "Conceptualization, Measurement, and Improvement of Classroom Processes: Standardized Observation Can Leverage Capacity." *Educational Researcher* 38 (2): 109–119. doi:10.3102/0013189X09332374.
Podsakoff, P. M., MacKenzie, S. B. J.-Y.Lee, J.-Y., and N. P. Podsakoff. 2003. "Common Method Biases in Behavioral Research: A Critical Review of the Literature and Recommended Remedies." *The Journal of Applied Psychology* 88 (5): 879–903.
Powell, R. B., and M. J. Stern. 2013a. "Is It the Program or the Interpreter? Modeling the Influence of Program Characteristics and Interpreter Attributes on Visitor Outcomes. Special Issue." *Journal of Interpretation Research* 18 (2): 45–60. doi:10.1177/109258721301800203.
Powell, R. B., and M. J. Stern. 2013b. "Speculating on the Role of Context in the Outcomes of Interpretive Programs. Special Issue." *Journal of Interpretation Research* 18 (2): 61–78. doi:10.1177/109258721301800204.
Powell, R. B., M. J. Stern, B. T. Frensley, and D. Moore. 2019. "Identifying and Developing Crosscutting Environmental Education Outcomes for Adolescents in the Twenty-First Century (EE21)." *Environmental Education Research* 25 (9): 1281–1299. doi:10.1080/13504622.2019.1607259.
Regnier, K., M. Gross, and R. Zimmerman. 1992. *The Interpreter's Guidebook: Techniques for Programs and Presentations*. UW-SP Foundation Press, Inc. Stevens Point, WI.
Reis, G., and W. M. Roth. 2009. "A Feeling for the Environment: Emotion Talk in/for the Pedagogy of Public Environmental Education." *The Journal of Environmental Education* 41 (2): 71–87. doi:10.1080/00958960903295217.
Rickinson, M. 2001. "Learners and Learning in Environmental Education: A Critical Review of the Evidence." *Environmental Education Research* 7 (3): 207–320. doi:10.1080/13504620120065230.
Schumacker, R. E., and R. G. Lomax. 2004. *A Beginner's Guide to Structural Equation Modeling*. New Jersey: Lawrence Erlbaum Associates.
Skibins, J. C., R. B. Powell, and M. J. Stern. 2012. "Exploring Empirical Support for Interpretations Best Practices." *Journal of Interpretation Research* 17 (1): 25–44. doi:10.1177/109258721201700103.
Smith-Sebasto, N. J., and L. M. Walker. 2005. "Toward a Grounded Theory for Residential Environmental Education: A Case Study of the New Jersey School of Conservation." *The Journal of Environmental Education* 37 (1): 27–42. doi:10.3200/JOEE.37.1.27-42.
Stern, M. J., B. T. Frensley, R. B. Powell, and N. M. Ardoin. 2018. "What Difference Do Role Models Make? Investigating Outcomes at a Residential Environmental Education Center." *Environmental Education Research* 24 (6): 818–830. doi:10.1080/13504622.2017.1313391.
Stern, M. J., and R. B. Powell. 2013. "What Leads to Better Visitor Outcomes in Live Interpretation?" *Journal of Interpretation Research* 18 (2): 9–44. doi:10.1177/109258721301800202.
Stern, M. J., and R. B. Powell. 2020. "Field Trips and the Experiential Learning Cycle." *Journal of Interpretation Research* 25 (1): 46–50. doi:10.1177/1092587220963530.
Stern, M. J., R. B. Powell, and N. M. Ardoin. 2008. "What Difference Does It Make? Assessing Outcomes from Participation in a Residential Environmental Education Program." *The Journal of Environmental Education* 39 (4): 31–43. doi:10.3200/JOEE.39.4.31-43.
Stern, M. J., R. B. Powell, and N. M. Ardoin. 2010. "Evaluating a Constructivist and Culturally Responsive Approach to Environmental Education for Diverse Audiences." *The Journal of Environmental Education* 42 (2): 109–122. doi:10.1080/00958961003796849.
Stern, M. J., R. B. Powell, and D. Hill. 2014. "Environmental Education Program Evaluation in the New Millennium: What Do we Measure and What Have we Learned?" *Environmental Education Research* 20 (5): 581–611. doi:10.1080/13504622.2013.838749.

Stern, M. J., M. E. Wright, and R. B. Powell. 2012. "Motivating Participation in National Park Service Curriculum-Based Education Programs." *Visitor Studies* 15 (1): 28–47. doi:10.1080/10645578.2012.660840.

Stronge, J. H., T. J. Ward, P. D. Tucker, and J. L. Hindman. 2007. "What is the Relationship between Teacher Quality and Student Achievement? An Exploratory Study." *Journal of Personnel Evaluation in Education* 20 (3-4): 165–184. doi:10.1007/s11092-008-9053-z.

Tabachnick, B. G., and L. S. Fidell. 2007. *Using Multivariate Statistics*. 5th ed. Needham Heights, MA: Allyn & Bacon.

Thomas, R. E., T. Teel, B. Bruyere, and S. Laurence. 2019. "Metrics and Outcomes of Conservation Education: A Quarter Century of Lessons Learned." *Environmental Education Research* 25 (2): 172–121. doi:10.1080/13504622.2018.1450849.

Tilden, F. 1957. *Interpreting Our Heritage*. 3rd ed. Chapel Hill: The University of North Carolina Press.

UNESCO. 1977. *Final Report Intergovernmental Conference on Environmental Education, Tbilisi, USS, 14–26, October 1977*. Paris: UNESCO.

United States Department of Education. 2018. *Improving basic programs operated by local educational agencies (Title I, Part A)*. https://www2.ed.gov/programs/titleiparta/index.html

Volk, T. L., and M. J. Cheak. 2003. "The Effects of an Environmental Education Program on Students, Parents, and Community." *The Journal of Environmental Education* 34 (4): 12–25. doi:10.1080/00958960309603483.

Ward, C. W., and A. E. Wilkinson. 2006. *Conducting Meaningful Interpretation: A Field Guide for Success*. Golden: Fulcrum.

Woehr, D. J., A. C. Loignon, P. B. Schmidt, M. L. Loughry, and M. W. Ohland. 2015. "Justifying Aggregation with Consensus-Based Constructs: A Review and Examination or Cutoff Values for Common Aggregation Indices." *Organizational Research Methods* 18 (4): 704–737. doi:10.1177/1094428115582090.

Wong, H. K., and R. T. Wong. 2005. *The First Days of School: How to Be an Effective Teacher*. Mountain View, CA: H. K. Wong Publications.

Wurdinger, S. D. 2005. *Using Experiential Learning in the Classroom*. Lanham: Scarecrow Education.