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Influence of the natural setting on environmental education outcomes

Ryan G. Dale[a], Robert B. Powell[b], Marc J. Stern[c] and Barry A. Garst[a]

[a]Department of Parks, Recreation and Tourism Management, Clemson University, Clemson, SC, USA; [b]Department of Parks, Recreation and Tourism Management, Department of Forestry and Environmental Conservation, Clemson University Clemson, SC, USA; [c]Department of Forest Resources and Environmental Conservation, Virginia Polytechnic Institute and State University Clemson, SC, USA

ABSTRACT

Environmental education (EE) typically occurs in natural settings, which research suggests may enhance learning outcomes. Although field trips are commonly used to teach EE, few studies have isolated the influence of different setting characteristics for enhancing participant outcomes during an EE field trip. According to the literature, certain attributes of the natural setting, including novelty, beauty, and naturalness, as well as how the setting is used such as through place-based education, immersion, and time spent inside vs. outside, are thought to positively impact people's experiences with nature. In this study, we collected data from 334 EE field trip programs for 5-8th grade students to investigate the influence of these natural setting characteristics on positive learning outcomes. Results suggest that the naturalness and novelty of the setting, the use of place-based education, and spending more time outside vs. inside all positively correlated with more positive student outcomes. The implications of the results for environmental educators are discussed.

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Introduction

Does direct exposure to nature during an environmental education (EE) program enhance learning outcomes? Research suggests it does, but what are the specific qualities of the setting that enhance students' learning outcomes? Researchers and advocates argue that exposure to nature and natural features enhances cognitive functioning, increases self-discipline, promotes imagination and creativity, and enhances social relationships (Kuo, Barnes, and Jordan 2019; Becker et al. 2017; Kahn and Kellert 2002; Maller 2009; Wells 2000; Wells and Evans 2003; Williams et al. 2018). Researchers also argue that childhood, and in particular middle childhood (age 9-12), is an important period in which exposure to nature improves cognitive and moral development (Dewey 1899; Kellert 2002; Kohlburg 1979; Krathwohl, Bloom, and Masia 1956; Piaget 1953; Wells 2000; Wells and Evans 2003). One mechanism for exposing children to nature is through environmental education (EE).

Research has generally indicated that cognitive, social, emotional, and behavioral benefits are associated with environmental education (Ardoin, Biedenweg, and O'Connor 2015; Stern, Powell, and Hill 2014). However, little research has isolated the specific attributes and uses of the natural

CONTACT Robert B. Powell rbp@clemson.edu Department of Parks, Recreation and Tourism Management, Department of Forestry and Environmental Conservation, Clemson University Clemson, SC, USA

setting and their influence on positive learning outcomes. We investigated 334 EE field trip programs for middle-school-aged students (grades 5-8) in the United States to explore how specific attributes of the natural setting, including levels of naturalness, novelty, and beauty as well as the degree of interaction with the setting, measured by the use of place-based educational techniques, the degree of immersion in the natural environment and proportion of time spent inside versus outside, influence positive learning outcomes.

Literature review

Environmental education

EE is a process of imparting knowledge and awareness about the environment and its associated challenges, developing skills and expertise to address these challenges, and fostering positive attitudes and motivations to make informed decisions and take actions to solve these challenges (Ardoin, Biedenweg, and O'Connor 2015; Emmons 1997; Mcbeth et al. 2010; Stern, Powell, and Hill 2014; UNESCO. 1977). EE programs designed for youth also seek to enhance place connection (Ardoin 2006; Gruenewald 2003; Vaske and Kobrin 2001), improve positive youth development (Bowers et al. 2010; Garst, Browne, and Bialeschki 2011; Lerner et al., 2005), and meet educational standards (e.g. Powell et al. 2011). However EE programs can vary in their programmatic content, pedagogical approaches, and degree and qualities of contact with nature (e.g., Storksdieck 2006; Stern, Powell, and Hill 2014). Therefore, EE programs provide an ideal opportunity to investigate the influence of different characteristics of the setting and the degree of contact with nature on student's positive learning outcomes.

Children and nature

According to Dewey's (1899) philosophy of education, the theory of cognitive development (Piaget 1953), the taxonomy of affective maturation (Krathwohl, Bloom, and Masia 1956), and the theory of moral development (Kohlburg 1979), middle-childhood is a particularly important developmental stage to establish a positive relationship with nature and develop higher level cognitive abilities (Maller 2009; Wells and Evans 2003; Kahn and Kellert 2002). Studies have suggested that children learn best through sensory experiences provided by direct hands-on interaction and immersion in the environment (Boss 1998; Bredekamp and Copple 2006; Kahn 1997; Kahn and Kellert 2002; White and Stoecklin 2008), and that exposure to nature enhances prosocial value orientations (Weinstein, Przybylski, and Ryan 2009), enhanced cognitive performance and attention capacity (Hartig, Mang, and Evans 1991; Wells 2000), and increased enthusiasm and positive affect (Ryan et al. 2010). However, in the United States, the average child spends 90% of their time indoors (Kellert 2015) and 8-12 year-olds spend approximately 3 h in front of screens daily (Twenge and Campbell 2018; Kellert et al. 2017). Many have theorized about the negative effects of this disconnection from nature (e.g. Louv 2008; Williams 2017; Kellert 2005). Theories rooted in evolutionary and environmental psychology suggest that increased interactions with natural settings are beneficial (e.g.Kaplan and Kaplan 1989; Kellert and Wilson 1993; McCormick 2017; Wilson 1984) and that particular natural characteristics of the learning setting may enhance outcomes (e.g.Kaplan, Kaplan, and Ryan 1998; Kuo, Barnes, and Jordan 2019; Ryan et al. 2010). While emerging empirical evidence supports these theories (e.g. Kuo, Barnes, and Jordan 2019; McCormick 2017), attention to the relationships between the specific attributes of natural settings and positive learning outcomes in EE program research is lacking (Maller 2009; Wells and Evans 2003).

Characteristics of the natural setting

Research suggests that natural settings enhance mental and physical well-being (Herzog et al. 1997; Kaplan and Talbot 1983; Kuo, Barnes, and Jordan 2019; Plante et al. 2006; Ryan et al. 2010; Tarrant 1996). These studies and others have also begun to identify attributes of the natural landscape that people prefer and that enhance positive benefits to humans, which include naturalness, novelty, and beauty.

Naturalness

Naturalness refers to the degree to which a setting is perceived to be in its natural state, contains natural features such as vegetation, as well as the absence of human disturbance and features (e.g.Tveit, Ode, and Fry 2006). Landscape preference research suggests people prefer more natural environments over more man-made settings (Han 2010; Smardon 1988; Ulrich 1981, 1983). Similarly, prior research investigating the relationship between naturalness and educational outcomes suggests that locations with natural features support learning (Born et al. 2001; Kuo, Barnes, and Jordan 2019; Wells 2000; Wells and Evans 2003).

Novelty

Novelty is the contrast between what has been previously experienced and a new experience (Bevins, Klebaur, and Bardo 1997; Jenkins 1969; Pearson 1970) or as something new, unique, or unfamiliar (Garst, Williams, and Roggenbuck 2009). While Falk, Martin, and Balling (1978) postulated that too much novelty in field trip experiences may distract students from learning, research has shown that novel experiences can inspire curiosity, learning, and collaborative and collective action (DeWitt and Storksdieck 2008; de Waal 2008; Keltner et al. 2014; Orion 1989; Sober and Wilson 1998). When appropriately planned for, novelty in natural environments can support personal restoration, and can reduce stress and anxiety through the action of getting away from the familiar (Berman and Davis-Berman 1995; Garst, Browne, and Bialeschki 2011). Additionally, novelty of the setting can help youth develop new perspectives while also developing appreciation for the natural environment (Orion and Hofstein 1994). For example, in a study of outdoor adventure programs and their influence on youth, novelty was found to be a prominent component, both during and after the experience, and a major driver for change among the youth who participated (Garst, Scheider, and Baker 2001). According to the theory of transformative learning, highly novel contexts provide contrast between what a learner thinks they know and what they are experiencing. This disorienting dilemma sets the stage for guided reflection, which may lead to long-term cognitive, emotional, and personal change (e.g.Mezirow 1997; Soulard, McGehee, and Stern 2019).

Beauty

The link between beauty of a natural setting and a range of psychological outcomes has interested scholars for decades (Kaplan, Kaplan, and Ryan 1998). Beauty of nature may enhance creativity and imagination (Holton 1988), awareness of balance, symmetry, harmony and grace (e.g.Kellert, 2008), motivation to participate in science (Chandrasekhar 1987), and connection to place (Gruenewald 2008).

Historically, two paradigms dominate the discussion of beauty in nature: the objective paradigm, in which certain attributes/characteristics of a setting are universally perceived as beautiful, and the subjective paradigm, in which beauty is in the eye of the beholder (Arthur, Daniel, and Boster 1977; Lothian 1999). Research pertaining to landscape preference (e.g.Kaplan, Kaplan, and Ryan 1998; Kellert 2005) as well as contemporary environmental psychology has favored the former – that the aesthetic beauty of a location can be objectively assessed irrespective of cultural

and social influences (Di Dio, Macaluso, and Rizzolatti 2007; Kaplan, Kaplan, and Ryan 1998; Kellert 2005). In empirical research, attempts have been made to assess and quantify beauty by using setting attributes such as openness, complexity, mystery, and the presence of water features such as waterfalls (e.g.Daniel & Boster, 1976; Han 2010; Ribe 2009), as well as through qualitative assessments (e.g.Powell et al. 2012, 2016).

Uses of the natural setting

While attributes of the setting may influence learning outcomes in EE, how the setting is utilized in the program also appears theoretically important. Therefore we examine programmatic attributes including place-based learning, level of immersion, and time spent outside vs. inside.

Place-based learning

As a response to evidence suggesting that children are disconnected from both their physical and social environment, educators have developed place-based approaches to education that can be both multi-disciplinary and multi-functional (Gruenewald 2003; Lerner et al., 2005; Smith and Sobel 2010; Sobel 1995; Woodhouse and Knapp 2000). Place-based education is grounded in constructivist and experiential approaches and strives to utilize the local heritage, culture and landscape as a context for education (i.e.place as pedagogy) (Sobel 1995; Orr 1993). Though not limited to a particular pedagogical approach, place-based EE generally utilizes hands-on, issue-based, and experiential techniques, to link characteristics and elements of the local environment to the lives of students to develop skills, understanding, and attitudes aimed towards sustaining local communities (Ardoin 2006; Stedman 2003; Gruenewald 2003).

Immersion

Research investigating the effects of nature on human health and development has been inconsistent in terms of how scholars have defined nature and what level of contact, or immersion, with nature is necessary to reap potential benefits. For instance, Kellert (2002, 2005) describes three different types of contact with nature; direct, indirect, and vicarious. Direct contact refers to physical interaction with natural landscapes and features (vegetation, wildlife, soil, etc.); indirect contact refers to passive interaction such as viewing nature from a window; and vicarious contact utilizes representations of nature, such as art. All three types of contact with nature are associated with positive benefits, although direct contact is assumed to deliver greater benefits. In the context of EE, this study focused on direct immersive contact with nature versus more passive interactions, which is assumed to enhance outcomes such as environmental literacy, positive youth development, place connection, and environmental stewardship (Rickinson 2001; Stern, Powell, and Hill 2014).

Time spent inside vs. outside

In addition to the quality of the interaction with nature, it is generally assumed that increased duration of exposure leads to more positive outcomes (Stern, Powell, and Ardoin 2008). In studies of positive youth development, it has been claimed that sufficient nature exposure is necessary for benefits to be fully realized (Garst 2018). Additionally, duration of a nature experience has been shown to be a positive predictor of increased learning in informal educational nature-based settings (e.g.Powell, Kellert, and Ham 2009). However, results from a systematic review of research on EE suggests that the relationship between time inside vs. outside and positive outcomes is more complicated with many studies reporting mixed results from entirely indoor and

entirely outdoor programs (see Stern, Powell, and Hill 2014). Therefore, this study further examines the influence of time spent inside versus outside on positive learning outcomes in EE.

Methods

This study examines linkages between attributes of program settings, interactions with those settings, and positive learning outcomes for middle school aged students (grades 5-8; ages 9-12) attending single day EE field trips. This data collection was a part of a larger EE study designed

Table 1. State rankings for environmental education/literacy plan implementation (Ruggiero 2016).

State Ranking	# providers (by state)	State	Score (out of 1.0)	Groupings	# providers (by quartile)
1	4	Oregon	0.9875		
2	1	District of Columbia	0.825		
3	0	Kansas	0.8		
4	2	Illinois	0.75		
5	3	Colorado	0.7375	**Above 0.6**	
6	6	Washington	0.7125	Most up to date	18
6	0	Tennessee	0.7125	with formal EE	
7	1	Connecticut	0.7	requirements.	
7	0	Kentucky	0.7		
8	0	Hawaii	0.6625		
9	0	North Carolina	0.6375		
10	1	New Hampshire	0.625		
11	0	Rhode Island	0.6125		
12	2	Wisconsin	0.6		
13	0	Alaska	0.5625		
14	0	Alabama	0.525	**0.4125-0.6**	
15	3	Pennsylvania	0.5125	High levels of	
16	3	Ohio	0.5	progress on	
16	0	Nevada	0.5	ELPs, room to	39
16	0	New Mexico	0.5	develop.	
17	14	Florida	0.475		
17	0	Iowa	0.475		
18	3	Maine	0.4625		
19	14	California	0.4375		
20	0	Louisiana	0.4125		
21	7	Texas	0.4		
22	1	Nebraska	0.375		
23	2	New York	0.3375		
24	0	Missouri	0.3	**0.1-0.4**	
24	0	South Dakota	0.3	Low to minimal	
25	0	Idaho	0.2875	progress on	19
25	2	Michigan	0.2875	formal EE	
26	0	Vermont	0.25	requirements.	
27	0	New Jersey	0.2375		
28	3	Virginia	0.15		
29	0	Oklahoma	0.1375		
30	2	Indiana	0.1125		
31	2	Maryland	0.1		
32	0	Arkansas	0.05		
32	0	Delaware	0.05		
32	2	Georgia	0.05		
32	4	Massachusetts	0.05	**0-0.05**	
32	1	Minnesota	0.05	minimal to no	
32	0	Mississippi	0.05	ELPs or	14
32	0	South Carolina	0.05	formal EE plan	
32	0	Utah	0.05	progress.	
32	0	West Virginia	0.05		
32	0	Wyoming	0.05		
33	7	Arizona	0		
33	0	Montana	0		
33	0	North Dakota	0		

Table 2. Environmental education outcomes for the 21st Century (EE21) (Powell et al. 2019).

Outcome	Definition	Items
Place connection	The development of appreciation for and positive personal relationships with the physical location and its story.	How much do you agree with the following statements? (anchors: not at all, some, totally) • Knowing this place exists makes me feel good. • I want to visit this place again. • I care about this place.
Learning	Knowledge regarding the interconnectedness and interdependence between human and environmental systems	How much did you learn about each of the following things as a result of . . .? (anchors: nothing at all, a fair amount, a huge amount) • How different parts of the environment interact with each other. • How people can change the environment. • How changes in the environment can impact my life. • How my actions affect the environment.
Interest in Learning	Enhanced curiosity, increased interest in learning about science and the environment.	Did this . . . make you feel any more interested in any of the following things? (anchors: not at all, more interested much more interested) • Science. • How to research things I am curious about. • Learning about new subjects in school.
21st Century Skills	Critical thinking and problem solving, communication, and collaboration	How much did this . . . help you improve any of these skills? (anchors: not at all, a fair amount, a huge amount) Solving problems. • Using science to answer a question. • Listening to other people's points of view. • Knowing how to do research.
Meaning/Identity	A heightened sense of self-awareness, critical reflection, and purpose.	Did this . . . do any of the following things for you? (anchors: not at all, a fair amount, a huge amount) • Taught me something **that will be useful to me** in my future. • Really made me think. • Made me realize something I never imagined before. • Made me think differently about the choices I make in my life. • Made me curious about something.
Self-Efficacy	Belief in one's own ability to achieve one's goals and influence their environment.	Retrospective pre/post items (anchors: not at all, somewhat agree(d), strongly agree(d): • I believe in myself • I feel confident I can achieve my goals • I can make a difference in my community.
Environmental Attitudes	Sensitivity, concern, and positive dispositions towards the environment	Retrospective pre/post items (anchors: not at all, somewhat agree(d), strongly agree(d):: • I feel it is important to take good care of the environment • Humans are a part of nature, not separate from it. • I have the power to protect the environment.
Actions: Environmental Stewardship	Motivations to perform stewardship-related behaviors.	Did this . . . make you any more likely to do any of the following things within the next year? (anchors: no more likely, somewhat more likely, way more likely) • Help to protect the environment. • Spend more time outside. • Make a positive difference in my community.
Actions: Cooperation/ Collaboration	Motivation to collaborate more with others	Did this . . . make you any more likely to do any of the following things within the next year? (anchors: no more likely, somewhat more likely, way more likely) • Listen more to other people's points of view. • Cooperate more with my classmates.
Actions: School	Motivation to work harder in school.	Did this . . . make you any more likely to do any of the following things within the next year? (anchors: no more likely, somewhat more likely, way more likely) • Work harder in school. • Pay more attention in class.

to examine EE field trip programs (unit of analysis) and the linkages between a range of pedagogical approaches and positive student learning outcomes, involving the observation of over 70 programmatic characteristics at 345 EE field trip programs across the United States.

Selection of sites

Program providers included national parks, state and local parks, nature centers, botanical gardens, wildlife reserves, farms, public forests, science museums, and other environmental organizations. Working with the North American Association of Environmental Education (NAAEE), the National Park Service (NPS), and the Association of Nature Center Administrators (ANCA), we identified a broad range of organizations that offered single-day EE focused field trip programs for students in grades 5-8 across the United States. To narrow our selection of field trip programs for the study, we relied on Ruggiero's (2016) evaluation of Environmental Literacy Plans in the US, which ranked states in terms of the status and quality of their statewide Environmental Literacy Plans, as a proxy for the general status of EE in each state. We divided the states into quartiles based on this evaluation and then systematically sought to sample at least 10 program providers from states in each quartile to ensure a diversity of programs (Table 1).

We identified over 300 potential program providers across all four quartiles, using the following criteria: programs were field trips taking place away from the school, programs focused on EE lasting a single day or less in duration serving grades 5-8; program providers expressed a willingness to participate, and program providers ran multiple programs during the period of research (i.e.January-June 2018). We also sought to maximize diversity in terms of both program types and socioeconomic context. Ultimately, we observed 345 programs provided by 90 unique organizations: 18 providers from the first quartile, 39 providers from the second quartile, 19 providers from the third quartile, and 14 providers from the fourth quartile.

Measurement

Student outcomes

One of the biggest challenges facing EE research is developing meaningful outcomes that are valid, reliable, and sensitive (ie.vary depending upon the quality of the program) that apply across a range of program types (NRC, 2009; Fenichel and Schweingruber 2010). Such measures are necessary to conduct a large-scale comparative study to isolate which programmatic characteristics and practices are associated with better student outcomes. The process we undertook for developing a survey to measure cross-cutting EE outcomes for this study included 1) reviewing the literature, 2) involving a wide range of academics, organizational leaders, stakeholders, and program providers in a series of workshops to identify, define and refine crosscutting outcomes applicable to a range of EE programs; 3) operationalizing the outcomes following recommended scale development procedures (e.g.DeVellis, 2003), which included iterative stakeholder review to ensure external validity; and 4) conducting 6 pilot studies in a range of EE settings across the US to refine and cross-validate the scales using confirmatory factor analyses and multi-group invariance testing procedures so that the outcomes were cross-tested for reliability and validity (see Powell et al. 2019 for full description of development process). This work identified and developed 10 crosscutting outcome scales, including Place Attachment, Learning, Interest in Learning, 21st Century Skills, Self-Identity, Self-Efficacy, Environmental Attitudes, Environmental Behaviors, Cooperation/Collaboration Behaviors, and School Behaviors in which all items were scored on a scale of 0-10 (Table 2). Eight of the scales were measured using retrospective post-only questions in which students reported the extent of change attributed to the program. Self-Efficacy and Environmental Attitudes were measured using retrospective pre/post questions asking students to reflect on how they felt about given statements before the

program, and then after as a result of the experience. The mean scores for these items represent the difference between pre and post scores. The outcome measure, EE21, used in this study, is a single composite measure representing the mean of each subscale presented in Table 2, equally weighted. Results from previous CFA procedures supported the use of a composite EE21 variable (see Powell et al. 2019). Following extensive cleaning of the student survey data, individual survey responses were aggregated to the program (group) level to represent the mean EE21 outcome score for each program, encompassing all constructs in Table 2, equally weighted. ICC (1) and ICC (2) values were 0.21 and 0.78, respectively, justifying the aggregation of individual

Table 3. Natural setting variables.

Variable	Definition	Operationalization			
Attributes					
Naturalness (as experienced/ perceived by the students)	Degree to which the program takes place in a manmade vs. wild setting	1 Setting is completely manmade/ built	2 Setting is mostly manmade with some components of a natural environment	3 Setting is mostly natural with some manmade components	4 Setting is wilderness-like, almost entirely.
Novelty of setting	Degree to which the setting is unique or special for the audience. In these situations, the students reflect the setting is unexpected/ unfamiliar and they are more focused on environment.	1 Completely familiar or mundane setting to the students	2 Some minor uniqueness or quality that appears to be out of the ordinary to the students	3 A mostly novel setting that appears to be out of the ordinary for the students.	4 Students' reactions make it obvious that the setting stands out as special (excitement, selfies, exclamations, etc.)
Beauty of the non-built environment N/A if entirely indoors	Degree to which the setting is aesthetically pleasing. At the extreme positive end these are amazing, of overwhelming attraction, or mesmerizing that create a "wow" effect in students.	1 Nothing at all desirable in the appearance of the settings or entirely indoors.	2 Somewhat pleasing setting	3 Clearly visually appealing setting	4 Setting is absolutely beautiful, awe-inspiring, breathtaking
Utilization of Setting					
Place-Based	Degree to which the program emphasized and utilized the unique attributes of the place/resource in the lesson.	1 Place-based was nearly irrelevant	2 Minor verbal connections were made to the activities	3 Moderate efforts to connect the lesson to place	4 The connection to place was well developed through repetition and engagement
Immersion	Degree to which students are immersed in the natural environment (muddy, wet, digging in the dirt, etc.)	1 Not at all	2 Mostly at arm's length. Maybe touching something here or there.	3 Students are fully immersed for part of the program.	4 Fully immersed for most of the program.
Inside vs. Outside	Proportion of time spent inside vs. outside	1 Entirely inside	2 Mostly inside	3 Mostly outside	4 Entirely outside

student surveys (EE21) to the group level (Woehr et al. 2015). These data served as the dependent variable.

Setting characteristics and interaction

Based on past research (e.g. Powell and Stern 2013; Stern and Powell 2013) and literature review (Stern, Powell, and Hill 2014), we developed a list of variables pertaining to the setting in which EE field trips might take place. These variables were intended to measure the type and degree of students' interactions with the setting, as well as the characteristics of the setting itself (Table 3), and were measured through observation by members of the research team at each program in the sample.

Pilot testing. We developed and refined all observational techniques and data collection procedures through extensive pilot testing. We first observed 81 lessons provided by 17 different educators at the NorthBay Adventure Education Center in Maryland to establish initial procedures (Frensley, Stern, & Powell, 2020). Following revisions based on the first pilot study, the entire research team observed an additional 17 field trip programs. During these pilot studies, members of the research team scored each program as individuals and then compared and discussed at length any discrepancies in scoring and clarified the operational definitions and/or measurement of each programmatic element under consideration. We used this process to develop consistent, reliable, and valid scoring of all observations across the eight field researchers.

Data collection. Four pairs of researchers visited and collected data at 345 EE field trip programs for 5th to 8th graders between January and June 2018. During each program, the researchers systematically monitored the extent and quality of program characteristics, including attributes and uses of the natural setting using quantitative scoring on a predesigned observation sheet. Immediately following each program, all attending students in grades 5-8 were invited to complete the EE21 survey regarding their opinions of the program and its influence on them (Table 2). For all programs, we attempted a census of all eligible attendees. No time limit was given for the students to complete the survey. The average completion time was around 8 min. Overall, 5,317 surveys were collected from participants from 345 programs, and the average response rate was 81%. All researchers also recorded narrative descriptions and specific notes on the settings of each program.

To ensure reliability and consistency in scoring of observational variables, pairs of researchers observed programs together and completed scoring independently for the first two weeks of data collection. This enabled each team to compare scoring and reach consensus on the measure of each programmatic characteristic. After roughly two weeks for each pair, discrepancies in scoring were rare and researchers then began to observe programs individually. Throughout the 22-week field season, researchers periodically attended programs together to continue to ensure reliability and consistency in scoring each variable. Team members also met weekly to discuss any questions about scoring of certain variables. At three points over the course of the study, separate pairs were purposefully intermingled to observe programs together to further enhance the reliability of observation measures.

Data cleaning procedures

Data from the 345 programs were entered into Microsoft Excel and then transferred to SPSS for screening and analysis. First, we dropped three programs (26 surveys) because student response rates were below 50%. We then screened surveys for missing values and removed 210 surveys that were missing more than 25% of the items. With these removals, one additional program dropped below a 50% response rate. It was removed entirely (8 additional surveys). We also

Table 4. Data cleaning procedures.

STEP	Changed/removed	Programs remaining	Respondents remaining
Starting point	N/A	345	5,317
Removed all programs for which we did not achieve at least a 50% response rate	3 programs	342	5,291
Removed all individual surveys with more than 25% of data missing	218 surveys; 1 program	341	5,073
Removed all obvious patterns or invalid surveys – for example, no variability in more than half of the responses (e.g., all 10s), strings of consecutive numbers in responses, one circle around all numbers.	101 surveys; 1 program	340	4,972
Removed multivariate outliers using Mahalanobis Distance.	596 surveys; 6 programs	334	4,376

screened for obvious patterns indicating invalid responses, such as no variability in answers, strings of consecutive numbers, or using one circle to indicate responses for multiple items. We identified and removed 94 surveys with these problems. One additional program dropped below 50% response rate following these removals. It was removed from the database along with 7 additional surveys. Data were then screened for multivariate outliers using Mahalanobis Distance (MAH). A total of 563 cases were removed for exceeding the criterion Mahalanobis Distance value. Six more programs dropped below 50% response rate and as a result and were removed from the database (dropping an additional 33 surveys). Our final resulting sample was 4,376 individual surveys from 334 programs provided by 90 organizations in 24 states and Washington, DC (Table 4).

Structural equation modeling

As part of our analyses, we used confirmatory factor analysis (CFA), a form of Structural Equation Modeling (SEM), to confirm the structure and measurement of EE21 and structural regression modeling to examine the influence of characteristics and use of the setting on EE21. We used SEM for this analysis because it is confirmatory (as opposed to exploratory) in nature and requires the researcher to have an explicit hypothesized model; it can model measurement error, which reduces inaccuracies; it allows for the analysis of a complete multivariate model including direct and indirect effects; and, it can simultaneously assess causal relationships between independent variables and a dependent variable (Byrne, 2006; Kline 2005). We report the Satorra-Bentler Scaled Chi-Square (S-B x2), Robust Comparative Fit Index (CFI), Standardized Root Mean Square Residual (SRMR), the Robust Root Mean Square Error of Approximation (RMSEA) and its associated 90% confidence interval to evaluate model "fit" (Bentler and Yuan 1999; Byrne 2006). We also report the Beta weights, which in structural regression models reflect the effect size of an independent variable on the dependent variable. R^2 values gauge the predictive validity of the structural model, explaining the proportion of the total observed variance in the dependent variable explained by the model. It is recommended to assess R^2 values independently of fit indices, as the latter do not pertain to predictive validity (Kline 2005).

Results

Program descriptions

All descriptive statistics reported are calculated from the 334 programs validated by data cleaning procedures. The 334 programs were provided to diverse audiences across the country: 46% of programs served majority White students; 32% serviced majority LatinX; 8% were for majority Black students; and 14% of programs served a multi-racial group of students with no clear racial

Table 5. Natural setting descriptive statistics.

			Frequencies %, (n)			
Variable	N	Mean (SD)	(1)	(2)	(3)	(4)
Naturalness	334	2.64 (.73)	6% (20)	33.5% (112)	51.2% (171)	9.3% (31)
Novelty	334	2.50 (.71)	3.6% (12)	51.5% (172)	36.2% (121)	8.7% (29)
Beauty	319	2.63 (.68)	1.9% (6)	42.4% (137)	46.4% (150)	9.3% (30)
Place-based	334	2.59 (.87)	9.3% (31)	38.6% (129)	35.9% (120)	16.2% (54)
Immersion	334	2.23 (.77)	13.2% (44)	58.1% (194)	21.3% (71)	7.5% (25)
Outdoors	334	3.25 (.80)	3.3% (11)	12.6% (42)	39.8% (133)	44.3% (148)

majority. The sample was also comprised of diverse age groups: 39% of programs serviced fifth grade participants; 29% of programs supported sixth grade students; 18% were for seventh grade; 5% of programs were for eighth grade. The remaining 8% were comprised of mixed grades. The mean program duration was 190.8 min, with a standard deviation of 77.2 min. The mean group size was 15.8 with a standard deviation of 7.3.

Descriptive statistics: Independent variables

Naturalness, novelty, beauty, and place-based techniques reflect approximately normal distributions (Table 5). Sixty percent of programs occurred in moderately or extensively natural locations. However, this does not mean that they occurred in rural or wilderness areas, as many programs occurred in suburban and urban areas at locations such as nature-centers, botanical gardens, or parks. A little over half of programs used a moderate or extensive amount of place-based techniques. Seventy-one percent of programs were either not at all or only slightly immersive. Eighty four percent of programs occurred mostly or entirely outside.

Descriptive and confirmatory factor analysis results: EE21

Table 6 displays the means, standard deviations and factor loadings for each item that composes EE21 as well as the grand mean and standard deviation for the scale. Fit indices for the confirmatory factor analysis to confirm the structure and measurement of EE21 (S-Bx2 = 2732.0996, 496DF, CFI = 0.973, SRMR = 0.027, RMSEA = 0.036 (.034, .037)) indicated that the EE21 scale was an excellent fit of the data and cross-validated the structure and measurement from previous research (see Powell, et al 2019). For this analysis, we developed a composite score for the overall EE21 measure, with each subscale equally weighted and aggregated to the group (program) level (mean of all students attending a program).

Do characteristics and use of the setting correlate with positive learning outcomes?

Table 7 displays the correlations between EE21 and the characteristics of the setting variables. Examination of the distribution and relationship between each variable and EE21 revealed that the time spent inside vs. outside variable displayed a nonlinear relationship with EE21. A specific cut point was observed and confirmed through one-way ANOVA with post hoc analyses and independent samples t-test (Table 8). The variable was thus recoded into a dichotomous variable that best reflected the data and the relationship with EE21 and was scored 1= Mostly indoors (previously scored 1 and 2) and 2 = mostly outdoors (previously scored 3 and 4).

Qualitative results

Using the results of Table 7, we describe the attributes of the natural setting that were significantly correlated with more positive outcomes using examples from field notes (Table 9).

Table 6. EE21 Means, standard deviations, and CFA factor loadings of items.

Constructs and Items ($n = 4376$)	M	SD	CFA Factor Loadings
Connection/Place attachment			
Knowing this place exists makes me feel good.	7.38	3.07	.799
I want to visit this place again.	7.41	2.88	.896
I care about this place.	7.81	2.77	.863
Learning			
How different parts of the environment interact with each other.	6.93	2.43	.766
How people can change the environment.	7.33	2.68	.813
How changes in the environment can impact my life.	7.41	2.67	.830
How my actions affect the environment.	7.73	2.65	.799
Interest in Learning			
Science.	6.33	3.20	.788
How to research things I am curious about.	6.36	3.07	.878
Learning about new subjects in school.	6.04	3.24	.844
21st Century Skills			
Solving problems.	5.56	3.18	.857
Using science to answer a question.	6.15	3.07	.852
Listening to other people's points of view.	6.56	3.10	.851
Knowing how to do research	6.26	3.29	.834
Meaning/Self Identity			
Taught me something **that will be useful to me** in my future.	6.63	3.07	.827
Really made me think.	6.67	3.12	.868
Made me realize something I never imagined before.	6.38	3.24	.840
Made me think differently about the choices I make in my life.	6.53	3.27	.817
Made me curious about something.	6.63	3.07	.840
*Self-Efficacy (Retrospective pre-post)			
I believe in myself.	0.83	1.75	.578
I feel confident I can achieve my goals	0.78	1.59	.704
I can make a difference in my community.	1.12	1.77	.710
*Environmental Attitudes (Retrospective pre-post)			
I feel it is important to take good care of the environment.	0.78	1.47	.577
Humans are a part of nature, not separate from it.	0.97	1.73	.622
I have the power to protect the environment.	1.17	1.85	.723
Actions: Environmental Stewardship			
Help to protect the environment.	7.34	2.81	.866
Spend more time outside.	7.12	3.03	.778
Make a positive difference in my community.	7.06	2.83	.920
Actions: Cooperation/Collaboration			
Listen more to other people's points of view.	6.80	2.99	.883
Cooperate more with my classmates.	6.79	3.08	.860
Actions: School			
Work harder in school.	7.08	3.26	.949
Pay more attention in class.	7.04	3.33	.913
EE21 Composite	5.01	1.77	Cronbach's Alpha=.964

Table 7. Correlation matrix.

	1	2	3	4	5	6	7
1. EE21	–						
2. Naturalness	.234**	–					
3. Novelty	.280**	.456**	–				
4. Beauty	.098	.592**	.542**	–			
5. Place-based	.202**	.346**	.449**	.205**	–		
6. Immersion	.043	.537**	.324**	.347**	.236**	–	
7. Inside/Outside	.156*	.704**	.325**	.371**	.218**	.447**	–

*Correlation is significant at the .05 level (2-tailed).
**Correlation is significant at .01 level (2-tailed).

Modeling the relationship between setting and EE21

We used Structural Equation Modeling (SEM) to create a regression model to investigate the influence of the natural setting on positive learning outcomes. Initially, all of the independent

Table 8. EE21 Means comparison of time Mostly Inside vs. Mostly Outside.

Variable	Mostly Inside (1–2) ($n = 53$)	Mostly Outside (3–4) ($n = 281$)	t	df	p
EE 21 M(SD)	1.84 (.36)	5.29 (.99)	−4.182	332	<.001

Table 9. Examples of significantly correlated attributes of natural setting.

Variables	Examples
Naturalness: Degree to which the program takes place in a manmade vs. wild setting	HIGH: The entire day was spent in a 70 years old coniferous forest. The trail we traveled on was almost entirely snow covered. At one point, the group crossed a small creek over a bridge made of downed trees, which was the only man-made feature on the trail. Eventually the students reached the old growth forest, made up mostly of large pines and cedars. The students also spent time in a creek bed to explore changes caused by different land uses.
	HIGH: The program involved a 2-mile paddle down the XXXX River, which took a couple of hours. The landscape was a virtual wilderness; there were no sounds or roads, and few signs of humanity.
	LOW: The program occurred in a modern building complex. One activity was entirely indoors, while two others occurred outside the buildings under an awning.
	LOW: The program site was next to a major road. There was a large power line over most of the site and the powerline clearing dominated the landscape. Because there was little vegetation, the views were of suburban neighborhoods and nearby strip malls. While the environment was highly disturbed, no effort was made to discuss invasive species, the impacts of ecosystem disturbance and how this may influence the species present at the site.
Novelty of setting: Degree to which the setting is unique or special for the audience. In these situations, the students reflect the setting is unexpected/unfamiliar and they are more focused on environment	HIGH: The students were at high elevation and walking in snowshoes, which most of the students hadn't done before. The views were expansive and most of the snow cover was pristine, with no tracks of other humans or wildlife, which seemed to contribute to the uniqueness of the environment and the experience.
	HIGH: The program took place in a densely forested cypress swamp in which students were wading for much of the day. The depth of the swamp varied but all of the students were wet to their waist. It appeared to be a new and unique setting for many of the participants as evidenced by the nervous laughter and sounds of excitement as the group explored the landscape.
	LOW: The setting was a large lawn surrounded by disturbed second or third growth forest. The site mirrored local backyards and the school-yard environment.
Place-Based: Degree to which the program emphasized and utilized the unique attributes of the place/ resource in the lesson.	HIGH: Each instructor focused on the local environment and used the resources that the space provided to teach about the local ecosystem and aspects of the city's water supply.
	HIGH: The program was focused on the history, ecology and geology of the local river and park setting. The educator started the day with a discussion of history of the site and also a brief lesson on ecosystems and communities, which was taught using the local wildlife as examples. As the students explored the site and observed the local wildlife and vegetation, the instructor focused on relating what was observed to the specific site.
	LOW: The program focused on performing experiments designed to meet curriculum standards. Water quality tests, dissolved oxygen tests, and wind speed tests were performed in a manner that could have taken place anywhere. The highly unique attributes of the locality were not discussed or made relevant.
Time Spent Inside vs. Outside:	HIGH: The program took place entirely in nature. All day they were surrounded by a natural habitat. They were physically engaged with the natural environment for around 3 hours. They waded through knee-deep swamp water, slogged through mud, and had every opportunity to see, feel, and hear nature around them.
	LOW: The entire program took place in the classroom. There was no focus on the natural setting. The students were the recipients of a lecture and just sat and received information and looked at three captive animals.

variables were tested as direct predictors of EE21, but the fit of the model was deemed unacceptable. We also tested a model to examine theories suggesting the importance of novelty (e.g.Garst 2018) to determine if novelty mediated the relationship between all other independent variables and EE21. We adjusted the model through an iterative process using diagnostics that indicated potential changes to this model that would improve fit and parsimony. The final result (Figure 1) is a "best fit" model that represents the most parsimonious and predictive model for

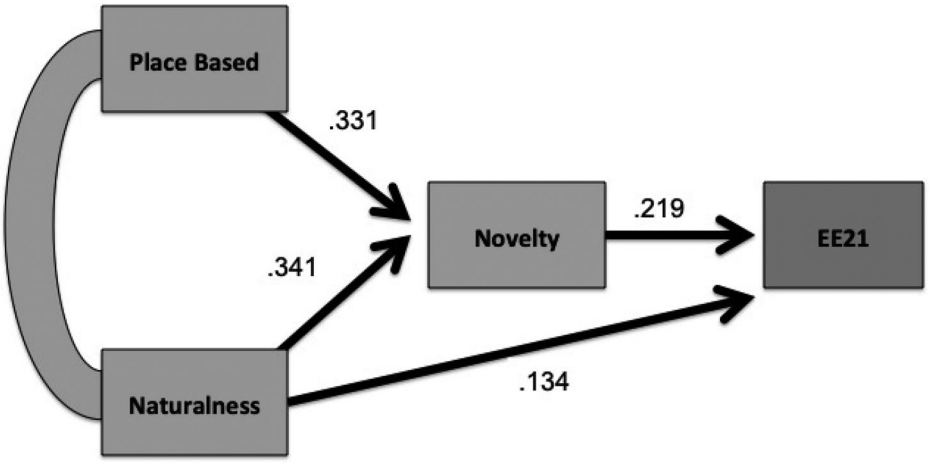

Figure 1. Final Model: Setting characteristics relationship with learning outcomes.

EE21 (SB ChSq = 1.337, 1-DF; CFI .998; SRMR=.018; RMSEA =.032 (.000; .153)). The variables *place-based* (β=.331, p <.05) and *naturalness* (β=.341, p <.05) were predictors of *novelty* and accounted for approximately 30% of its variance. *Place-based* was not a significant direct predictor of EE21. *Novelty* (β=.219, p <.05) and *naturalness* (β=.134, p <.05), however, were both direct predictors of EE21 and accounted for 9.3% of variance[1].

Discussion

This study examined environmental education field trip programs across the United States for middle-school aged children (grades 5-8) to determine the influence of the natural setting and its use on positive learning outcomes. Looking across a large sample of programs, our initial analysis looked at the bivariate relationships between the natural setting (i.e.naturalness, novelty, and beauty) and use of the setting (i.e.place-based, immersion, and time spent inside vs. outside) and positive outcomes measured by the EE21 scale. The naturalness of the site, the novelty of the experience/site, the use of place-based educational approaches, as well as the proportion of time spent outside were all positively and significantly related to EE21. These findings suggest that highlighting and using the unique attributes of the place and spending time outdoors in more natural settings can enhance positive learning outcomes. All natural setting variables were significantly correlated with each other, suggesting that when one was present, often the others were also typically present.

To further investigate the relationships between the characteristics and use of the setting and student learning outcomes, we used structural equation modeling. The resulting model revealed two lessons. First, place-based techniques and the naturalness of the site enhanced novelty, which had a significant relationship with positive learning outcomes. Second, programs that occurred in more natural settings exhibited more positive outcomes.

Certain limitations in the data and analyses are important to consider when interpreting these findings. First, structural equation modeling explicitly aims to produce the most parsimonious model for selected outcomes. As such, the model does not display variables that might explain similar variance in EE21. For example, naturalness, beauty, and proportion of time spent outside covaried, and therefore beauty and time outside vs. inside were dropped from the model. Additionally, the small amount of variance in EE21 explained by the aspects of the natural setting (9.3%) suggests that while high degrees of novelty and naturalness enhance learning outcomes, other program characteristics and pedagogical approaches are also important. As such,

our results help to illuminate the influence of only one part of environmental education programming—the setting.

Despite these limitations, the results suggest that outcomes are influenced by attributes of the setting and students' interactions with those attributes. The findings also suggest that these variables influence and interact with each other. For example, highlighting the unique attributes of place in a program and locating the program in more natural settings both enhance the novelty for the students, which relates to improved outcomes. This finding supports research suggesting novelty (i.e.unique, unusual, uncommon activities and settings) can be one of the most salient and influential parts of an outdoor experience for youth (Berman and Davis-Berman 1995; Garst, Scheider, and Baker 2001), especially when logistical preparation is used to set realistic expectations and thus enhance student comfort, potentially balancing the influence of overwhelming novelty (Jarvis and Pell 2005; Berlyne 1950; Lee, Stern, & Powell, in review; Falk, Martin, and Balling 1978; Orion 1989). In this work and other research, novelty of the setting has been shown to have a positive relationship with learning and supports the idea that novelty contributes to the formation of new ideas and new attitudes (Mezirow 1997; Woods and Moscardo 2003).

Spending a majority of the field trip experience outside versus inside was also correlated with positive learning outcomes. This finding supports evidence from previous research suggesting natural environments can enhance outcomes associated with EE21 including interest, attitudes, emotions, and learning (Kahn and Kellert 2002; Kaplan and Kaplan 1989; Kaplan, Kaplan, and Ryan 1998; Kellert 2005). However, the results also highlight that simply exposing youth (ages 9-11) to the outdoors will not necessarily produce transformative outcomes. Instead, results reinforce the importance of complementing outdoor and novel experiences with effective programming, implementation, and pedagogical approaches (Duerden and Witt 2012; Durlak and DuPre 2008; Morgan, Sibthorp, and Browne 2016). With this knowledge, we urge practitioners to highlight the unique attributes of place, enhance novelty, and spend most of a field trip outside and immersed in the natural environment, yet to do so within a program framework that fully integrates and implements effective pedagogical practices.

Disclosure statement

No potential conflict of interest was reported by the author(s).

Note

1. To account for the potential unequal weighting of specific subscales in the EE21 index, we also calculated a standardized EE21 index score using z scores from each subscale and reran all analyses presented in this paper. The results/significant pathways on all tests did not change. We also controlled for the influence of majority race of group and grade level by group mean centering EE21 data and the results/significant pathways also did not change.

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ORCID

Robert B. Powell http://orcid.org/0000-0003-2775-2571
Marc J. Stern http://orcid.org/0000-0002-0294-8941

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