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Do pre-visit preparation and post-visit activities improve student outcomes on field trips?

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ABSTRACT

Studies of individual environmental education (EE) field trip programs have found that pre-visit preparation and post-visit follow-up activities can enhance desired student outcomes. We examined these relationships across a broad sample of single-day EE field trip programs for adolescent youth (grades 5-8) across the United States. We measured student outcomes, reflecting environmental literacy, 21st century skills, positive youth development, and student learning, through end-of-visit retrospective student surveys and follow-up surveys with visiting teachers two weeks after the field trip. Pre-visit logistical preparation as well as both pre-visit preparation and post-visit follow-up related to the subject matter were each associated with more positive student outcomes. The study provides further evidence across a large sample of programs that pre-visit preparation and post-visit follow-up can have meaningful impacts on student outcomes for EE field trips. We discuss the implications of the findings and provide examples and guidance for future programming efforts.

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Introduction

Out-of-school field trips with nonformal environmental education (EE) providers, such as nature centers and parks, have been shown to enhance student learning outcomes desired by schools and EE organizations, including the advancement of knowledge, attitudes, skills, and behaviors regarding science and the environment, positive youth development, and academic motivation and achievement (Ardoin, Biedenweg, and O'Connor 2015; Powell et al. 2019; Stern, Powell, and Hill 2014). Field trips provide opportunities for experiential learning (Behrendt and Franklin 2014), and their success is influenced not only by the experience itself, but also by events in the classroom before and after (Storksdieck 2006).

Pre-visit preparation and post-visit follow-up activities have been associated with greater achievement and longevity of student outcomes (Farmer and Wott 1995; Smith-Sebasto and Cavern 2006; Stern, Powell, and Ardoin 2008; Storksdieck 2001). However, many teachers report doing little to no preparation or follow-up to field trips (Anderson, Kisiel, and Storksdieck 2006; Stern, Powell, and Ardoin 2008; Storksdieck 2001), and many organizations report that supplementary materials they provide for these purposes are rarely used (Phillips, Finkelstein, and

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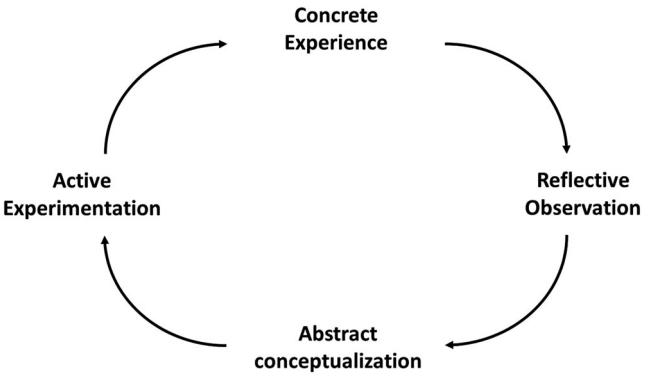

Figure 1. Kolb's (2015) experiential learning cycle.

Wever-Frerichs 2007). Previous studies have examined the relationship between preparation and/or follow-up for individual programs, but none have done so across multiple programs and providers. This study investigates the relationships between pre-visit preparation, post-visit follow-up, and student outcomes across a large sample of nonformal EE programs for adolescent youth, ages 10-14, in the United States (US).

The outcomes under consideration include elements of environmental literacy, positive youth development, 21st century skills, and student learning, as reported by student participants and their teachers. Environmental literacy refers to students' awareness, knowledge, attitudes, skills, and dispositions to address environmental issues (Hollweg et al. 2011; Stern, Powell, and Hill 2014). Positive youth development includes students' physical, intellectual, social, and psychological well-being (Eccles and Gootman 2002). Recent research illuminates the importance of these outcomes in the promotion of student success (Bowers et al. 2010; Lerner et al. 2005; Seligman et al. 2009). Twenty-first century skills include critical thinking, problem solving, collaboration, and communication abilities to solve real-world problems (Institute of Museum and Library Services 2009). While prior research has demonstrated that EE field trips can achieve these goals, we know of no study yet to examine the role of pre-trip preparation and post-trip follow-up in enhancing student outcomes across a large sample of programs.

Theoretical framework

Storksdieck's (2006) Integrated Experience Model, describes field trips as having three distinct phases in which student learning can occur: pre-trip (preparation), trip, and post-trip (follow-up). Kolb's (2015) Experiential Learning Cycle provides a useful framework for considering these phases. Although the cycle was designed originally with adult learners in mind, it has often been successfully applied to younger audiences as well (e.g.Huang, Chen, and Chou 2016; Moseley et al. 2019). Grounded in constructivist learning theory, which espouses that learning takes place as learners construct meaning from their experiences, Kolb's (2015) experiential learning process is depicted as a cycle with four stages. Learning can begin at any stage, but the hypothesized sequence remains constant: (a) concrete experience, (b) reflective observation, (c) abstract conceptualization, and (d) active experimentation (Figure 1). The experiential learning cycle may transpire over long periods of time or in short bursts; therefore, there are several ways experiential learning can manifest within and around field trip experiences.

One way to conceptualize student learning on a field trip is to think of the trip as the concrete experience (Krakowka 2012; Moseley et al. 2019). Concrete experiences occur when students are actively engaged in learning activities, such as laboratory experiments or fieldwork. DeWitt and Storksdieck's (2008, p. 181) assertion that field trips "serve best as opportunities for

exploration [and] discovery" further supports this notion. Reflective observation typically occurs after the field trip, when students reflect on their experience and consider any inconsistencies within their understanding. In the abstract conceptualization stage, students modify prior concepts, incorporate new knowledge, and formulate new understanding. This process readies the student to plan to test this knowledge, leading into the active experimentation phase. During active experimentation, students begin to apply newly constructed knowledge to make sense of a new situation. This phase involves organizing knowledge transformed from prior experiences, such as classroom lessons, and planning to use it in an upcoming experience— in some cases, on a field trip (Krakowka 2012; Moseley et al. 2019).

While the on-site components of a field trip could potentially encompass the entire learning cycle (for example, in the case of making observations, developing a research question and hypotheses, collecting data, drawing conclusions, and then testing them in a new location), planning, reflection, and conceptualization may often happen before or after the concrete experience on-site. Pre-visit preparation and planning can help students to formulate reasonable expectations, potential questions, and hypotheses based on their prior knowledge. This may include a form of active experimentation, in which students begin to build hypotheses to test during an upcoming field trip (Krakowka 2012; Moseley et al. 2019). Prior research suggests that logistical preparation may be similarly important in managing student expectations prior to a field trip (e.g., Orion and Hofstein 1994; Wong and Wong 2018). Oftentimes, field trips may involve only a portion of the learning cycle, such as data collection in a stream. Post-trip reflection may involve analysis and interpretation of the meaning of the data in relationship to watershed activities, drawing out abstract conceptualizations of the system-wide relationships between people and their environment. Students might then test this new knowledge by designing their own stream-related research or taking another field trip (active experimentation and new concrete experiences). Learning happens throughout the cycle, though understanding, skill development, and meaning-making increase as the cycle progresses through meta-cognitive processes beyond the concrete experience (Kolb and Kolb 2018).

Prior research on pre-visit and post-visit activities

Prior empirical research demonstrates the importance of pre-visit preparation and post-visit follow-up for enhancing student outcomes on EE and other science-based field trips (Anderson et al. 2000; Farmer and Wott 1995; Finson and Enochs 1987; Gennaro 1981; Lucas 2000; Smith-Sebasto and Cavern 2006; Stern, Powell, and Ardoin 2008; Storksdieck 2001). For example, Stern, Powell, and Ardoin (2008) found that greater pre-visit preparation was associated with higher environmental awareness measures in students and increased interest in learning and discovery following a residential EE program. In another study, students completing follow-up activities facilitated by field trip educators, including content review and interactive lessons, after a field trip at a public garden demonstrated more positive outcomes than those who did not (Farmer and Wott 1995). Storksdieck (2001) also found a significant difference in post-experience environmental attitudes between students who reported follow-up activities and those who did not after a museum field trip. Another study, however, found that only when *both* pre-experience preparation and post-experience follow-up were included did students exhibit significant increases in positive attitudes toward the environment (Smith-Sebasto and Cavern 2006). Other studies suggest that on-line or paper materials can facilitate curriculum integration by providing relevant preparation and follow-up activities (Anderson, Kisiel, and Storksdieck 2006; Anderson and Zhang 2003; Dewitt and Storksdieck 2008).

Taken together, the results from these and other studies (see Stern, Powell, and Hill 2014) highlight pre-visit preparation and post-visit follow-up activities as potentially important drivers of program success in terms of overall achievement of student outcomes. Existing literature,

however, has only investigated preparation and follow-up within single organizations. This study examines a large sample of EE programs provided by diverse organizations to analyze the effect of preparation and follow-up on student outcomes more broadly in an effort to uncover lessons that could enhance experiential learning in light of Kolb's (2015) experiential learning cycle hypothesis. We address the research question: How are pre-visit preparation and post-visit follow-up activities, alone and in combination, related to student outcomes from EE field trips?

Methods

Sampling/site selection

As part of a larger study (see "Funding" and Dale et al. 2020), we sought a diverse sample of single-day EE-focused school field trips for grades 5-8 across the US. We focused on middle school grades, because research suggests this is a developmentally critical period for developing 21st century skills and connection with place (Gu and Belland 2015; Kahn and Kellert 2002; Piaget 1964; Kohlberg 1979). To ensure diversity in our site selection, we relied on Ruggiero's (2016) evaluation of Environmental Literacy Plans (ELPs) in the US, which ranked states in terms of the status and quality of their statewide ELPs to serve as a proxy for the general status of environmental education in each state. ELPs are "state-specific comprehensive frameworks that support school systems in expanding and improving environmental education programs" (NAAEE. 2014, p. 4) and thus represent a measure of the formal degree of support for EE in each state. We divided states into four quartiles based on this ranking and systematically sought to sample programs of at least 10 providers from states within in each quartile to ensure diverse contexts of the programs we observed. We worked with the North American Association of Environmental Education (NAAEE), the National Park Service (NPS), and the Association of Nature Center Administrators (ANCA) to identify organizations and sites that offered single-day EE-focused school field trips for grades 5-8 during our field season (January – June 2017). We also identified additional potential program providers by conducting internet searches. We directly contacted potential program providers to identify geographic clusters that met our criteria to enable sampling of diverse programs within logistical, budgetary, and time constraints. We collected data from 334 field trip programs provided by 90 unique organizations in 24 states and Washington, DC, across the four quartiles (see supplemental Table A1 for a more complete breakdown).

We used this larger sample to conduct the two related studies reported in this manuscript. In the first study, data were collected from student participants in field trip programs and their accompanying teachers to examine the relationship between teacher-reported pre-visit preparation and student-reported outcomes. We refer to this investigation as ***Study 1***. In the second study, ***Study 2***, we relied on post-visit online surveys from teachers, completed 2-4 weeks after their field trip experiences, to examine the relationships between different forms of follow-up and teacher-reported student outcomes. This second sample was paired with valid surveys from the Study 1 sample to examine the relationships of both preparation and follow-up on teacher-reported student learning outcomes.

Study 1 data collection

All participating students in the 334 field trips were invited to complete a survey on-site at the conclusion of their field trip to measure student outcomes. Student outcome measures were developed over a two-year participatory process, which included a literature review, iterative stakeholder input, pilot studies in 6 locations, and psychometric testing using confirmatory factor analyses (see Powell et al. 2019). This process resulted in a set of outcomes, called "EE21," short for "environmental education outcomes for the 21st Century." The single EE21 measure used in this study represents the overall mean of the ten subscales defined in Table 1, equally weighted.

Table 1. Mean scores and standard deviations for student-reported outcomes included in the EE21 index. Means of sub-scales are provided in bold italics. All items were measured on a scale of 0-10. Self-efficacy and environmental attitudes were measured as a change score, and the means reflect the difference between how students viewed these outcomes before and after the program, each on a 0 to 10 scale. $N = 279$.

Outcome	Definition	Items	Mean	SD
Place connection	Appreciation and the development of personal relationships with the physical location and its story.	*How much do you agree with the following statements? (anchors: not at all, some, totally)*	***7.72***	***1.23***
		• Knowing this place exists makes me feel good.	7.59	1.27
		• I want to visit this place again.	7.60	1.47
		• I care about this place.	7.98	1.21
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)*	***7.49***	***1.05***
		• How different parts of the environment interact with each other.	7.08	1.12
		• How people can change the environment.	7.47	1.22
		• How changes in the environment can impact my life.	7.54	1.12
		• How my actions affect the environment.	7.87	1.11
Interest in learning	Enhanced curiosity, increased interest in learning about science, 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)*	***6.44***	***1.43***
		• Science.	6.51	1.49
		• How to research things I am curious about.	6.58	1.47
		• Learning about new subjects in school.	6.24	1.54
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)*	***6.35***	***1.42***
		• Solving problems.	5.73	1.54
		• Using science to answer a question.	6.39	1.43
		• Listening to other people's points of view.	6.76	1.46
		• Knowing how to do research.	6.50	1.57
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)*	***6.78***	***1.35***
		• Taught me something **that will be useful to me** in my future.	6.83	1.41
		• Really made me think.	6.89	1.41
		• Made me realize something I never imagined before.	6.62	1.53
		• Made me think differently about the choices I make in my life.	6.73	1.50
		• Made me curious about something.	6.82	1.35
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):*	***0.97***	***0.56***
		• I believe in myself	0.90	0.72
		• I feel confident I can achieve my goals	0.84	0.59
		• I can make a difference in my community.	1.16	0.66
			1.01	***0.49***

(*continued*)

Table 1. Continued.

Outcome	Definition	Items	Mean	SD
Environmental attitudes	Sensitivity, concern, and positive dispositions towards the environment.	*Difference between retrospective post-experience and pre-experience scores (anchors: not at all, somewhat agree(d), strongly agree(d):*		
		• I feel it is important to take good care of the environment	0.81	0.50
		• Humans are a part of nature, not separate from it.	1.02	0.63
		• I have the power to protect the environment.	1.20	0.69
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)*	***7.33***	***1.15***
		• Help to protect the environment.	7.51	1.22
		• Spend more time outside.	7.28	1.19
		• Make a positive difference in my community.	7.21	1.24
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)*	***6.96***	***1.28***
		• Listen more to other people's points of view.	6.96	1.32
		• Cooperate more with my classmates.	6.96	1.31
School motivations	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)*	***7.24***	***1.45***
		• Work harder in school.	7.27	1.43
		• Pay more attention in class.	7.21	1.51
EE21[3]	Index	Mean of all subscales.	5.83	1.00

We were able to administer surveys to 430 accompanying teachers on site at 289 of the field trip programs provided by 87 organizations across 24 US states and the District of Columbia. The short paper survey asked questions about the nature of teachers' preparation with their students prior to the field trip (s1, Table 2). Each survey also contained a question that asked the teacher what proportion of the students attending the field trip received the reported preparation. The surveys also asked for permission and contact information to send a follow-up survey (Study 2).

Logistical issues, primarily school groups arriving late or leaving early, accounted for the drop in the overall sample size of programs (from 334 to 289), as we were not always able to administer the on-site surveys to teachers. In ninety-seven cases, more than one teacher filled out a survey on-site for the same program. All programs were removed in which no accompanying teacher was able to report that at least "most" students on the field trip received the stated forms of preparation (10 programs). In the cases in which responses differed between multiple teachers on-site (50 programs), we used the response that indicated the highest degree of preparation for the greatest proportion of students, as we assumed this best reflects the actual preparation the students received (other respondents were often unaware of the actual preparation received). In other cases, we sampled consecutive programs in which some of the same teacher(s) attended multiple times with different student groups. Because each visit involved a distinct set of students, we administered a separate survey to the same teachers to account for potential differences in pre-visit preparation for each group. This resulted in some teachers being surveyed more than once. These procedures resulted in a final sample of 279 programs provided by 86

unique host organizations. Collectively, 3,721 valid EE21 surveys (following all data cleaning procedures – see Dale et al. 2020) were completed by students at these 279 programs. Forty percent of programs were attended by 5th graders, 29% were 6th grade programs, 17% were 7th grade programs, 6% were 8th grade programs, and 8% were mixed grade level programs.

Study 2 data collection

An invitation to the follow-up online survey was sent two weeks after their field trip date to the 270 teachers who provided contact information on the first survey. The survey included questions about follow-up educational activities as well as teachers' assessments of student outcomes (s2, Table 2). Thirty-four emails bounced back, dropping our starting sampling frame to 236 teachers with valid email addresses. After two reminder emails, spaced at weekly intervals, seventy-five teachers completed follow-up surveys (32% adjusted response rate). Two were removed due to missing data. The seventy-three teachers in the final sample for Study 2 had attended 66 unique programs[1] from 48 different program providers in 21 states. Each of these responses was paired with the on-site teacher surveys containing information about student pre-trip preparation. Forty percent of programs included in Study 2 were for 5th graders, 25% were 6th grade programs, 15% were 7th grade programs, 12% were 8th grade programs. For 8%, we had insufficient data regarding grade level of the group.

Two open-ended comment boxes were provided on the survey. Twenty-eight teachers provided written comments following closed-ended questions about follow-up activities. Forty teachers responded to an open-ended question asking them to share "any additional comments you have on the overall field trip experience and/or educational materials provided by the organization." These responses were inductively qualitatively coded by two members of the research team using open coding to provide additional nuance to the quantitative findings (Babbie 2015). Most comments reflected general praise of the program. Comments most relevant to this study included those labeled "follow-up," "preparation," "curriculum integration," "collaboration," and "experiential learning cycle" in our coding scheme. These codes were applied to comments from twenty-seven respondents. Examples of other codes not relevant to this manuscript included "on-site logistics," "hands-on," "English as a second language," and others reflecting specific characteristics of the on-site experience. Members of the research team also observed each of the field trips in person (as part of a larger study, see "Funding" and Dale et al. 2020). Notes from open-ended conversations with visiting teachers were taken regarding trip preparation, curriculum linkages, and relationships with the program providing organization. These were used to help interpret findings from the survey research and lend additional context to open-ended survey responses.

Analyses

Study 1

Following extensive cleaning of the student survey data associated with all 334 observed programs (see Dale et al. 2020), individual survey responses were aggregated to the group level to represent single mean student EE21 outcome scores, encompassing all constructs in Table 1, equally weighted. ICC (1) and ICC (2) values were 0.21 and 0.78, respectively, justifying the aggregation of individual outcomes variables to the group level (Woehr et al. 2015). These data served as the dependent variables for Study 1.

The degree and type of pre-experience preparation served as the independent variables. Conversations with visiting teachers and examinations of effect sizes associated with different potential cutpoints each indicated the most meaningful differences in responses existed between scores of "somewhat" and "a moderate amount" on the survey. Because of this and to address

Table 2. Teacher survey items. [s1] denotes items on the first survey and [s2] denotes items on the second survey.

Pre-visit preparation [s1]	**To what extent did you do any of the following with your students prior to this field trip?** *(5-point scale, not at all to a great deal).* • We discussed logistics (scheduling, what to bring, rules, etc.) • We talked about the subject matter the students would be learning about. • We did specific lessons/activities related to the lessons on site.
Pre-trip visit/outreach [s1]	**Did anyone from the host organization visit your school to interact with your students prior to the field trip?** Yes/no.
Materials use [s1]	**Did you use any education materials provided by the host organization prior to the field trip?** Yes/no.
Proportion [s1]	**To the best of your knowledge, what proportion of all the students visiting the program today had the preparation you noted above?** • All (or almost all) • Most • About half • Less than half
Post-visit follow-up [s2]	**To what extent did you do any of the following with your students after the field trip?** *(5-point scale, not at all to a great deal).* • We reviewed what happened on the field trip, but we didn't review the subject matter in detail. • We reviewed the subject matter of the field trip as a class. • We did specific lessons/activities related to the field trip content to follow up.
Materials use, and when [s2]	**Did you receive any educational materials from the organization that provided the field trip? *If yes…* Did you use the materials? Please check all that apply.** • Yes, before the field trip. • Yes, after the field trip. • No, not at all.
Teacher perceptions of student outcomes [s2]	**To what extent did you feel the overall experience, including the field trip and any pre-trip preparation and post-trip reflections, positively influenced the following for your students?** *5-point scales, not at all to a great deal.* • 13 items relevant to student learning outcomes (see Table 3).

the severe left skew in most of the data, we transformed preparation responses into binary variables reflecting "a moderate amount" and a "great deal" as "high" and "not at all" to "somewhat" as "low" levels of preparation (Table 3) to provide the most valid and reliable measures of meaningful preparation possible (Babbie 2015). We then ran independent samples t-tests to determine the extent to which different forms of preparation were related to mean outcome scores. Levene's test was applied to test the assumption of equal variances for each t-test. Welch's t-tests were performed in cases where unequal variances were observed between groups. Cohen's d effect sizes are reported for cases in which statistically significant differences in means were observed ($p < 0.05$). Cohen's d scores of at least 0.2 are considered small yet meaningful, 0.5 medium or moderate, and 0.8 large (Cohen 1988).

Study 2

Study 2 examined the relationship between teachers' perceptions of student outcomes and pre-visit preparation and post-visit follow-up. Measures of teachers' perceptions of student outcomes were developed to roughly mirror the primary concepts of the EE21 survey (Table 1). Principal component analysis of teachers' perceptions of student outcomes resulted in two internally consistent factors, accounting for 66% of the total variance (Table 4). The first factor, consisting of eight items, was termed "21st century skills" (Cronbach's alpha = 0. 936). We labeled the second

Table 3. Teacher-reported preparation and follow-up types.

Study 1 ($n = 279$)							
	Responses					Binary	
Preparation type	Not at all	A little	Somewhat	A moderate amount	A great deal	Yes	No
Logistics	0.0%	3.2%	11.5%	36.2%	49.1%	85.3%	14.7%
Subject matter	2.9%	7.5%	19.4%	40.5%	29.7%	70.2%	28.8%
Lessons	15.5%	10.5%	18.4%	31.8%	23.8%	55.6%	44.4%
Use of Pre-Visit Materials	[redacted]					33.2%	66.8%
Pre-trip Visit						20.4%	79.6%
Study 2 (n = 74)							
	Responses					Binary	
Preparation type	Not at all	A little	Somewhat	A moderate amount	A great deal	Yes	No
Logistics	4.1%	6.8%	5.4%	32.4%	51.4%	83.8%	16.2%
Subject matter	6.8%	12.2%	21.6%	36.5%	23.0%	59.5%	40.5%
Lessons	28.8%	9.6%	17.8%	20.5%	23.3%	43.8%	56.2%
Use of Pre-Visit Materials	[redacted]					24.7%	75.3%
Pre-trip Visit						18.9%	81.1%
Follow-up type	Not at all	A little	Somewhat	A moderate amount	A great deal	Yes	No
Discussed what happened	16.4%	19.2%	26.0%	26.0%	12.3%	38.4%	61.6%
Subject matter	26.4%	9.7%	15.3%	29.2%	19.4%	48.6%	51.4%
Lessons	39.2%	6.8%	21.6%	16.2%	16.2%	32.4%	67.6%

factor, made up of three items, "environmental literacy" (Cronbach's alpha = 0.910). An index was created for each factor by calculating the overall mean of each of the highly loading component items, equally weighted. The items comprising each index are in bold text in Table 4. Two additional survey items, reflecting student learning inside and outside of teachers' curriculum goals, did not compose a reliable factor (Cronbach's alpha = −0.480) and were thus retained as separate outcomes measures.

We paired responses about follow-up from the Study 2 survey with pre-visit preparation items from the Study 1 survey for each group. We converted follow-up items into binary variables in the same way as for preparation items (described above), following the same logic (Table 3). Independent samples t-tests were performed to examine differences in the means of each teacher-reported outcome associated with different forms of preparation and follow-up. Levene's tests and Cohen's d effect sizes were similarly applied in Study 2 as reported in Study 1. We also conducted one-way ANOVAs to examine different combinations of pre-experience preparation and post-experience follow-up. No statistically significant differences were observed in pre-trip preparation between those who responded to the follow-up survey and those who did not.

Study 1 results

Discussing logistics was the most commonly reported form of preparation for the upcoming field trip, followed by *talking about the subject matter students would be learning about*, and then *doing specific lessons or activities related to the lessons that would take place on site*. About one-third reported using materials provided by the host organization, and about 20% reported a pre-trip visit by members of the host organization (Table 3).

Means and standard deviations for survey items that make up the EE21 index are displayed in Table 1. The overall mean score for the EE21 index was 5.83. Independent samples t-tests revealed that EE21 scores were more positive for groups that received high levels of logistical preparation, subject matter preparation and preparatory lessons (Table 5).[2] The effect size was largest for logistical preparation. Teachers that used materials provided by program providers were more likely to provide "high" levels of subject matter and lesson preparation (Pearson $\chi^2 = 8.38$; $p = 0.004$ and Pearson $\chi^2 = 12.17$; $p < 0.001$, respectively), but no more likely to provide

Table 4. Teacher perceptions of student outcomes (Study 2). Factor loading results from principal component analysis with varimax rotation and Kaiser normalization, reducing data from 13 to four dependent variables to be used in the analysis.

	Teacher Perceived Outcomes		Component		
Outcome	Survey items	Mean(sd)	1	2	3
21st Century Skills		***3.63 (0.93)***			
	Students' motivation to do well in school.	3.29 (1.17)	**0.843**	0.211	0.109
	Students' ability to work together collaboratively.	3.79 (1.19)	**0.843**	0.066	−0.219
	Your classroom environment.	3.51 (1.29)	**0.832**	0.155	0.068
	Students' relationships with each other.	3.79 (1.07)	**0.825**	0.227	−0.145
	Students' motivation to learn new things.	3.96 (1.01)	**0.812**	0.188	0.065
	Students' problem-solving skills.	3.58 (1.03)	**0.774**	0.239	−0.008
	Students' actual academic performance.	3.32 (1.15)	**0.773**	0.339	0.105
	Students' critical thinking skills.	3.79 (0.96)	**0.689**	0.394	0.103
Environmental Literacy		***4.50 (0.80)***			
	Students' knowledge about the environment.	4.19 (0.81)	0.145	**0.938**	0.006
	Students' awareness of environmental issues.	4.14 (0.82)	0.215	**0.895**	0.034
	Students' level of concern about the environment.	3.84 (0.97)	0.357	**0.832**	0.123
Out-of-curriculum learning	Student learning outside of your curriculum goals.	***4.08 (0.89)***	0.306	0.169	0.769
In-curriculum learning	Student learning relevant to your curriculum goals.	***4.23 (0.92)***	0.424	0.05	−0.608

The Kaiser-Meyer-Olkin measure of sampling adequacy is 0.87, which suggests an adequate distribution for conducting factor analysis. Bartlett's Test of Sphericity ($\chi^2 = 692.6$; $p < 0.001$) further suggests the data are approximately multivariate normal and thus acceptable for factor analysis.

higher degrees of logistical preparation. No relationships were observed between any forms of teacher-led preparation and pre-field trip visits from the host organization. No direct statistically significant differences were observed in EE21 scores between groups that used host-provided materials or received a pre-field trip visit and those that did not.

Study 2 results

We paired responses from the Study 2 survey with Study 1 to determine the types of pre-visit preparation for each group (Table 3). Eighty-four percent of teachers in study sample 2 reported a high level of discussion about logistics; 60% reported a high level of discussions of subject matter the students would be learning about on the field trip; and 44% reported a high level of preparation using specific lessons or activities related to the lessons that would take place on site. Forty-nine percent of teachers in study 2 reported a high level of reviewing the subject matter; 38% reported a high degree of review regarding the activities of the field trip; and 32% reported a high level of lessons or activities related to the field trip content. Eighty-nine percent of the programs in Study 2 were associated with at least one form of at least high-level pre-trip preparation. Sixty percent were associated with at least one form of high-level post-trip follow-up; of the 44 field trips with high degrees of follow-up, only one lacked at least one form of high-level pre-trip preparation.

Table 6 shows the mean scores for teacher-reported student outcomes. All mean scores were above the midpoint, reflecting positive beliefs about the programs' impacts on students. Only two of the teacher-reported student outcomes exhibited statistically significant differences for different levels of preparation and follow-up (Table 7). Teachers' perceptions of ***21st century skills outcomes*** were more positive for groups with "high" amounts of subject matter and lesson preparation, each with moderate effect sizes. They were also higher for teachers reporting "high" levels of lesson-related follow-up activities. Teachers' perceptions of ***curriculum-relevant learning*** were more positive for groups with "high" levels of logistical, subject matter, and lesson preparation, with moderate to large effect sizes. They were also higher for those reporting higher degrees of subject matter and lesson-related follow-up.

Table 8 displays the results of one-way analyses of variance (ANOVA) examining differences in outcomes for specific combinations of preparation and follow-up. No statistically significant

Table 5. Results of independent-samples t-test comparing student outcome means between groups receiving different amounts of pre-visit preparation.

		EE21		
	High/Low (n)	Mean (SD)	t (df)	Cohen's d
Prep. Logistics	High (238)	5.94 (0.92)	3.66*** (48.1)[a]	0.66
	Low (41)	5.21 (1.22)		
Prep. Subject	High (196)	5.94 (0.95)	3.03** (277)	0.38
	Low (83)	5.56 (1.07)		
Prep. Lessons	High (154)	5.97 (0.89)	2.88** (138.8)[a]	0.32
	Low (123)	5.65 (1.11)		

[a]Welch's t-test performed to account for unequal variances between groups.
**$p < 0.01$.
***$p < 0.001$.

differences were observed for the environmental literacy outcome or out-of-curriculum learning. In-curriculum learning was highest in cases where both preparation and follow-up occurred and lowest when neither occurred. Moreover, 21st century skills were highest when either subject matter discussions or related lessons took place both before and after the field trip and lowest when neither occurred.

Qualitative observations and open-ended responses

Responses within the open-ended comment boxes on the follow-up survey, as well as conversations with teachers on site, reflected three primary themes relevant to embedding field trips within the experiential learning cycle: the importance of preparation, curriculum integration, and collaboration with the host organization. These themes were evident in our observations of a large proportion of programs. We first share the details of one particular program that we feel best illustrates them. Not all programs contained similar elements. However, teachers regularly cited similar themes as important to their students' experiences, while others lamented the lack of support for implementing them.

In the example program, accompanying teachers were given an electronic teacher's guide prior to the field trip that provided background information on the EE organization and field trip site; explained what should happen before, during, and after the field trip; and provided additional resources to facilitate content integration with in-class lessons. Resources included videos designed to introduce students to scientific equipment that would be used on the field trip and exercises for practice, as well as lesson plans for activities to familiarize students with the program content and relevant vocabulary. Detailed logistical information was provided for teachers to share with their groups, including maps, what to bring, itineraries, and rules. Prior to the field trip, teachers attended a workshop, and an educator from the site visited the classroom to provide a lesson for students on the instruments they would be using on-site and the habitats they would be visiting. On the trip, it was clear that the students and the teachers were well prepared. Everyone was dressed and ready to wade into the swamp, students were comfortable using all equipment, and groups were careful not to disturb the habitat they walked through, making a novel, complex field trip experience run extremely smoothly.

One teacher from this program commented, "My students love [this] field trip. The curriculum is top notch and included collaboration between the [*organization*] and local science teachers, so it is meaningful and useful." This program was developed with the help of local teachers and designed to meet state science standards. The program provider not only listed the curriculum standards that were being covered by the field trip and supporting materials, but also included a curriculum guide for the whole school year with suggestions of how and when to incorporate field trip preparation and follow-up lessons into the classroom, such as analyzing and presenting data collected on the field trip. Based on conversations with teachers and survey responses, it

Table 6. Means and standard deviations for teacher-reported outcomes in Study 2.

	N	Min.	Max.	Mean	SD
Environmental Literacy	73	2.0	5.0	4.05	0.80
21st Century Skills	73	1.5	5.0	3.63	0.93
In-curriculum Learning	73	1	5	4.23	0.92
Out-curriculum Learning	73	1	5	4.08	0.89

was apparent that learning associated with the field trip did not end when the students left the site. Teachers collected student workbooks completed during the trip and mentioned to the group that this information would be used during future activities. Overall, collaboration with teachers and a focus on curriculum alignment created a field trip experience that teachers felt was relevant to the students and valuable in meeting their own teaching goals.

In many cases, like the one described above, field trips appeared to fit seamlessly into the curriculum and could represent various stages of the experiential learning cycle. Sometimes, the field trip was clearly embedded as a single concrete experience within a larger curriculum, preceded by extensive preparation (active experimentation) and multi-faceted follow-up (multiple forms of reflection, conceptualization, and subsequent active experimentation). In other cases, the field trip was one element in a larger series of field trips – establishing some concrete experience so that students could travel through subsequent stages of the learning cycle before their next concrete experience. In these cases, the field trip appeared to serve the functions of both concrete experience and active experimentation, as teachers used the field trip to develop expectations and hypotheses for the next.

Open-ended comments also highlighted some specific challenges associated with connecting field trips effectively to overall learning cycles. Some teachers complained that materials were not available to help them prepare or review with their students. Others noted that the timing of the field trip didn't always fit in neatly with the flow of their lesson plans. For example, when field trips take place at the end of the school year, little opportunity exists for follow-up. One teacher also noted delays due to inclement weather creating disconnects between classroom content and field trip content. In other cases, related field trip and classroom content was presented to students weeks or months apart simply due to misaligned planning. Finally, some teachers noted that not all students receive similar levels of preparation and follow-up. One teacher stated, "This field trip was not attended by all 7th graders in the school so no formal, all-class lessons were administered." While some challenges might prove difficult to overcome (e.g., weather-related delays), others might be addressed through better coordination between host organizations, teachers, and their schools.

Discussion

Our findings support the idea that factors influencing field trip success may often occur before and after the trip (Storksdieck 2006). Consistent with prior studies (Gennaro 1981; Stern, Powell, and Ardoin 2008), we found preparing students in the classroom prior to EE field trips was associated with more positive outcomes. Higher levels of logistics preparation were strongly related to more positive student outcomes, supporting the concept that students do better in a learning environment if they understand what is expected of them, such as rules and procedures (Wong and Wong 2018). Out-of-school experiences, such as field trips, are typically novel to students, and while this may positively influence student interest and learning outcomes (Garst, Scheider, and Baker 2001), it can also hinder overall learning if the novelty is overwhelming or distracting (Orion and Hofstein 1994). Logistical preparation can set realistic expectations and thus enhance student comfort, balancing the influence of potentially overpowering novelty (Jarvis and Pell 2005).

Table 7. Results of independent-samples t-test for pre-visit preparation, post-visit follow-up and teacher perceptions of student outcomes.

		Environmental Literacy			21st Century Skills			In-Curriculum Learning			Out-Curriculum Learning		
	High/Low (n)	Mean (SD)	t (df)	Cohen's d	Mean (SD)	t (df)	Cohen's d	Mean (SD)	t (df)	Cohen's d	Mean (SD)	t (df)	Cohen's d
Prep. Logistics	High (61)	4.07 (0.81)	0.36 (70)	–	3.66 (0.95)	0.89 (70)	–	4.36 (0.90)	3.19** (70)	1.14	4.15 (0.89)	1.44 (70)	–
	Low (11)	3.97 (0.81)			3.39 (0.77)			3.45 (0.69)			3.73 (0.90)		
Prep. Subject	High (43)	4.13 (0.78)	1.04 (70)	–	3.84 (0.73)	2.38* (45)[a]	0.59	4.53 (0.59)	3.42** (39)[a]	0.86	4.05 (0.93)	−0.42 (70)	–
	Low (29)	3.93 (0.84)			3.29 (1.09)			3.76 (1.12)			4.14 (0.88)		
Prep. Lessons	High (31)	4.13 (0.80)	0.94 (69)	–	3.92 (0.76)	2.69** (69)	0.65	4.48 (0.68)	2.25* (69)	0.55	4.23 (0.62)	0.89 (69)	–
	Low (40)	3.96 (0.81)			3.35 (0.97)			4.00 (1.04)			4.05 (0.96)		
Follow-up, What Happened	High (28)	4.07 (0.71)	0.37 (69)	–	3.74 (0.85)	1.04 (69)	–	4.43 (0.69)	1.62 (69)	–	4.18 (0.86)	0.93 (69)	–
	Low (43)	4.00 (0.86)			3.51 (0.96)			4.07 (1.03)			3.98 (0.91)		
Follow-up Subject	High (35)	4.03 (0.76)	0.15 (68)	–	3.75 (0.87)	1.65 (68)	–	4.49 (0.56)	2.70** (50)[a]	0.66	4.14 (0.77)	0.94 (68)	–
	Low (35)	4.00 (0.84)			3.40 (0.92)			3.91 (1.12)			3.94 (1.00)		
Follow-up Lessons	High (24)	4.01 (0.84)	−0.17 (70)	–	3.94 (0.83)	2.20* (70)	0.56	4.58 (0.58)	2.42* (70)	0.63	4.17 (0.92)	0.65 (70)	–
	Low (48)	4.05 (0.79)			3.45 (0.92)			4.04 (1.01)			4.02 (0.89)		

[a]Welch's t-test performed to account for unequal variances between groups.
*$p < 0.05$.
**$p < 0.01$.
***$p < 0.001$.

Table 8. Results of ANOVA tests to determine whether different combinations of preparation and follow-up are related to different teacher-reported student outcomes.

Timing (n)	21st Century Skills means Mean (SD)	In-Curriculum Learning Mean (SD)
Any high level of extra-trip engagement		
Before only (22)	3.34 (0.91)[a]	3.95 (1.17)[a,b,c]
After only (1 – not included in ANOVA)	*3.38*	*3.00*
Both (44)	3.77 (0.89)[a]	4.48 (0.63)[b]
Neither (4)	3.22 (1.12)[a]	3.00 (0.82)[c]
	F-statistic = 2.02	F- statistic = 5.21**
Subject matter or lessons only		
Before only (12)	3.59 (0.57)[a,b,c]	4.33 (0.65)[a,b,c]
After only (8)	3.42 (1.13)[a,b,c]	4.25 (0.46)[a,b,c]
Both (31)	3.88 (0.76)[b]	4.55 (0.62)[b]
Neither (19)	3.14 (1.07)[c]	3.53 (1.26)[c]
	F-statistic = 2.83*	Welch's statistic = 3.66*

Logistical preparation and talking about what happened only occurred in isolation from subject matter or lesson-related engagement 13 times in the sample. No statistically significant differences were observed when considering only these forms of engagement.

Means that do not share superscripts in Table 8 are statistically different ($p < 0.05$) from each other (Dunnett's C for post-hoc tests on in-curriculum learning and subject matter or lessons only and Tukey's HSD for all others).

Higher levels of subject matter and lessons preparation were also related to more positive EE21 scores. Pre-visit preparation specific to the subject matter of the field trip can enable students to connect what they are learning on the field trip to prior experiences in the classroom (Rennie 2007). This idea is supported by constructivist learning theory, which stresses that people learn by fitting together new information with what they already know (Bada 2015). Through the lens of the experiential learning cycle, reflection, conceptualization, and experimentation with knowledge gained from prior experiences will influence future experiences. Information assembled during preparatory lessons are thus important ingredients for the development of new knowledge, enabling students to develop hypotheses, experiment with the ideas, and reflect on field trip experiences in light of what they already know (Kolb 2015).

Although teachers reporting the use of host-provided materials were more likely to report subject matter-related preparation and pre-trip lessons, neither the use of these materials nor host visits to the school prior to the field trip were directly related to more positive outcomes for students. Our data, including open-ended qualitative insights from teachers, provide no clear explanation for these findings. Our general observations suggest that materials provided by host organizations may vary widely in quality, content, and connection to teachers' desired learning outcomes. Moreover, it was evident that some teachers were unclear as to whether such materials were available. Future research examining the quality of these materials, their alignment with teachers' goals, and their use could provide valuable lessons for enhancing field trip preparation and follow-up learning activities.

Teacher surveys further corroborated findings from the student surveys in Study 1. Teacher-perceived outcomes were also linked to higher levels of logistical, subject matter, and lesson-related preparation. Higher levels of all three forms of preparation were positively related to teachers' perceptions of curriculum-related learning; higher levels of subject matter and lesson preparation were also positively related to teacher's assessments of the development of 21st century skills in their students. No forms of preparation or follow-up were statistically related to teachers' perceptions of students' gains in environmental literacy or learning outside the curriculum. While multiple explanations might exist for these findings, perhaps the most realistic is that teachers may not be able to directly observe and therefore accurately opine about these outcomes in the same way they can about in-curriculum learning and 21st century skills, which they can more easily observe in the classroom.

Higher levels of follow-up activities were also associated with better student outcomes, consistent with prior studies of single programs (Farmer and Wott 1995, Storksdieck 2001).

Encouraging students to make cognitive connections after the field trip helps to advance the experiential learning cycle by engaging in the reflective observation and abstract conceptualization stages (Falk and Dierking 2000; Kisiel 2005; Kolb 2015). Follow-up activities reported by teachers in this study included written reflections about environmental issues, activities to interpret data collected on the field trip, and applications of the scientific method practiced or observed on the field trip in a new setting. These exercises may not only help students organize recently gained knowledge, but also lay the groundwork for active experimentation, as students learn to apply their gained understanding in new situations. Programs with "high" levels (moderate amounts to a great deal) of *both* preparation and follow-up achieved the most positive teacher-reported outcomes.

Organizations that provide EE field trips should thus consider how they can work with attending teachers to integrate the field trip experience into the classroom, including adequate logistical and subject matter preparation as well as follow-up content and activities. In some cases, teachers were invited to visit the site prior to the field trip or attended workshops provided by the host organization. Prior studies have found that when field trip materials were co-developed with teachers and organizations, they were judged to be more effective and were more likely to be used (Dewitt and Osbourne 2007).

Qualitative comments from teachers reflected that both pre-visit and post-visit linkages were easier to facilitate in collaboration with the host organization than alone. Teachers' perceptions of the importance of effective curriculum integration for successful student outcomes and as a primary motivator for attending field trips has also emerged in previous studies (Anderson and Zhang 2003; Stern, Wright, and Powell 2012). Anderson and Zhang (2003) found that 60% of teachers felt that planning responsibilities for field trip visits should be shared between themselves and the host organizations, and about one-third felt that the primary responsibility for providing post-visit activities lay with the host organization. EE providers should thus strive to facilitate connections, forging partnerships to design not only effective site visits, but also valuable post-visit reflection and follow-up activities in the classroom, such as providing take-home materials, suggesting field trip-related lessons integrated with classroom curricula, or planning post-experience visits to the school.

We also suggest that organizations take an open-minded and creative view of how field trips may fit within the experiential learning cycle. Prior research suggests that field trips commonly represent the "concrete experience" upon which students may then reflect, draw conclusions, and attempt to then apply their new knowledge in subsequent active experimentation and further concrete experiences (Huang, Chen, and Chou 2016). In this light, pre-visit preparation can include any number of previous learning cycles, with active experimentation seen as the planning or hypothesizing phase preceding the field trip (Moseley et al. 2019). This raises the question of the extent to which formal educators are actually conducting activities consistent with *active experimentation* or simply providing logistical preparation such that students can embark on a new learning cycle when they arrive. Our study suggests that both pathways can occur, and that each might be valuable.

Alternatively, a field trip could instead provide more of a reflective experience at the end of a series of concrete experiences in school (i.e., an opportunity to observe learned principles at work in the real world or to solidify theoretical concepts). Considering the broader possibilities of how to appropriately situate fieldtrips within students' experiential learning cycles expands the possibilities for creatively intertwining formal and nonformal learning experiences. Multiple learning cycles may be at play at any point in time. How might field trips serve to advance students along, wherever they may be with regard to different content and learning objectives? A purposeful and collaborative approach between field trip providers and classroom teachers in this regard could further enhance the overall student experience.

Limitations and recommendations for further research

Although we achieved a broad and diverse sample of program providers across the US (see supplemental Table A1), we cannot claim that the sample is statistically representative of all such programs in the country. Moreover, the study was limited to single-day programs for 5th to 8th graders in the US. Therefore, we cannot confidently generalize beyond these age groups or these types of programs. We also cannot generalize to international settings. However, the diversity of the sample, we believe, is a strength of the study. We urge future researchers to test our conclusions in a wider array of settings. A larger sample might enable an exploration of potentially differential effects of preparation and follow-up activities on different types of audiences, including those of different socioeconomic status, race, achievement level, or other characteristics.

Follow-up response rates were low for the teachers in our study. Thus, this sample may not be representative of the broader array of teachers accompanying these field trips. We therefore cannot draw conclusions about how often teachers in general reflect on the field trip experience with their students. However, this should not affect the validity of the relationships uncovered in our analyses. Future studies may consider incentives for teachers to encourage responsiveness. Moreover, future studies may consider which outcomes teachers might be best positioned to report. While teachers may be able to directly observe in-curriculum learning and 21st century skills development, they may not be able to make confident determinations about broader concepts such as environmental literacy or learning outside the curriculum.

The logistical complexity of the study precluded our ability to conduct follow-up surveys with participating students. Thus, follow-up measures were limited to teachers' perceptions of student outcomes. Future efforts would be enhanced with the collection of longer-term student outcome measures. They might also consider collecting students' and teachers' perceptions of the quality of pre-trip preparation and post-trip follow-up activities.

We were unable to conduct detailed qualitative (or other) research on the qualities of the pre- and post-visit experiences that took place outside the field trips or on the specific materials provided to (and sometimes used by) visiting school groups. Future research could examine whether the nature of these experiences or the quality of the materials relate to the outcomes of field trip programs.

Conclusion

This study lends empirical evidence of the value of preparation and follow-up for EE field trips by demonstrating statistical trends across a large sample. By setting realistic expectations for students and by situating the field trip within the experiential learning cycle, teachers may better integrate field trip experiences with classroom curricula, thus enhancing student learning. Teachers also have the power to improve field trip outcomes for their students by integrating content in the classroom both before and after programs and clarifying logistical expectations for the experience. Program providers can make it easier for teachers to do so by providing high quality easy-to-use materials and other opportunities to collaborate on-site and/or in curriculum development. Together, we urge teachers and program providers to work together to consider how to best situate field trips within students' relevant experiential learning cycles, acknowledging that field trips may serve concrete, conceptualizing, reflective, and active experimentation purposes within the broader curriculum.

Notes

1. Seven teachers provided feedback on follow-up activities for different subsets of students attending the same field trip program.

2. We conducted an additional analysis to control for grade level and the racial make-up of the student groups. Controlling for these elements, the results are not meaningfully different from those reported here. See the online supplemental material for the specific results.
3. To account for potential unequal weighting of the items measured as change scores (which had lower means), we also calculated a standardized EE21 score using the z-scores of each subscale and re-ran all analyses. The results of all statistical tests did not change. The standardized EE21 index comprised of z-scores of the subscales was almost perfectly correlated with the original measure ($r = 0.99$). For simplicity's sake, and to enhance the ease of potential replicability of the study, we used the non-transformed EE21 index in the analyses reported herein.

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