

**Investigating the links between lesson characteristics, student engagement,  
and outcomes at a residential environmental education program.**

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## **Academic Abstract**

This dissertation investigates the links between lesson characteristics, student engagement, self-determination, and environmental literacy outcomes at a residential environmental education (EE) program. I developed a novel methodology using observations of 81 lessons at the study site to isolate the characteristics hypothesized to influence student engagement, self-determination, and outcomes of environmental literacy. Student surveys provided self-reported data on student engagement, self-determination, and environmental literacy. Mixed-methods analyses allowed me to explore these links within the 81 lessons observed in this case study. The results are organized into five chapters: an introduction chapter; three manuscripts planned for stand-alone publication (Chapters 2 – 4); and a conclusion chapter. Chapter 2 reports on the links between student engagement, self-determination, and environmental literacy. Chapter 3 provides insights on the links between the lesson characteristics (e.g., educator characteristics, teaching approaches, and schoolteacher/chaperone behaviors) and environmental literacy outcomes. Chapter 4 investigates the degree to which measures of student engagement, observed or self-reported, are associated with environmental literacy outcomes. Chapter 5 summarizes the findings from this study and presents additional analyses intended to fully synthesize the links between lesson characteristics, student engagement, self-determination, and environmental literacy. This study provides a novel methodology and survey items that may be of use to both practitioners and researchers. This research offers useful information about why and how EE works in this case and some of the specific characteristics and practices that engender positive environmental literacy outcomes.

## General Audience Abstract

This dissertation investigates the links between lesson characteristics, student engagement, self-determination, and environmental literacy outcomes at a residential environmental education (EE) program. I developed a novel methodology using observations of 81 lessons delivered to diverse middle school students at the study site to isolate the characteristics hypothesized to most positively influence student engagement, self-determination, and outcomes of environmental literacy. Student surveys completed at the end of each lesson observed provided self-reported data on student engagement, self-determination, and outcomes of environmental literacy. I performed a variety of mixed-methods analyses to explore these links and have organized the results into five chapters: an introduction chapter; three manuscripts planned for stand-alone publication (Chapters 2 – 4); and a conclusion chapter. Chapter 2 provides details on the links between student engagement, self-determination, and environmental literacy. Chapter 3 provides insights on the influences of a myriad of lesson characteristics (e.g., educator characteristics, teaching approaches, and schoolteacher/chaperone behaviors) on student environmental literacy outcomes. Chapter 4 provides results on the degree to which student engagement, observed or self-reported, is positively associated with environmental literacy outcomes. Chapter 5 summarizes the findings from this study and presents additional analyses intended to fully synthesize the holistic links between lesson characteristics, student engagement, self-determination, and environmental literacy outcomes. This study provides a new novel methodology and survey items that may be of use to both practitioners and researchers, particularly those with time constraints in the field. This research offers useful information about why and how EE works at this study site and provides details on specific characteristics and practices that led to positive student environmental literacy outcomes.

## **Dedication**

I dedicate this to my wife and two daughters. To my wife, without you none of this would have been possible. To my daughters, you are by far the best thing to happen to me these past four years. Thank you all for your patience and support. I love you.

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## **Attribution**

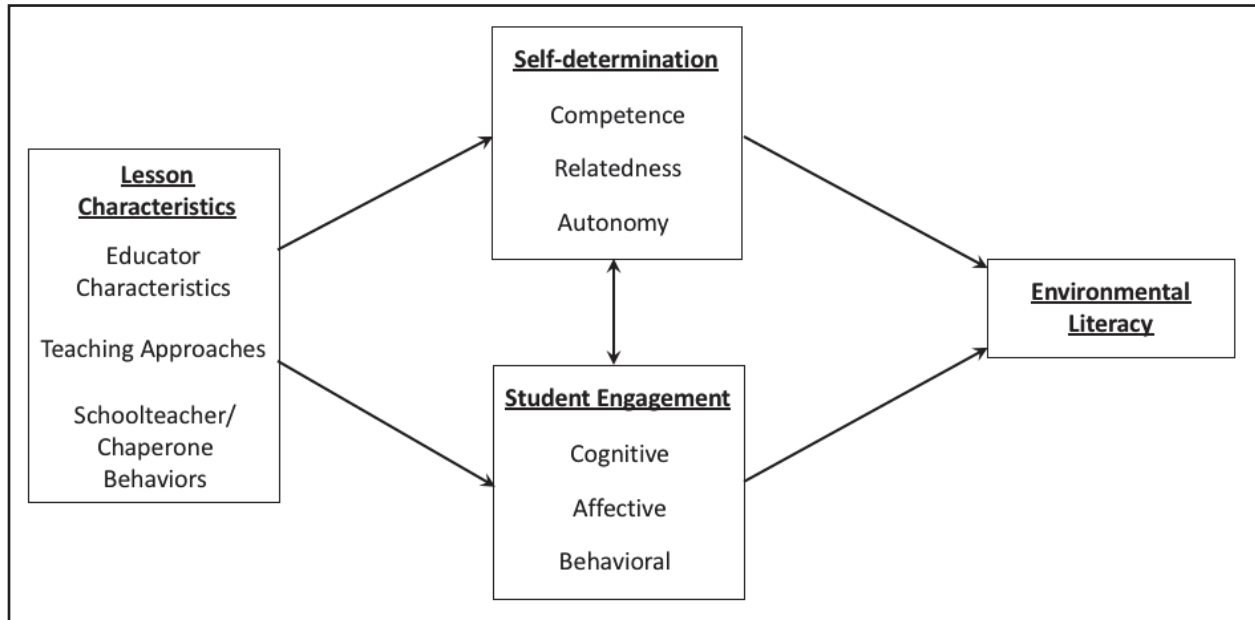
The work presented in this dissertation was primarily carried out by me. Chapters 2 through 4 are journal article manuscripts, which were written with co-authors. The co-authors contributed to these manuscripts by improving the writing, suggesting analyses, clarifying ideas, and aiding in organization of key concepts and ideas. The co-authors are listed in the order they will appear in journal articles and represents the level of contribution made by each author. All three manuscripts, and a fourth yet to be written arising from this work, will be submitted for publication in the near future.

# Chapter 1

## **Introduction**

This dissertation examines the relationships between the characteristics of environmental education (EE) lessons, student engagement, elements of self-determination theory, and student environmental literacy outcomes at a residential EE program. Decades of EE evaluation research has found that single or multi-day programs can achieve positive learning outcomes (Rickinson 2001; Stern, Powell, and Hill 2014), yet little is known about the specific characteristics of the experience most powerfully linked to measured outcomes (Ardoin Biedenweg, and O'Connor 2014; Stern, Powell, and Hill 2014). Extensive prior research in the education psychology field suggests that higher levels of student engagement and self-determination (e.g., students' levels of competence, autonomy, and relatedness) lead to improved student outcomes (Fredricks, Blumenfeld, and Paris 2004; Furlong and Christenson 2008; Ryan and Deci 2000a; 2000b), yet very little research has been done investigating the role of either in the EE context. This dissertation seeks to directly address these gaps in the literature and aims to further our understanding of the links between lesson characteristics, student engagement, self-determination, and environmental literacy outcomes (Figure 1-1).

Figure 1-1. Conceptual model depicting the hypothesized links between lesson characteristics, student engagement, self-determination, and environmental literacy outcomes.



The learning outcomes in this study are related to the concept of environmental literacy which is comprised of students' knowledge, attitudes, dispositions, and competencies needed to effectively recognize, analyze, and address important environmental issues in their community and beyond (Hollweg et al. 2009; Intergovernmental Conference on Environmental Education 1977). Student engagement consists of cognitive, affective, and behavioral engagement (Fredricks, Blumenfeld, and Paris 2004) and students' levels of competence, autonomy, and relatedness comprise the elements of self-determination (Ryan and Deci 2000a; 2000b). I use a

novel methodology consisting of observations of lessons to isolate the characteristics hypothesized to influence engagement, self-determination, and outcomes and observe affective and behavioral forms of engagement exhibited by the student group. Student surveys were also used to gather self-reported data on all three forms of student engagement, all three elements of self-determination, and environmental literacy outcomes. In total, 81 EE lessons were observed at the study site and the mixed-methods approach and comparative nature of this study allowed for the exploration of the following research questions:

- 1. How are student engagement and self-determination related to environmental literacy outcomes in a residential EE program?*
- 2. Which educator characteristics, teaching approaches, and schoolteacher/chaperone behaviors are most consistently associated with more positive environmental literacy outcomes?*
- 3. Is student engagement, observed or self-reported, positively associated with environmental literacy?*

The findings from these research questions are organized into three manuscripts, each intended on being a stand-alone publication. Chapter 2 examines the influence of both self-reported student engagement and elements of self-determination on environmental literacy outcomes. Chapter 3 investigates the lesson characteristics most positively associated with environmental literacy outcomes and details the novel comparative methodology in this study. Chapter 4 focuses on student engagement and environmental literacy in this novel EE context and delves into distinctions between observed versus self-reported student engagement. Each chapter that follows provides relevant literature, key findings, the unique contributions of the methodology used in this study, its limitations, and potential future directions.

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## Chapter 2

### **What leads to positive outcomes in environmental education? A case study investigating the links between student engagement, self-determination, and environmental literacy.**

B. Troy Frensley, Marc J. Stern, R. B. Powell, and Mike Sorice

#### **Abstract**

We explored the relationship between student engagement, elements of self-determination, and environmental literacy outcomes at a residential environmental education (EE) center. We surveyed diverse groups middle school students following the completion of 80 EE lessons delivered at NorthBay Adventure to assess their self-reported levels of engagement, self-determination (i.e., measures of competence, autonomy, and relatedness), and environmental literacy outcomes associated with each lesson. Elements of self-determination, particularly students' self-reported feelings of competence and autonomy, mediated the relationship between student engagement and environmental literacy outcomes, with this model explaining over 60% of the variance of the outcome. These findings suggest that elements of self-determination may be more relevant to student learning outcomes than engagement alone. We discuss the implications of these findings for both the practice of EE and future research, with particular regard to program design, implementation, and evaluation.

#### **Introduction**

Decades of research in the educational psychology field have found that student engagement is a predictor of enhanced student learning and achievement (e.g., Fredricks, Blumenfeld, and Paris 2004; Furlong and Christenson 2008; National Research Council (NRC) 2004). Self-determination theory (SDT) provides a theoretical framework for examining more contextual nuances of student motivation and engagement, considering how students' inner motivational resources may result in different levels of engagement (Deci and Ryan 1985; Klem and Connell 2004; Reeve 2012; Ryan and Deci, 2000a, 2000b). While studies examining elements of student engagement and self-determination are commonplace in the educational psychology literature (see Fredricks, Blumenfeld, and Paris 2004), studies focusing on student engagement, SDT, and or the interactions between them the EE context are rare (see Skinner et al. 2012). Our observations from having worked in the field for decades is that educators often make the assumption that observing positive student engagement surely means that students are learning. In other words, if students appear to be enjoying themselves and actively taking part in activities, we assume we are meeting our goals. Sam Ham refers to this assumption as "poof theory," insinuating that the assumption happy or engaged program participants means we are achieving meaningful learning outcomes is akin to believing in magic, without appropriate theoretical or empirical backing (Ham, 2013). We explore this assumption by investigating whether engagement alone or specific aspects of the experience associated with SDT are more predictive of learning outcomes.

While our investigation doesn't provide a complete picture of the multitude of factors influencing student learning, it has practical implications for both program design and for future research within the EE context. For example, if SDT factors are better predictors of learning outcomes, programs can be designed and educators trained specifically to enhance their presence. Moreover, researchers can focus measurement on these factors as mediating variable

between program characteristics (e.g., specific pedagogical approaches, student characteristics, contextual factors) and learning outcomes (e.g., environmental literacy measures).

### **Student engagement**

Student engagement is typically defined as consisting of cognitive, affective, and behavioral forms of engagement (Fredricks, Blumenfeld, and Paris 2004). Students who are cognitively engaged are dutiful in their learning, appreciate challenges, and seek to go beyond the minimum requirements (Appleton & Lawrenz 2011; Connell & Wellborn 1991; Fredricks, Blumenfeld, and Paris 2004). Affective engagement has been linked to students' willingness to work and presumed to aid in cultivating a connection between the student, educator, and learning site (Connell and Wellborn 1991; Fredricks et al. 2002; Trowler 2010). Students who are behaviorally engaged demonstrate effort, concentration, perseverance through challenges, and make positive contributions to learning, such as asking relevant questions (Appleton et al. 2006; Finn, Pannozzo, and Voelkl 1995; Fredricks, Blumenfeld, and Paris 2004; Skinner and Belmont 1993). Measurements for student engagement most commonly consist of self-reports, because some aspects of engagement, such as cognitive engagement, cannot be readily observed (Fredricks, Blumenfeld, and Paris 2004).

While some studies have explored student engagement in EE (Balantyne, Fien, and Packer 2000; 2001; Ballantyne and Packer 2009, Sivek 2002) and in environmental interpretation (Skibins, Powell, and Stern 2012; Stern and Powell 2013), the extent to which student engagement influences outcomes of interest is still not fully understood.

### **Self-determination theory**

SDT addresses how specific personal and social factors result in different levels of engagement (Klem and Connell 2004; Reeve 2012). Self-determined behaviors typically lead to greater engagement, improved performance, heightened self-esteem, and longer-term retention of desirable behaviors (Deci and Ryan 2000; Ryan and Deci 2000a; 2000b). According to SDT, behaviors become self-determined if they fulfill the students' fundamental psychological needs of competence, autonomy, and relatedness (Deci and Ryan 2000). Students' sense of competence (e.g., self-efficacy, ability) has been linked to effort and persistence in learning (Bandura 1997; Dweck 1999; Stipek 2002; Wigfield et al. 2006). Students with greater freedom of choice and self-direction in learning settings (autonomy) generally show enhanced engagement, persistence, and learning (Connell 1990; Skinner et al. 2008). Students with a stronger sense of belonging (relatedness) also demonstrate greater academic motivation, flexibility, and emotional engagement (Anderman 1999; Furrer & Skinner 2003; Skinner et al. 2008). Optimal student engagement may be reached when students' needs of competence, autonomy, and relatedness are met (Deci and Ryan, 1990; 2000; Skinner and Belmont 1993; Darner 2009).

A few studies have explored SDT in an EE context. A study by Covitt (2006) focused on the impacts of student autonomy on students' attitudes towards conservation-related service-learning projects and found that when middle school students had more perceived choice (autonomy) over the service learning projects they participated in, they had more favorable attitudes towards service learning. Darner (2012) used an experimental design to conduct the first empirical tests of SDT as a guide to EE development with the aim of fostering environmental motivation in college biology coursework. The results of this study suggest that college students participating in a university biology course developed to support students' competence, autonomy, and relatedness (see Darner 2009) were more environmentally motivated than

students in a traditional biology course. This study used the Motivation Towards the Environment scale (MTES; Pelletier et al. 1998), based on Ryan and Deci's (1985) typologies of different forms of motivation but does not provide direct insights into all three of the students' psychological needs simultaneously (e.g., competence, autonomy, and relatedness).

A study by Skinner et al. (2012) on garden-based programming for middle school students focused explicitly on measuring students' competence, autonomy, and intrinsic motivation examined their interactions with students' engagement, learning outcomes and academic achievement. Findings from this study suggest that students' perceived autonomy, competence, and intrinsic motivation predicted their levels of engagement, which in turn, predicted learning outcomes and academic achievement. To our knowledge, the study was the first to investigate the links between SDT, student engagement, and outcomes in an EE context. However, it did not include any measures of relatedness, or sense of belonging. The research described in the current manuscript may thus be the first to fully explore all elements of self-determination (e.g., competence, autonomy, and relatedness) and its associated interactions with student engagement and learning outcomes in an EE setting.

The learning outcomes in this study are related to the concept of environmental literacy which is comprised of students' knowledge, attitudes, dispositions, and competencies needed to effectively recognize, analyze, and address important environmental issues in their community and beyond (Hollweg et al. 2009; Intergovernmental Conference on Environmental Education 1977). Students attending residential EE programs leave their homes and spend two or more days in a natural setting, exploring natural environment firsthand in the hope that the experience will enhance their connection to nature, knowledge of the environment, awareness of, and interest in, environmental issues, attitudes, and even behavioral intentions (Ardoin, Biedenweg, and O'Connor 2015; Dettmann-Easler and Pease 1999; Stern, Powell, and Ardoin 2008; 2010). These outcomes are each components of environmental literacy.

## **Research question**

*How are student engagement and self-determination related to environmental literacy outcomes in a residential EE program?*

## **Study site**

The five-day residential EE program at NorthBay Adventure (NorthBay) hosts diverse middle school students from urban, suburban, and rural schools from across Maryland, Washington D.C., and Philadelphia. Each week, 50 to over 400 students stay at the over 90-acre NorthBay campus, located on the shores of the Chesapeake Bay, along with their teachers and parent chaperones. NorthBay employs a constructivist and culturally responsive approach that uses experiential-learning, adventure activities, and multi-media messaging (Stern et al., 2010). This constructivist approach relates on-site learning to relevant social and environmental issues students may encounter at home. Many of the teaching approaches used at NorthBay are designed to empower students to have a positive impact on the environment, their school, and their community. NorthBay employs a diverse team of educators, counselors, adventure activity staff, and live evening show performers that interact with the diverse student population attending the program.

NorthBay delivers two-hour long EE lessons during the morning and afternoon of students' three full days' onsite (Tuesday, Wednesday, and Thursday). These lessons represent

the primary EE that occurs at NorthBay and take place in a variety of habitats and locations across the campus. NorthBay’s curriculum incorporates the action and personal responsibility-oriented education model called Investigating and Evaluating Environmental Issues and Actions (IEEIA) (Hungerford et al. 2003) and the Better Environmental Education Teaching, Learning, Expertise, and Sharing (BEETLES) model (BEETLES 2014). During the lessons, students commonly make observations and collect data via hands-on approaches in the natural environment, investigate relevant environmental issues, and reflect on their experiences, often linking new knowledge back to their home environments.<sup>1</sup> These lessons serve as the primary unit of analysis of the study.

## Methods

### Measurement

#### *Environmental literacy*

The dependent variable of this research was environmental literacy. We measured this construct through retrospective student surveys immediately following each EE lesson during their weeklong visit. Eight survey items were developed based on key literature to measure environmental literacy (Hollweg et al. 2011, McBeth et al. 2011; McBride et al. 2013). Response categories were comprised of a five-point Likert-type scale ranging from: (1) not at all; (2) a little; (3) somewhat; (4) a lot; (5) a huge amount (Table 3-2). We hypothesized that these items might form a single coherent latent variable, effectively measuring environmental literacy.

Table 2-1. Environmental literacy index survey items.

Survey Question	Environmental Literacy Outcome
This lesson made me appreciate nature more than I did before. (Appreciate)	Attitude/Disposition
This lesson made me feel more connected to nature than I ever have before. (Connect)	Attitude/Disposition
This lesson taught me something that will be useful to me after I leave. (Useful)	Knowledge/Skills
This lesson helped me understand how my actions can affect the environment. (Actions)	Knowledge/Competency
This lesson made me feel I can make a difference in my community at home. (Difference)	Disposition/Behavioral intention
This lesson made me want to spend more time in nature after I leave here. (Time)	Disposition
This lesson made me want to learn more about environmental issues. (Lmore)	Knowledge/Behavioral intention
This lesson made me want to do something to take care of the environment. (Do something)	Disposition/Behavioral intention

*Note: Labels for confirmatory factor analysis in parenthesis*

<sup>1</sup> More information on the NorthBay program can be found at: Powell, Stern, and Ardoin 2013; Stern, Powell, and Ardoin 2008; Stern et al. 2017; and Frensley et al. 2018a; 2018b.

### *Self-reported student engagement*

Five survey items measuring cognitive, affective, and behavioral engagement were developed based on prior research (Fredricks, Blumenfeld, and Paris 2004, Trowler 2010; Table 2-2). Response categories were comprised of a five-point Likert-type scale ranging from: (1) not at all; (2) slightly; (3) somewhat; (4) mostly; (5) a great deal. We hypothesized that these items might form a single coherent latent variable, effectively measuring student engagement.

Table 2-2. Student engagement index survey items.

<b>Survey Question</b>	<b>Student Engagement</b>
I enjoyed the lesson. (Enjoy)	Affective
The lesson really made me think. (Think)	Cognitive
I tried hard during the lesson. (Tried)	Behavioral
I disliked the lesson. (Dislike_inv)	Affective
I paid attention during the lesson. (Attention)	Behavioral

*Note: Labels for confirmatory factor analysis in parenthesis; the inverse of dislike was used in analyses for consistency on the positive scale*

### *Student self-determination*

Three survey items were developed from prior research (Reeve and Sickenius 1994) to measure students' levels of competence, autonomy, and relatedness (Table 2-3). Response categories were comprised of a five-point Likert-type scale ranging from: (1) not at all; (2) slightly; (3) somewhat; (4) mostly; (5) a great deal.

Table 2-3. Self-determination survey items.

<b>Survey Question</b>	<b>Student Engagement Outcomes</b>
I was able to understand the lesson.	Competence
I felt free to learn in my own way during the lesson.	Autonomy
I felt comfortable with the group during the lesson.	Relatedness

### **Sampling**

Surveys were administered immediately following 80 EE lessons delivered at NorthBay over the span of nine weeks of the program. Fifteen student groups from 17 different schools (12 suburban, 3 urban, 2 rural; NCES 2017) participated in the study. Each week, the randomly-selected student groups we surveyed were paired with a single educator for all lessons, with two exceptions (explain). Student group sizes ranged from 11 to 29 students. Eight student groups were female and seven student groups were male and were always matched with an educator of the same gender.

### **Pilot testing**

Pilot testing occurred during 18 lessons taught by eight different NorthBay educators over four weeks to help us refine the student survey, with the aim of producing easily understood survey items and surveys that could be completed in five minutes or less. The researchers led conversations following each survey administration to identify appropriate revisions that would promote consistent understanding of the items.

## Data cleaning

We first screened student survey responses for missing data. Any surveys missing more than 50% of data (Tabachnick and Fidell 2007) and responses failing the inversely worded validity check (agreement on both “I disliked the lesson” and “I enjoyed the lesson”) were removed. This screening process resulted in the removal of 77 individual student surveys resulting in 1,392 individual student surveys from 81 lessons at NorthBay. Data were also screened for multivariate outliers using Mahalanobis Distance; which resulted in the removal of an additional 94 student surveys (Tabachnick and Fidell 2007). This reduced our sample to 1,298 student surveys from 81 lessons

To determine the appropriate level of analyses, we examined the intraclass correlation coefficients (ICC(1)) for students’ responses on the environmental literacy outcome index. ICC(1) scores calculated on the dependent variable offer a measure of non-independence and aids in answering the question of whether or not outcomes are impacted in some way by group membership (Bliese 2000; Byrk and Radenbush 1992; Kreft and DeLeeuw 1998). In other words, this test determines whether the variance in student scores was due to differences at the individual-level or lesson level. Analysis revealed a high ICC(1) score (0.27), which is above the threshold of 0.25 for a large effect, suggesting the majority of the variance in outcomes occurred at the group level and not at the individual level (Bliese 2000; Byrk and Radenbush 1992). ICC(1) analyses were also performed on the student engagement index and measures of competence, autonomy, and relatedness with all scores ranging between 0.16 and 0.23 indicating moderate to strong effects of group membership. We thus aggregated individual student scores to the lesson level for analyses by taking the means of each measure for each lesson. The small number of student groups in this study (N = 15) precluded the use of multi-level modeling (Mass and Hox 2005) or selecting the student group as an appropriate unit.

Student mean scores for the aggregated environmental literacy, student engagement, and self-determination survey items were then checked for skewness and kurtosis. All lessons except for one were below the threshold for concern ( $\pm 0.6$ ; Schumacker and Lomax 2004). Data were then screened for multivariate outliers using Mahalanobis Distance, confirming this same lesson as an outlier, leading to its removal from the sample (Tabachnick and Fidell 2007). This resulted a final sample size of 80 lessons.

## Analyses

### *Confirmatory factor analysis*

We performed confirmatory factor analysis (CFA) to test the hypothesis that the eight environmental literacy comprise a single latent variable reflecting environmental literacy and the five self-reported student engagement items comprise a single latent variable reflecting student engagement. The inverse of the survey item “I disliked the lesson” was used to ensure all responses were on the same positive scale prior to performing the CFA and any missing data were handled using multiple imputation methods. CFA accounts for common measurement errors in survey research and provides empirical justification for the model (Byrne 2001; Kline 2005). We report the: Sattora-Bentler (S-B) Comparative Fit Index (CFI); S-B Root Mean Square Error of Approximation (RMSEA); S-B Tucker-Lewis index (TLI); and the Standardized Root Mean Square Residual (SRMR). The CFI accounts for non-centrality and represents the total covariation in the data with values greater than 0.95, indicating an excellent fit (Byrne 2001; Hu and Bentler 1999). RMSEA values below 0.08 are considered acceptable (Browne and Cudeck 1993; Hu and Bentler 1999). The Tucker Lewis Index (or Non-Normed Fit Index, NNFI)

is a relative fit index, and results above 0.95 indicate a good fit (Schumaker and Lomax 2004). The SRMR statistic provides an average difference between the sample and the predicted correlation matrices with values less than 0.1 considered acceptable (on a 0 to 1 scale) (Hu and Bentler 1995; Kline 2005).

Because Chi-square statistics are considered an unreliable measures of model fit with large sample sizes (those greater than 250; Fan, Thompson, and Wang 1999; Hu and Bentler 1999; Joreskog and Sorbom 1996; Schermelleh-Engel, Moosbrugger, and Muller 2003), we report the normed Chi-square statistic (also known as the parsimonious Chi-square), which is calculated through the ratio of S-B  $\chi^2/df$  (Schermelleh-Engel, Moosbrugger, and Muller 2003).

*How are student engagement and self-determination related to environmental literacy outcomes in a residential EE program?*

To answer the research question, we first performed bivariate regressions to understand the individual relationships between student engagement, competence, autonomy, and relatedness and environmental literacy. We performed these tests to confirm that each predictor was significantly related to the outcome. We then performed an OLS regression analysis with the four predictor variables (student engagement, competence, autonomy, and relatedness) and environmental literacy.

We hypothesized that the self-determination variables may be acting as mediators between student engagement and environmental literacy outcomes. We conducted a mediation OLS regression analysis (single-step multiple mediator model) using the PROCESS command developed for use in SPSS (Hayes 2012; Hayes 2018) to investigate the role of self-determination in mediating the relationship between student engagement and environmental literacy outcomes. We estimated the standardized total, direct, and indirect effects ( $\beta$ ), and the bias-corrected (BC) bootstrapped 95% confidence interval (CI) for the indirect effects. These statistics reveal the degree of mediation observed in the data (Field 2013). This technique, known as the PROCESS technique, goes beyond Baron and Kenny's (1984) causal steps approach, which only infers the indirect (mediating) effect through hypothesis testing and relies on statistical significance instead of actually quantifying the indirect effect (Field 2013; Hayes 2009). The Baron and Kenny (1984) approach is also low in statistical power (Fritz and MacKinnon 2007).

Unlike the Sobel test, the PROCESS technique makes no assumptions about the shape of the sampling distribution of the indirect effect and no standard error is required to make the inference, thus eliminating the controversy over how best to estimate the standard error of the indirect effect (Hayes 2009). The PROCESS technique instead calculates the BC bootstrap 95% CI which corrects for any bias and skewness in the distribution by estimating the properties of the sampling distribution through resampling by replacement using simulations (5,000 in our case) (Chernick and LaBudde 2011; Field 2013). The result is a percentile-based (95%) bootstrap CI. If zero is not between the lower and upper bound of these BC CI's, then the interpretation is that the effect of the mediation is not zero with 95% confidence (Field 2013; Hayes 2009). Simulation research has shown bootstrapping to be a valid and powerful method for testing intervening variable effects (MacKinnon et al. 2004; Williams and MacKinnon 2008). By estimating indirect effect of the mediation and its BC CI's through this PROCESS technique, we directly report the degree of mediation observed in the data associated with each mediating variable (Field 2013). We report the standardized effect sizes ( $\beta$ ) and associated 95% BC CI's

for each hypothesized mediator (competence, autonomy, and relatedness) on the environmental literacy outcome. The larger the coefficient and its associated 95% BC CI's are, the larger the mediating effect of a variable is likely to be (Field 2013).

We also provide a model to report the standardized regression coefficients ( $\beta$ ) and statistical significance of the total, direct, and indirect effects of the relationship between student engagement and environmental literacy, both with and without the mediating self-determination variables.  $R^2$  values indicate the portion of variance explained by both models (with mediation and without).

## Results

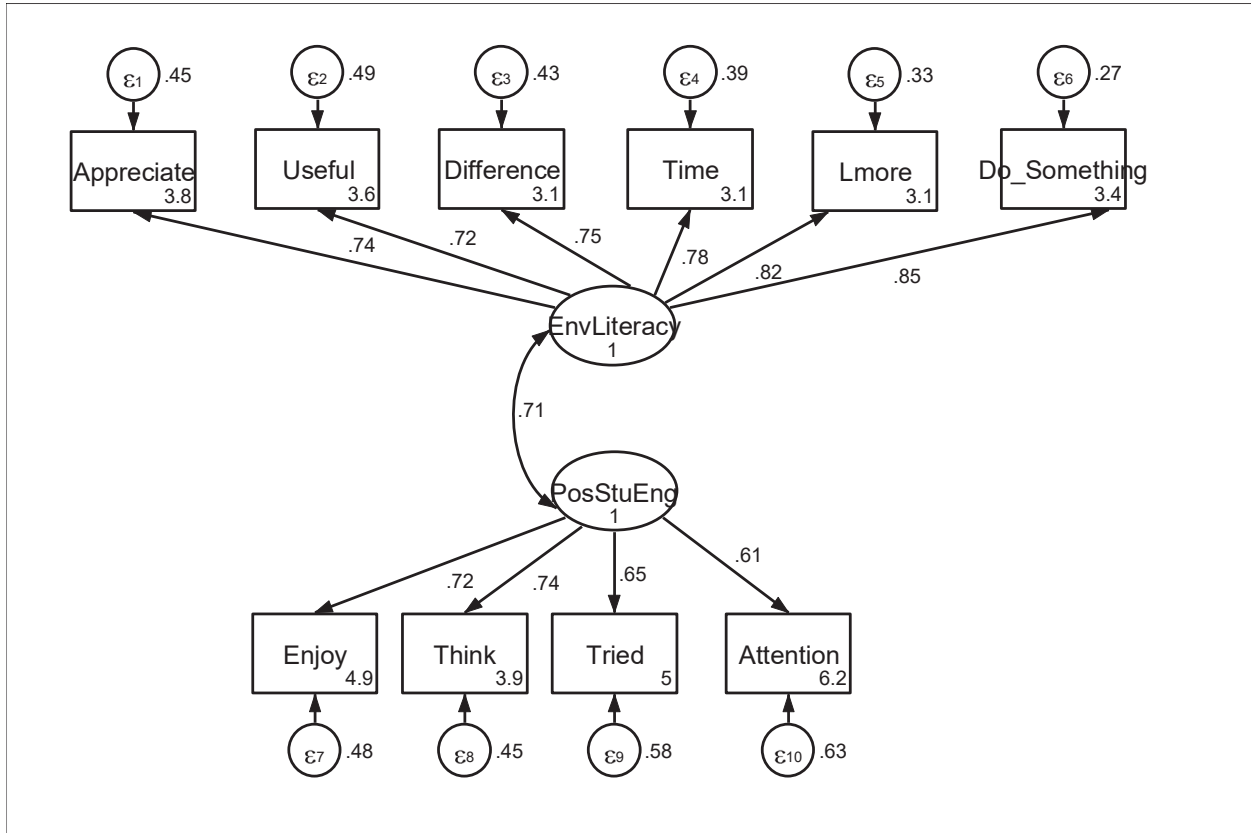
### Confirmatory factor analysis

CFA confirmed our hypotheses of a single latent environmental literacy factor and a single latent student engagement factor. To achieve sufficient model fit, two environmental literacy items were removed ('This lesson made me feel more connected to nature than I ever have before' and 'This lesson helped me understand how my actions can affect the environment') and one student engagement item was removed ('I disliked the lesson') based on high modification indices (covariances between items above 50.0). The resulting model (see Figure 2-1) exhibited good fit with statistics all within the acceptable range. The normed Chi-square statistic = 0.17, well below the suggested acceptable threshold of 2.0 (Schermelleh-Engel, Moosbrugger, and Muller 2003; Schreiber et al. 2006).<sup>2</sup> And the remaining model fit statistics were all within the acceptable ranges (S-B CFI = 0.97; S-B RMSEA = 0.06; S-B TLI = 0.96; SRMR = 0.04). An analysis of internal consistency of the environmental literacy index resulted in a Cronbach's alpha score of 0.90 and 0.72 for the student engagement index. Cronbach's alpha scores above 0.70 are considered acceptable for developing indexes (DeVellis 2003). Because the unit of analysis in this study is at the lesson-level, we first aggregated individual student scores to the lesson (student group) level for each lesson. We then created an environmental literacy index by taking the mean of these student group scores for each survey item within the index, for every lesson observed. This was done for the six items in the environmental literacy index and the four survey items in the student engagement index.

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<sup>2</sup> We also conducted CFA on first, fourth, and sixth lessons students participated in each week. These lessons were selected because they had the largest sample size of individual students and represented overall low, middle, and high mean lesson scores across all weeks observed. Each CFA resulted in acceptable model fit and the exact final model presented in Figure 2-1. Lesson 1 (N = 228) fit statistics include: (S-B  $\chi^2$  = 43.17, p = 0.14; S-B CFI = 0.99; S-B RMSEA = 0.03; S-B TLI = 0.98; SRMR = 0.04). Lesson 4 (N = 228) fit statistics include: (S-B  $\chi^2$  = 45.38, p = 0.07; S-B CFI = 0.99; S-B RMSEA = 0.04; S-B TLI = 0.98; SRMR = 0.04). Lesson 6 (N = 230) fit statistics include: (S-B  $\chi^2$  = 48.36, p = 0.052; S-B CFI = 0.98; S-B RMSEA = 0.04; S-B TLI = 0.98; SRMR = 0.04).

Figure 2-1. Final confirmatory factor analysis model indicating the latent constructs of environmental literacy (EnvLiteracy) and student engagement (PosStuEng).



### Descriptive statistics

Table 2-4 summarizes the grand means and standard deviations for student responses for the environmental literacy index, student engagement index, and self-determination survey items.

Table 2-4. Means and standard deviations of student responses for the environmental literacy index, student engagement index, and self-determination items.

<b>Student Outcomes</b>	<b>Means (with SD)</b>
Environmental literacy index	3.78 (0.40)
Student engagement index	4.28 (0.25)
Competence	4.53 (0.24)
Autonomy	4.07 (0.38)
Relatedness	4.27 (0.32)

*Note: All items on a 1 to 5 Likert-type scale.*

### How are student engagement and self-determination related to environmental literacy outcomes in a residential EE program?

Bivariate regression analysis indicated that student engagement was a statistically

significant predictor of environmental literacy ( $\beta = 0.70$ , SE 0.34,  $p < .001$ ,  $R^2 = 0.49$ ). We also performed bivariate regression analyses for each of the self-determination items. All three were statistically significant predictors of the environmental literacy outcome: competence ( $\beta = 0.57$ , SE 0.16,  $p < .001$ ,  $R^2 = 0.33$ ); autonomy ( $\beta = 0.66$ , SE 0.09,  $p < .001$ ,  $R^2 = 0.44$ ); and relatedness ( $\beta = 0.49$ , SE 0.13,  $p < .001$ ,  $R^2 = 0.24$ ).

Table 2-5 summarizes the OLS regression analysis investigating the relationship between all four predictor variables together and environmental literacy. Student engagement and relatedness were not statistically significant in this model. Only measures of competence and autonomy were statistically significant predictors. This suggests that competence and autonomy (but not relatedness) are likely mediating the relationship between student engagement and environmental literacy.

Table 2-5. Summary of ordinary least squares regression with self-reported student engagement, competence, autonomy, and relatedness with the environmental literacy student outcome index.

Predictor variables	<i>B</i>	<i>SE B</i>	$\beta$	<i>t</i>	<i>p</i>
(Constant)	-1.87	.58		-3.24	.002
Competence	.39	.19	.23	2.10	.039
Autonomy	.46	.10	.44	4.76	<.001
Relatedness	.19	.11	.15	1.71	.092
Student engagement	.28	.22	.18	1.25	.215

Notes:  $R^2 = 0.62$ ; *B* = unstandardized coefficient; *SE B* = unstandardized standard error;  $\beta$  = standardized coefficient; *p* = p-value

The PROCESS technique further confirmed the mediation. The direct effects of student engagement on environmental literacy are mediated by competence and autonomy,  $\beta = 0.52$ , BC CI [0.271, 0.776]. The standardized regression coefficient and 95% BC CI's do not contain zero (Field 2013; Hayes 2009). Table 2-6 summarizes the standardized effect sizes for the indirect (mediation) effects of each self-determination variable on the environmental literacy outcome. Following the same cutoffs of non-zero values in the standardized regression coefficients and BC 95% CI's, these data suggest the strongest mediating effect by autonomy and a significant mediating effect by competence. Meanwhile, the BC 95% CI's for relatedness contain zero (-0.017 value at lower CI), indicating that relatedness is barely outside of the acceptable range to be considered a mediator.

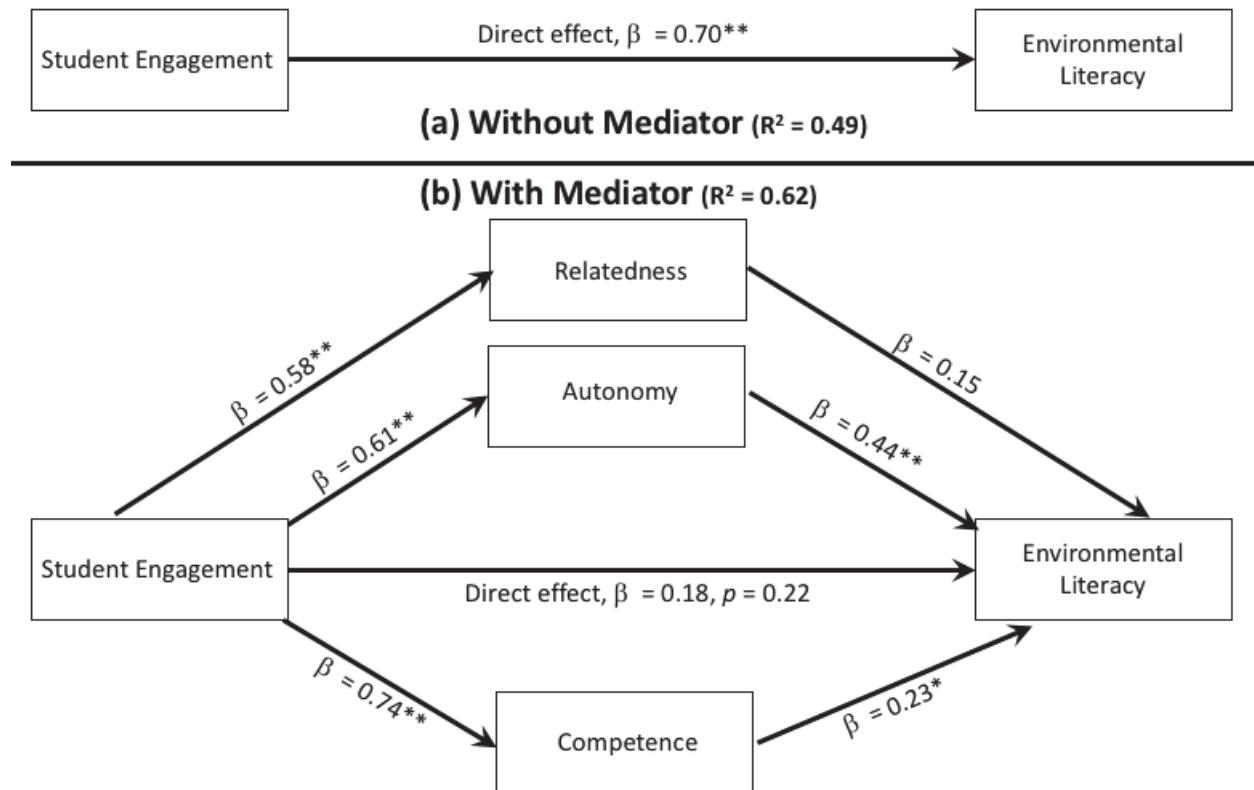
Figure 2-2 summarizes the resulting path diagram with standardized regression coefficients and a comparison of the effects (with  $R^2$  values) of student engagement on environmental literacy both with and without mediators. The regression model without the mediators indicates that student engagement has a statistically significant direct effect on environmental literacy and explains 49% of the variance in this outcome. The regression model with the three self-determination mediator variables explains more variance in the outcome, approximately 62%. The direct effect of student engagement on environmental literacy in this model is statistically insignificant, again suggesting strong mediation by competence and autonomy.

Table 2-6. Summary of the fully standardized effect sizes of the mediation by competence, autonomy, and relatedness on environmental literacy outcomes.

Mediating variables	$\beta$	BC 95% CI
Competence	.17	.011, .347
Autonomy	.27	.155, .418
Relatedness	.09	-.017, .207

Notes:  $\beta$  = completely standardized indirect effect coefficient; BC 95% CI = bias-correlated bootstrap 95% confidence interval

Figure 2-2. Model of student engagement as a predictor of environmental literacy (a) and student engagement as a predictor of environmental literacy, mediated by competence and autonomy (b).



Notes:  $\beta$  = standardized regression coefficients; \*\*  $p < .01$ ; \*  $p < .05$

### Discussion

This study sought to investigate the links between student engagement, self-determination, and students' environmental literacy outcomes in a residential EE setting. Mediation regression analyses indicate that self-determination variables, in particular competence and autonomy, mediate the relationship between student engagement and environmental literacy. When the self-determination variables were added to the regression equation, the model explained 62% of the variance in the environmental literacy outcome versus only 49% of the variance explained when student engagement was the only predictor of environmental literacy. These data suggest that student engagement and self-determination are both related to students' environmental literacy outcomes, but that competence and autonomy have the most proximal impacts on environmental literacy outcomes.

SDT provides a clear pathway leading to enhanced student engagement and learning outcomes (Skinner et al. 2012), positing that students who feel greater competence, autonomy and relatedness tend to be more intrinsically motivated. Intrinsically motivated students typically demonstrate more positive student engagement, improved performance, and even long-term positive behavior changes (Deci and Ryan 2000a; 2000b). Our findings corroborate SDT and suggest that environmental educators might benefit from focusing on developing EE experiences that explicitly support students' self-determination needs (Skinner et al. 2012).

Educators that support students understanding of environmental issues, how these issues are relevant to their own lives, and ways in which they can make a positive difference may enhance students' sense of competence and even their engagement in pro-environmental behaviors (Darner 2009; De Young 2000). Students who feel helpless regarding the environment, and lack an understanding of human-environment issues, are less likely feel competent and be self-determined to take positive action (Darner 2009; Pelletier et al. 1999). Educators should provide ample opportunities for students to investigate environmental issues and topics of their own choosing and the opportunity to formulate their own solutions to problems. Being overly directive and prescriptive can constrain their sense of autonomy (Darner 2009). Even though our data suggests that relatedness was a marginal mediator, educators that create a class environment that invites diverse viewpoints, is free from judgement, and values everyone's input are more likely to support students' sense of relatedness (Darner 2009).

Self-determination theory focuses on autonomous rather than controlled motivation (Csikszentmihalyi 1990; Gagne and Deci 2005). Many in the field of EE have emphasized the positive impacts of students' immersive exploration and learning within the natural world (e.g., Chawla 1998; Hungerford and Volk 1990; Rickinson 2001; Stern, Powell, and Hill 2014) and even advocated for more student autonomous interaction with nature (Louv 2006; Sobel 2012). We suggest that positively supporting students' self-determination, particularly their needs of autonomy and competence, in the EE learning environment is important and may result in enhanced student engagement and outcomes of environmental literacy.

There also may be value in measuring students' self-determination instead of student engagement. By focusing survey items on measuring students' competence, autonomy, and relatedness, we were able to develop potentially more sensitive measures that moved beyond general student engagement. Some elements of student engagement, such as affective engagement in our study, may in reality be measuring student satisfaction. From a practitioner perspective, placing an emphasis on developing EE programs and experiences that support students' sense of competence, autonomy, and relatedness may be more tenable than attempting to develop programming to enhance student engagement. Self-determination theory suggests that when students needs of competence, autonomy, and relatedness are met, they are more likely to demonstrate enhanced engagement in learning, even when they do not have an intrinsic interest in the content or context (Ryan, Deci, and Grolnick 1995; Wigfield and Eccles 2000). Further investigation of the application of self-determination theory both in research and practice seems highly worthwhile.

### **Limitations of the study**

This study was conducted at a single site which may limit the generalizability of the findings. Exploration of additional constructs related to these measures, such as self-efficacy (Bandura 1977; 1986), may have also been worthwhile. We encourage future researchers to expand upon this work to further explore SDT in the EE context.

## **Conclusion**

This case study furthers our understanding of the links between student engagement, SDT, and environmental literacy. Through mediation regression analyses, we were able to determine that students' levels of competence and autonomy mediated the relationship between student engagement and environmental literacy and explained over 60% of the variance in this outcome.

With a larger and more diverse sample, research could begin to uncover the implications of students' self-determination in different conditions and with more diverse outcomes, revealing potentially powerful findings capable of enhancing program design and delivery. Observations of a large number of different EE lessons or experiences could also provide a way to isolate individual characteristics hypothesized to lead to enhanced levels of students' competence, autonomy, and relatedness. We are currently embarking on such a study investigating the links between students' competence, autonomy, and relatedness and outcomes of environmental literacy, positive youth development (PYD), and 21<sup>st</sup> century skills at EE field trip programs in the United States (NSF AISL grant #1612416; [https://www.nsf.gov/awardsearch/showAward?AWD\\_ID=1612416](https://www.nsf.gov/awardsearch/showAward?AWD_ID=1612416)).

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### **Chapter 3**

#### **What leads to better student outcomes? A case study on the characteristics of environmental education lessons most positively associated with student environmental literacy outcomes.**

B. Troy Frensley, Marc J. Stern, and R. B. Powell

#### **Abstract**

In this case study, we developed a novel methodology to identify the characteristics of environmental education (EE) lessons most positively associated with students' environmental literacy outcomes at one residential EE provider. We observed 80 lessons and 17 different educators, tracked 43 observable lesson characteristics (teaching approaches, educator characteristics, and schoolteacher/chaperone behaviors), and collected survey data on students' environmental literacy outcomes. Ten characteristics were positively linked with student outcomes, reflecting two key themes: relevant issue-based education with a meaningful conclusion; and emotional and social connections. We share examples from our qualitative notes to illustrate each of these key lesson characteristics in practice. Our novel methodology which enables the observation and comparison of potentially important lesson characteristics and student learning outcomes has valuable implications for future research. The eight-question environmental literacy survey developed in this study may be appealing to both researchers and practitioners, especially those with time constraints in the field.

#### **Introduction**

Since the Tblisi Declaration in 1977, the field of environmental education (EE) has focused on addressing on the complex issues between humans and the environment, with a goal of developing environmentally literate citizens (Farmer, Knapp, and Benton 2007; North American Association for Environmental Education 2004). Environmentally literate people are equipped with the knowledge, attitudes, dispositions, and competencies needed to effectively recognize, analyze, and address important environmental issues in their communities and beyond (Hollweg et al. 2009; Intergovernmental Conference on Environmental Education 1977). Decades of evaluation research have shown that EE programs, whether single or multi-day, can achieve positive outcomes related to environmental literacy (Rickinson 2001; Stern, Powell, and Hill 2014); yet these summative evaluations rarely focus on determining which characteristics of the experience are most powerfully related to measured outcomes (Ardoin Biedenweg, and O'Connor 2014; Bourke, Buskist, and Heron 2014; Stern, Powell, and Hill 2014). While measuring success or failure of an EE experience is important, only comparative or experimental studies can empirically isolate the factors most responsible for student outcomes (Stern, Powell, and Hill 2014). This study takes a comparative approach.

Students attending residential EE programs leave their homes and spend two or more days in a natural setting, exploring natural environment firsthand in the hope that the experience will enhance their connection to nature, knowledge of the environment, awareness of, and interest in, environmental issues, attitudes, and even behavioral intentions (Ardoin, Biedenweg, and O'Connor 2015; Dettmann-Easler and Pease 1999; Stern, Powell, and Ardoin 2008; 2010). These outcomes are each components of environmental literacy.

The design of EE programs are commonly based on guidelines, such as the North American Association for Environmental Education (NAAEE) *Guidelines for Excellence in Environmental Education* series. This series is considered a unifying document (Heimlich 2010) and is based on the ideas of hundreds of researchers, theorists, and practitioners about what works in EE and which characteristics of EE programs and lessons are most important for success (NAAEE 2010). But, there is little empirical evidence to actually link these practices to better programmatic outcomes. Stern, Powell, and Hill (2014) conducted a review of sixty-six peer-reviewed articles published between 1999 and 2010 and found only circumstantial evidence to broadly support the consensus-based practices in EE. This research project aims to begin to fill this gap by examining specific characteristics of the lessons delivered at a residential EE program to determine their influence on student outcomes of environmental literacy.

Experiential learning theory serves as foundation to explore the characteristics of EE lessons at the study site (i.e., teaching approaches, educator characteristics, and schoolteacher/chaperone behavior) and determine their connection with student environmental literacy outcomes (Kolb 1984; Kolb, Boyatzis, and Mainemelis 2001). Experiential learning is constructivist, building upon students' previous knowledge and experiences through a process of investigation, reflection, and experimentation. Experiential learning in the EE context is relevant to students' lives, using real-world, issue- and investigation-based approaches, has been linked to enhanced positive environmental literacy outcomes in numerous studies (Hungerford & Volk 1990; Rickinson 2001; Stern, Powell, and Hill 2014) and is considered a best practice (NAAEE 2010). Other studies have also associated experiential learning with better student outcomes when compared to traditional education models (Baker, Robinson, and Kolb 2012; Stern, Powell, and Hill 2014).

### **Teaching approaches**

A broad range of teaching approaches and pedagogies may influence students' learning outcomes in EE. A study by Ballantyne & Packer (2009) found that experiential teaching techniques facilitated longer lasting attitudinal and behavioral changes in elementary and middle school students participating in outdoor EE programs in Australia. Key characteristics they identified included: learning by doing; being in the environment; real life learning (real places, real issues, authentic tasks); sensory engagement; and a relevant, local context (Ballantyne & Packer, 2009). A review of empirical studies in EE by Rickinson (2001) revealed direct experiences in nature, positive role modeling behaviors, and collaborative group discussions as key aspects of effective EE programs. A systematic literature review by Stern, Powell, and Hill (2014) suggests that experiential learning in which issue-based, project-based, and investigation-focused approaches are used to address real-world environmental problems are commonly associated with positive student outcomes. Other effective EE program characteristics revealed in this review included: student-centered learning; cooperative group work; explicitly linking content to students' home lives; and supporting student reflection (Stern, Powell, and Hill 2014).

### **The characteristics of the educator**

Research in the fields of EE, interpretation, and informal science education suggests that the characteristics of the educator, such as their apparent degree of confidence, knowledge, and passion, may also be important factors influencing student outcomes (Ballantyne, Fien, and Packer 2001; Ham & Weiler 2002; Stern, Powell, and Hill 2014; Ward and Wilkinson 2006). A nationwide study on interpretive park rangers in nearly 400 ranger-led programs in National Park

Service locations across the United States found that the educator’s comfort, eloquence, apparent knowledge, passion, sincerity, and charisma were strongly associated with more positive visitor outcomes (Stern & Powell 2013). Studies have also shown the degree to which an educator is supportive of students’ emotional needs, and responds appropriately, has an impact on student success (see Fredricks, Blumenfeld, and Paris 2004).

### **Schoolteacher/Chaperone behavior**

In the EE field, schoolteachers and parent chaperones often accompany students during the learning experience. Their involvement may range from positive behaviors (e.g., encouragement, participating alongside students) to negative behaviors (e.g., disciplining students, distracting students). Research in the EE and informal science learning fields suggests that adults, particular known adults such as schoolteachers and parents, may positively impact student outcomes (Emmons 1997; Fenichel & Schweingruber 2010; Rickinson 2001; Stern et al. 2017). These known adults serving as role models to the students may also promote students’ short- and longer-term connection with nature (Chawla & Derr 2012).

### **Research question**

*Which educator characteristics, teaching approaches, and schoolteacher/chaperone behaviors are most consistently associated with more positive environmental literacy outcomes?*

We developed a novel methodology where researchers observed a total of 43 characteristics during 81 EE lessons at the NorthBay Adventure (NorthBay) residential program. These 43 independent variables were grouped into three distinct categories: educator characteristics (10 items) teaching approaches (31 items), and schoolteacher/chaperone behaviors (2 items). Students completed a short survey following each observed lesson to provide data on environmental literacy outcomes. We provide more details about the study location below prior to providing a detailed explanation of our methods.

### **Study site**

NorthBay offers weeklong (five-day) residential programs for visiting middle school students from inner-city urban areas (Baltimore, Washington D.C., and Philadelphia) and suburban and rural areas across the state of Maryland. The NorthBay campus is located on the shore of the Chesapeake Bay and spans over 90 acres of beach, wetlands, and forested habitat. NorthBay’s programming combines elements of traditional EE, positive youth development, multimedia presentations and performances, and adventure activities (Stern, Powell, and Ardoin 2010; Stern et al. 2017). NorthBay’s EE curriculum has been developed in conjunction with the Maryland State Department of Education and incorporates Hungerford et al.’s (2003) ‘investigating and evaluating environmental issues and actions’ (IEEIA) model and the ‘better environmental education, teaching, learning, and expertise sharing’ (BEETLES) project model (BEETLES 2014). NorthBay employs a diverse team of environmental educators, representing a range of races, ages, genders, personalities, and prior experiences. During the EE lessons, students are also accompanied by their school teachers and chaperones and interact with these adults in formal and informal ways.

Each week, NorthBay provides programming for student groups ranging in size from 50 to over 400 students from one or more schools. Students are subdivided into smaller same-sex

groups who share a cabin and move through the entire week together, usually with the same environmental educator. These students participate in two-hour experiential EE lessons, games during mealtimes, activities and free exploration in the afternoon, and live multi-media theater performances each evening. The two-hour EE lessons are the focus of this study and only take place during the morning and afternoon on Tuesday, Wednesday, and Thursday. They occur in a variety of habitats across the campus or on a boat in the Chesapeake Bay. During these lessons, students commonly make observations, collect data, work collaboratively, and investigate environmental issues. NorthBay's environmental educators aim to link lessons learned and new perspectives back to students' home environments through group discussions, reflection, and journaling. The final EE lesson each week is an 'action' lesson where students complete a service learning project on campus (e.g., beach cleanup) and develop a plan for when they return home to positively address issues related to the environment, their school, and their community.

## **Methods**

### **Sampling**

Nine weeks were purposefully selected from February 2015 to November 2015 to mirror the overall student demographics attending the program each year. Fifteen student groups were observed from 17 different schools (12 suburban, 3 urban, 2 rural; NCES 2017). Three of the schools were private schools (one rural and two suburban), and the remaining were public schools. Specific groups within each week were chosen at random. In total, 17 educators were observed. Student group sizes ranged from 11 to 29 students, and each researcher stayed with the same student group, observing every EE lesson they received. Students were always matched with an educator of the same gender (8 female and 7 male groups).

### **Data collection**

Two researchers conducted all field work in this study. Data collection consisted of observations of all EE lessons delivered to each student group and student surveys immediately following each lesson (Table 3-1). In total, 81 lessons were observed with each researcher observing a different student group each week. Seven student groups received six lessons during their weeklong visit, seven student groups received five lessons during their week, and one student group received four lessons during their week due to weather-related and logistical complications.

The observation methodology built on previous research in the fields of environmental interpretation (Stern and Powell 2013) and EE (Ballantyne, Packer, and Everett 2005; Ballantyne and Packer 2009). A researcher observed each entire lesson, maintaining an unobtrusive presence within the student group and not participating in the lesson's activities. Scores for each independent variable were representative of the characteristics of the educator, teaching approaches, and schoolteacher/chaperone behaviors observed across the entire two-hour lesson experience. Immediately following each lesson, we asked students to complete a short survey containing the environmental literacy items. Qualitative data were also collected throughout the lesson provide additional details about the independent variables observed during each lesson.

Table 3-1. Weekly data collection schedule at the NorthBay program.

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

## Measurement

### *Student outcomes: environmental literacy*

Surveys were administered to the students immediately following each EE lesson during their weeklong visit. Survey items were developed to measure environmental literacy, the dependent variable in this study, based on key literature (Hollweg et al. 2011, McBeth et al. 2011; McBride et al. 2013; Table 2-1). Response categories were comprised of a five-point Likert-type scale ranging from: (1) not at all; (2) a little; (3) somewhat; (4) a lot; (5) a huge amount. As a part of this same study, Frensley et al. (2018a) conducted confirmatory factor analysis on individual student survey responses (N = 1,298) and confirmed these six survey items comprise a statistically valid environmental literacy index (S-B  $\chi^2/df$  = 0.17; S-B CFI = 0.97; S-B RMSEA = 0.06; S-B TLI = 0.96; SRMR = 0.04). An analysis of internal consistency of the index resulted in a Cronbach's alpha score of 0.90. The index was computed by taking the mean of all six survey items for each lesson (Frensley et al. 2018a).

Table 3-2. Student survey items comprising environmental literacy outcome index.

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

### *Independent variables: Educator characteristics, teaching approaches, and schoolteacher/chaperone impacts*

The observation variables used in this study were based on prior literature in the EE (e.g., Rickinson 2001; Stern, Powell, and Hill 2014; Ballantyne and Packer 2009, NAAEE 2010), environmental interpretation (e.g., Ham 1992; Skibins, Powell, and Stern 2012; Stern and Powell 2013) informal science education (e.g., NRC 2009; Fenichel and Schweingruber, 2010), and educational psychology fields (e.g., Fredricks, Blumenfeld, and Paris 2004; Skinner and Belmont

1993). Tables 3-3, 3-4, and 3-5 provide a complete list of observed independent variables along with definitions and supporting literature for each. All were scored on a four-point Likert-type scale except for the four class management techniques (redirect, negative, positive, and request, see Table 3-4), which were scored on a three-point Likert-type scale ranging from: (0) did not occur; (1) sometimes occurred; (2) frequently occurred.

Table 3-3. Educator characteristic variables used in this study.

Variable	Definition
<b>Passion</b> (Stern and Powell 2013)	The educator’s apparent level of enthusiasm for the lesson content as opposed to a bored or apathetic attitude toward it. The overall vigor with which the material is presented.
<b>Charisma</b> (Stern and Powell 2013)	A general sense of the overall likeability/charisma of the educator, commonly recognized by seemingly genuine interaction with the students, including smiling, looking people in the eye, and having an overall appealing presence.
<b>Sincerity</b> (Stern & Powell 2013)	Degree to which the educator seems genuinely invested in the messages he or she is communicating, as opposed to reciting information, and seems sincere in the emotional connection they may exude to the message and/or place ( <i>demonstrating authenticity</i> ).
<b>Apparent knowledge</b> (Stern and Powell 2013)	Degree to which the educator appears to know the information presented in the lesson, able to answer relevant questions, and demonstrates personal knowledge of the resource in which the lesson takes place.
<b>Educator comfort</b> (Stern and Powell 2013)	Degree to which the educator seems comfortable with the students and capable of successfully presenting the program without apparent signs or nervousness or self-doubt.
<b>Eloquence</b> (Stern and Powell 2013)	The extent to which the educator spoke clearly and articulately, and did not mumble or frequently use filler words such as “um” or “like.” Exceptional eloquence is moving or persuasive ( <i>this is not a quality of content, only degree of eloquence</i> ).
<b>Emotional sensitivity</b> (Skinner and Belmont 1993; Stern, Powell, and Hill 2014)	The extent to which the educator responded to the emotional needs (e.g. caring, encouragement, trust, free from excessive judgment, etc.) of the students.
<b>Responsiveness</b> (Stern and Powell 2013)	The extent to which the educator interacts with the audience and responds to their specific questions, requests, or non-verbal cues (e.g., losing interest, eagerness to continue working, etc.)
<b>Opportunism</b> (Louv 2006; Sobel 2012)	The degree to which the educator positively adapts lesson content and logistics due to incidents or opportunities that arose while teaching in the natural environment (e.g. live animal encounter, student requests/questions about the place, etc.).

<b>Clarity</b> (Fredricks et al. 2002; Skinner and Belmont 1993; Wurdinger 2005)	The degree to which the educator effectively communicated instructions and expectations for the lesson.
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Table 3-4. Teaching approaches variables used in this study.

<b>Variable</b>	<b>Definition</b>
<b>Group reflection</b> (Hungerford and Volk 1990; Stern and Powell 2013; Stern, Powell, and Hill 2014).	Degree to which the reflection is group-based (e.g., discussion).
<b>Individual reflection</b> (Hungerford and Volk 1990; Stern and Powell 2013; Stern, Powell, and Hill 2014).	Degree to which the reflection is individual-based (e.g., journal writing).
<b>Affective messaging</b> (Stern and Powell 2013)	Degree to which the lesson communicated emotion ( <i>in terms of quantity, not quality</i> ).
<b>Play-based learning</b> (Liefländer and Bogner 2014)	Degree to which the lesson actively engages students in games or competition as an intentional teaching technique.
<b>Holistic storytelling</b> (Stern and Powell 2013)	Degree to which the lesson presented a holistic story as opposed to disconnected pieces of information ( <i>students can be characters in the story</i> ).
<b>Sensory-based learning</b> (Ballantyne and Packer 2009; Tilden 1957; Ward and Wilkinson 2006)	Degree to which students are encouraged to explicitly use their senses in a unique way to explore a concept, solve a problem, or connect to their environment.
<b>Cooperative group learning</b> (Rickinson 2001)	Degree to which the lesson content requires students to work with others, either through group deliberation/discussion and/or active participation/investigation.
<b>Multiple viewpoints</b> (Stern and Powell 2013)	Degree to which the lesson explicitly acknowledged multiple perspectives or uncertainty ( <i>often in controversial messaging; when an argument was made, was a counter-argument provided?</i> ).
<b>Relevance</b> (Ardoin, Clark, and Kelsey 2002; Ballantyne and Packer 2009; Stern and Powell 2013; Stern, Powell, and Hill 2014)	Degree to which the lesson content references or makes explicit connections to the students' experience outside the realm of the instruction.
<b>Role modeling</b> (Ardoin et al. 2013; Chawla & Derr 2012; Rickinson 2001; Stern et al. 2017)	Degree to which the educator demonstrates and shares their interests and "likes" about the topic and uses stories, actions, or models to create the impression that a desirable behavior is the norm.
<b>Environmental issue-based</b> (Ballantyne and Packer 2009; Rickinson 2001; Stern, Powell, and Hill 2014)	Degree to which the lesson focuses on real-world environmental problems/issues, their consequences, and potential solutions.

<b>Fact-based</b> (Stern and Powell 2013)	Degree to which the lesson communicated “factual” information as opposed to other forms of delivery, such as storytelling, discussion, or emotional messaging.
<b>Guided inquiry</b> (Jacobson 1999; Lewis 2005; Stern, Powell, and Hill 2014; Ward and Wilkinson 2006)	Degree to which educator asks questions and facilitates students’ pursuit of answers.
<b>Quality of questions</b> (Hungerford and Volk 1990; Stern, Powell, and Hill 2014)	Degree to which the educator’s questions were probing and encouraged critical thinking, problem solving, student-led solutions/discussion, and complexity (instead of one or two word answers, memorization, or educator giving students the answer).
<b>Investigation</b> (Hungerford and Volk 1990; Stern, Powell, and Hill 2014)	Degree to which students took part in active testing of a hypothesis (e.g., investigation) during the lesson ( <i>May be field-based, lab-based, or class based</i> ).
<b>Teacher-led investigation</b> ( <i>subset of investigation</i> )	Degree to which the investigation is teacher-led (e.g., educator told students what to investigate).
<b>Student-led investigation</b> ( <i>subset of investigation</i> )	Degree to which the investigation is student-led (e.g., students in charge of own investigation).
<b>Data collection</b> (Hungerford and Volk 1990; Stern, Powell, and Hill 2014)	Degree to which students carried out research techniques to address research questions. Data collection may be field-based or lab-based.
<b>Hands-on learning</b> (Ballantyne and Packer 2009; Stern, Powell, and Hill 2014)	Degree to which students were actively involved (e.g., touching or interacting with nature, props, etc.) during the lesson; not just passive receivers of verbal or visual communication (e.g., physical involvement).
<b>Free exploration</b> (Ardoin, Clark, and Kelsey 2012; Ballantyne and Packer 2009; Stern, Wright, and Powell 2012)	Degree to which students were encouraged to explore the environment for reasons other than scientific data collection ( <i>may be teacher or student-led</i> ).
<b>Student-led learning</b> (Ballantyne and Packer 2009)	Degree to which students are in charge of their own experience during the lesson instead of following detailed directions from an educator.
<b>Quality of introduction</b> (Stern and Powell 2013)	Degree to which the introduction oriented the students to the lesson’s content (and/or primary message) and captured student’s attention.
<b>Quality of conclusion</b> (Stern and Powell 2013; Stern, Powell, and Hill 2014)	Degree to which lesson connected the introduction and lesson-content into a conclusion in an organized or cohesive way (e.g., lesson “came full circle”).
<b>Transitions</b> (Stern and Powell 2013)	Degree to which educator incorporated transitions during shifts in location or content to keep the students engaged and did not detract from the lesson’s sequence ( <i>quality not quantity focused</i> ).
<b>Class management</b>	Degree to which the educator effectively managed disruptions or off-task behavior.

(Bohn et al. 2004; Henderlong & Lepper 2002; Regnier, Gross, and Zimmerman 1992; Wong & Wong 2005)	
<b>Redirect</b> (subset of class management)	Educator attempts to re-focus students attention through short games, repetition, or redirection (e.g., clap three times if you can hear me, etc.)
<b>Request</b> (subset of class management)	Educator asks students to behave in a certain way (e.g., please be quiet, stay focused, etc.)
<b>Negative</b> (subset of class management)	Educator threatens or disciplines students (e.g., loss of free team, sitting out of an activity, etc.)
<b>Positive</b> (subset of class management)	Educator praises or rewards students (e.g., thank you for your hard work, incentives, etc.)
<b>Time management</b> (Baker, Robinson, and Kolb 2012; Enfield 2001; Wurdinger 2005; Stern and Powell 2013)	The degree to which the students were able to complete all intended parts of the lesson in an organized and cohesive way, not just disconnected parts of the lesson (e.g. experience without reflection, etc.)
<b>Appropriate logistics</b> (Stern and Powell 2013)	Degree to which basic student and lesson needs were met (i.e., restrooms, weather, technology, accessibility, shade, etc.)

Table 3-5. Schoolteacher/chaperone behavior variables used in this study.

<b>Variable</b>	<b>Definition</b>
<b>Teacher/Chaperone positive behaviors</b> (Baker, Robinson, and Kolb 2012; Rickinson 2001; Sivek 2002; Stern et al. 2017)	Degree to which the visiting schoolteacher and/or chaperone is engaged and positively impacts (e.g. encouragement, enthusiasm, supports learning, etc.) the NorthBay educator and students during the lesson.
<b>Teacher/Chaperone negative behaviors</b> (Baker, Robinson, and Kolb 2012; Rickinson 2001; Sivek 2002; Stern et al. 2017)	Degree to which the visiting schoolteacher and/or chaperone is engaged and negatively impacts (e.g. distracts, hinders learning, etc.) the NorthBay educator and students during the lesson.

### Pilot testing

Four weeks of pilot testing aided in the development and refinement of the study methodology and enhanced the reliability of measurement by the two field researchers. Both researchers observed eight different NorthBay educators and 18 unique EE lessons together during this time. Extensive discussions allowed for further refinement to the independent variable definitions and observation techniques. For each measure, we sought to maximize the potential for measuring variability. Once the definitions and scoring for each variable were finalized, the two researchers continued to observe lessons at the study site until an interrater reliability above 0.90 was obtained. The average measure ICC was 0.928 with a 95% confidence interval from 0.889 to 0.957 ( $F(40, 440) = 15.512, p < .001$ ). ICC estimates and their 95% confidence intervals were calculated using SPSS 23 based on average measures using absolute-agreement and a two-way mixed-effects model.

We also pilot tested student surveys during these four weeks with the goal of developing a survey that could be completed by students in approximately five minutes following each lesson. We discussed the surveys with students to ensure they understood the intent of the questions and instructions. We eliminated or revised questions that were confusing to the students or exhibited little to no variability over the four weeks.

## **Analyses**

### *Data cleaning*

Any student surveys missing more than 50% of data (Tabachnick and Fidell 2007) and responses failing the inversely worded validity check (agreement on both “I disliked the lesson” and “I enjoyed the lesson”) were removed.<sup>3</sup> This screening process resulted in the removal of 77 student surveys, reducing the sample size to 1,392 individual student surveys from 81 lessons. Data were also screened for multivariate outliers using Mahalanobis Distance; which resulted in the removal of an additional 94 student surveys (Tabachnick and Fidell 2007). This reduced our sample to 1,298 student surveys from 81 lessons. To be able to compare our group-level observations to self-reported survey measures, we aggregated all individual student scores to the group level by taking the mean of all student scores from each lesson. Before doing so, we examined the intraclass correlation coefficients (ICC(1)) for students’ responses on the environmental literacy outcome index to determine validity of this aggregation. ICC(1) scores calculated on the dependent variable offer a measure of non-independence and aid in answering the question of whether or not outcomes are impacted in some way by group membership (Bliese 2000; Byrk and Radenbush 1992; Kreft and DeLeeuw 1998). Analysis revealed an ICC(1) score of 0.27. Any score above 0.25 is considered a large effect, suggesting a great deal of the variance occurred at the group level and not at the individual level (Bliese 2000; Byrk and Radenbush 1992). The small number of student groups in this study (N = 15) precluded the use of more complex multi-level modeling (Mass and Hox 2005).

Student mean scores for the aggregated environmental literacy survey items were then checked for skewness and kurtosis. All lessons except for one were below the threshold for concern ( $\pm 0.6$ ; Schumacker and Lomax 2004). Data were then screened for multivariate outliers using Mahalanobis Distance. This same lesson was confirmed as an outlier and was subsequently removed from the sample (Tabachnick and Fidell 2007). This resulted a final sample size of 80 lessons.

### *Principal Component Analysis: Independent Observation Variables*

Principal component analyses (PCA) and reliability analyses were used to explore the relationships between the individual educator characteristics and teaching approaches variables. We did not perform CFA for these data because they are observed formative variables representing a specific practice or characteristic that is hypothesized to directly influence student outcomes. We report the Kaiser-Meyer-Olkin (KMO) measure to confirm sampling adequacy and Bartlett’s test of sphericity to confirm that the correlations between variables are not too small. The KMO measure should be above 0.5 with a sample size less than 100 (MacCallum et al. 1999) and the Bartlett’s test of sphericity should be statically significant ( $p < 0.05$ ) (Field 2013). In this paper, we only report the Cronbach’s alpha values from the reliability analyses for

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<sup>3</sup> Six student engagement survey items were part of the larger research study (see Frensley et al. 2018a; 2018c) but were not relevant to this manuscript and are therefore not reported.

each index, but additional details on the criteria for extracting factors, the proportion of variance that each factor explains (with eigenvalues), and a table with rotated factor loadings can be found in Appendix A.

*Which educator characteristics, teaching approaches, and schoolteacher/chaperone behaviors are most consistently associated with more positive environmental literacy outcomes?*

To answer the research question, we first conducted bivariate correlation analyses between the educator characteristics, teaching approaches, schoolteacher/chaperone behaviors and student environmental literacy outcomes. We then conducted a one-way analysis of variance (ANOVA) with posthoc testing to identify any statistically significant differences in mean student environmental literacy outcome scores across the lessons delivered each week. Independent samples t-tests were conducted to identify significant differences in the characteristics of the highest scoring lesson versus all other lessons. Qualitative data from observations provide additional nuance of lesson characteristics in practice.

### Results

We used pre-existing measures for two educator characteristics in this study (see Stern and Powell 2013). The *Authentic Emotion index* is comprised of passion, charisma, and sincerity (Cronbach’s  $\alpha = 0.92$ ) and the *Confidence index* is comprised of educator comfort, apparent knowledge, and eloquence variables (Cronbach’s  $\alpha = 0.75$ ; Table 3-6). PCA with the remaining educator characteristics revealed the presence of a third educator characteristic comprised of emotional sensitivity and responsiveness, which we combined to form the *Emotional Sensitivity and Responsiveness index* (Cronbach’s  $\alpha = 0.93$ ).

PCA and reliability analysis with the teaching approaches and did not reveal any latent constructs, despite retaining seven factors with Eigenvalue’s above 1.0. No single factor exhibited a Cronbach’s alpha above 0.6. PCA and reliability analyses were performed separately on the four class management techniques, which were a subset of the class management variable and measured on a three-point Likert-type scale. This analysis revealed the presence of a single latent factor comprised of negative, redirect, and request class management techniques. We created an index of these items and call it *Non-positive class management techniques* (Cronbach’s  $\alpha = 0.74$ ).

Table 3-6. Independent variable indexes.

<b>Independent Variable Indexes</b>
<b>Educator characteristic: <i>Confidence</i></b> (Cronbach’s $\alpha = .75$ )
•Educator comfort
•Apparent knowledge
•Eloquence
<b>Educator characteristic: <i>Authentic emotion</i></b> (Cronbach’s $\alpha = .92$ )
•Passion
•Charisma
•Sincerity
<b>Educator characteristic: <i>Emotional stability</i></b> (Cronbach’s $\alpha = .93$ )

- Emotional sensitivity
- Responsiveness

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**Teaching approach: *Non-positive class management techniques***

(Cronbach's  $\alpha = .74$ )

- Negative
  - Redirect
  - Request
- 

**Descriptive statistics and bivariate correlation**

Tables 3-7, 3-8, and 3-9 display the descriptive statistics for the educator characteristics, teaching approaches, and schoolteacher/chaperone behaviors and the Spearman rho correlation statistics between each item and the environmental literacy outcome index. The Spearman rho statistic was used due to the ordinal nature of the independent and dependent variables in this study (Field 2013). Scores are displayed in rank order based on Spearman statistic values. None of the observed educator characteristics were significantly correlated with the environmental literacy outcome index (Table 3-7). Four teaching approaches were statistically significantly correlated with the environmental literacy outcome index: environmental issue-based; quality of conclusion; affective messaging; and role modeling; (Table 3-8). Schoolteacher/chaperone positive behaviors were also significantly correlated with environmental literacy outcomes (Table 3-9).

Table 3-7. Means and standard deviations of educator characteristics and Spearman correlation values with the environmental literacy index.

<b>Variable</b>	<b>Means (SD)</b>	<b>Environmental Literacy</b>
Authentic emotion index	3.14 (0.59)	.137
Opportunism	2.31 (1.14)	.146
Emotional sensitivity and responsiveness index	2.89 (0.75)	.114
Confidence index	2.95 (0.51)	.095
Clarity	2.80 (0.46)	-.113

*Note: All items on a 1 to 4 Likert-type scale*

Table 3-8. Means and standard deviations of teaching approaches and Spearman correlation values with the environmental literacy index.

<b>Variable</b>	<b>Means (SD)</b>	<b>Environmental Literacy</b>
Environmental issue-based	2.60 (0.94)	<b>.362**</b>
Affective messaging	1.82 (0.90)	<b>.356**</b>
Quality of conclusion	2.19 (0.91)	<b>.347**</b>
Role modeling	1.59 (0.88)	.245*
Appropriate logistics	2.94 (0.66)	.207
Group reflection	2.61 (0.83)	.199
Relevance	2.44 (0.90)	.196
Time management	3.39 (0.71)	.171
Free exploration	1.84 (1.02)	.130
Question quality	2.23 (0.53)	.115
Class management	3.11 (0.61)	.113

Storytelling	1.53 (0.82)	.095
Guided inquiry	3.04 (0.72)	.075
Hands-on	3.15 (0.98)	.072
Transitions	1.74 (0.91)	.044
Play-based	1.81 (0.99)	.040
Cooperative/group	2.43 (1.17)	-.013
Individual reflection	1.99 (0.88)	-.017
Sensory focus	1.70 (0.94)	-.026
Positive class management technique	0.90 (0.81) <sup>+</sup>	-.045
Non-positive class management techniques	0.85 (0.60) <sup>+</sup>	-.049
Fact-based	2.49 (0.77)	-.063
Quality of introduction	2.26 (0.74)	-.066
Data collection	2.81 (1.23)	-.165

Note: <sup>+</sup> items on a 3-point Likert-type scale (0 to 2); All remaining items on a 1 to 4 Likert-type scale; \*\* *p*-value < 0.01; \**p*-value < 0.05

Table 3-9. Means and standard deviations of schoolteacher/chaperone behaviors and Spearman correlation values with the environmental literacy index.

Variable	Means (SD)	Environmental Literacy
Teacher/chaperone positive	2.13 (1.06)	.275*
Teacher/chaperone negative	1.40 (0.67)	-.067

Note: All items on a 1 to 4 Likert-type scale; \*\* *p*-value < 0.01

### Most successful EE lesson versus all other lessons

We performed an ANOVA to investigate differences in student environmental literacy index scores across the lessons they received during the week. The analysis of variance yielded an *F* ratio of  $F(5, 75) = 3.93$ ,  $p < .01$ . Posthoc testing (Bonferroni) indicates the final lesson each week, which was always the “action” lesson, was associated with significantly higher environmental literacy outcomes when compared to all other lessons delivered each week (Table 3-10). Fifteen different NorthBay educators were observed delivering the Action lesson.

Table 3-10. ANOVA with Bonferroni posthoc test results for differences in student environmental literacy index scores across lessons.

Index	Mean Scores						P-value
	Lesson 1 (N=14)	Lesson 2 (N=12)	Lesson 3 (N=12)	Lesson 4 (N=14)	Lesson 5 (N=14)	Lesson 6 (N=14)	
Environmental Literacy	3.68 <sup>a</sup>	3.63 <sup>a</sup>	3.67 <sup>a</sup>	3.72 <sup>a</sup>	3.76 <sup>a</sup>	4.18 <sup>b</sup>	0.002

Note: <sup>a</sup> represents a statistically significant lower mean score than <sup>b</sup> ( $p < 0.05$ ; Bonferroni posthoc test).

Because the Action lesson was found to have significantly more positive environmental literacy outcomes, we conducted an independent samples t-test to compare the lesson

characteristics of the action lesson to all of the other lessons we observed (Table 3-11). We also report Cohen’s *d* effect sizes for each of the statistically significant differences between the action lesson and all others. Effect sizes with an absolute value greater than 0.8 indicates a large effect and greater than 0.5 indicate a moderate effect (Cohen 1988). All of the observed differences are moderate to large.

All but one action lesson we observed consisted of a service learning project (e.g., beach cleanup or invasive exotic plant removal), enabling the students to take action to improve the environment at NorthBay. Students always reflected on their experiences at NorthBay, and each educator engaged the students in different ways to develop an action plan to implement once they returned home. Students’ action plans ranged in formality and also in the focus of the plan, which consisted of ways to improve students’ own lives, their schools, communities, and natural environments where they lived. Each action lesson typically included less data collection and fact-based content and opened up more opportunities for student cooperative/group work and relevant discussion on transferring what students learned at NorthBay leading to positive changes back home.

Table 3-11. Independent samples t-test comparing lesson characteristics of the Action lesson to all other lessons observed.

<i>Variable</i>	<b>Action Lesson (N=15)</b>		<b>All Other Lessons (N=63)</b>		<i>df</i>	<i>t</i>	<i>Cohen’s d</i>
	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>			
Group reflection	3.20	0.862	2.48	0.776	77	3.15**	0.88
Individual reflection	2.53	1.060	1.86	0.794	77	2.77**	0.72
Affective messaging	2.47	0.834	1.68	0.856	76	3.20**	0.93
Cooperative/group	3.13	1.187	2.28	1.105	77	2.65*	0.74
Storytelling	2.00	1.134	1.43	0.706	78	2.48*	0.60
Relevance	3.13	0.743	2.28	0.863	77	3.53**	1.06
Sensory	1.07	0.258	1.85	0.988	79	-3.05**	-1.08
Role modeling	2.20	1.146	1.46	0.752	78	3.08**	0.76
Fact-based	1.71	0.611	2.66	0.695	76	-4.69**	-1.45
Data collection	1.40	1.056	3.16	1.027	77	-5.93**	-1.69
Conclusion quality	2.67	0.976	2.09	0.861	78	2.27*	0.63
<b>Environmental Literacy Index</b>	<b>4.16</b>	<b>0.311</b>	<b>3.69</b>	<b>0.370</b>	<b>78</b>	<b>4.58**</b>	<b>1.34</b>

Notes: \*\* *p*-value < 0.01; \**p*-value < 0.05; All items on a 1 to 4 Likert-type scale except for environmental literacy index which is on a 1 to 5 Likert-type scale.

### **What did the lesson characteristics most commonly associated with greater environmental literacy outcomes look like in practice?**

Ten characteristics were positively associated with students’ environmental literacy outcomes during the lessons at NorthBay. Qualitative observations provided additional nuance

and examples of what these characteristics looked like in practice when effectively delivered to students (Table 3-12).

Table 3-12. Observations of high scores for the characteristics positively associated with enhancing students’ environmental literacy outcomes.

<b>Characteristics</b>	<b>Examples</b>
<b>Environmental issue-based</b>	The educator engaged the students in a discussion about food waste, the lengthy journey from farm to table to trash, and the implications of these steps on the environment. Students then gathered all of the food waste and compost, weighed each, and recorded the data. While doing this, the educator told the students to think about every meal they ate, the steps that go into making their food, and what happens to it when thrown away. The students shared their thoughts about positive ways they can reduce their waste and impact(s) on the environment.
<b>Quality of conclusion</b>	The educator dedicated 15 minutes for a strong conclusion that was relevant and linked the content covered in the lesson to students’ home lives. During the lesson, the educator talked about how wetlands are filters, removing harmful pollution from the environment, preventing the area from becoming a degraded condition. During the conclusion, the educator linked the concepts of filter and degraded conditions to the experiences they had with bullying in their own life. The students and educator discussed ways to be positive filters for the species living in this ecosystem so a degraded condition doesn’t develop. The conversation continued to ways to be a positive filter and identify negative filters (a.k.a. role models) in the students’ lives at home so they are not harmed. Several students shared ideas for being positive filters for the natural environments in their community at home.
<b>Affective messaging</b>	The educator frequently conveyed the importance of loving a place or species. During a lesson on fungus, the educator says, “Today, I am going to teach you about fungi in all of their diversity. I know you think they are weird, but I am going to teach you to love them.” The educator focused less on facts and data in the first 20 minutes of the lesson and more on why fungi are so special, giving students an opportunity to find fungi, draw them, name them, and come up with stories about how these fungi live their lives and why they are important.
<b>Group reflection</b>	After students completed a lesson about food and worked as a group to identify the chains in food production for their morning meal, the educator asked the students to reflect on the point of the lesson and what we waste when we throw food away. The students shared lots of different things. One student said, “The cow that gave its life for you.” The educator asked the group if that was an issue, and a discussion ensued about whether or not the cow’s life matters. The educator asked the students to reflect on this new knowledge and think about what they can do. The students shared ideas aloud of ways to limit food waste both at NorthBay and at home.

<b>Individual reflection</b>	The educator encouraged the students to find a location along the beach to spread out and reflect on the lesson, their time at NorthBay, and how they may think differently about their lives and actions when they go home. The educator gave students ten minutes to draw, write, or just think and consider how they will take positive action when they return home. The educator also asked the students to reflect on the positive people in their lives and how surrounding themselves with these positive role models can help them achieve their goals.
<b>Cooperative/group learning</b>	Students partnered up, and each pair received random household items (soap, whisk, sponge, baby doll, animal cracker box, granola wrapper, etc.). The educator encouraged the students to think about how these items represented a way in which a wetland is important or works. The educator had students share aloud their thoughts and used these household items to explain how wetlands serve as filters and nursery grounds, how they improve water quality and water storage, how they serve as migration stopovers for birds, and other ecosystem services. The educator didn't reveal these answers until after the students worked together as a group to share what they thought each object represented and got help from other peers.
<b>Storytelling</b>	The educator opened the lesson by asking students to list the issues threatening the Chesapeake Bay. The educator encouraged the students to think about these issues, why they are a problem, and where these problems are coming from. She gathered the students around a plastic container, filled it with water, and told the students this was the Chesapeake Bay. She assigned students as characters in the story (e.g., farmers, crabbers, tourists). As the educator told the story, each student added something to the water in the container (e.g., soil, leaves, trash, "chemicals," etc.) to highlight the issues caused by humans over time. The educator concluded the lesson by asking students about how they felt about these issues and whether they felt like they had a choice in their behavior as a crabber, farmer, or other role? The students had a thoughtful conversation about the issues they listed at the start of the lesson but with a new perspective and interest. They saw themselves as characters in the story.
<b>Relevance</b>	Students completed a game that required them to work together to "stay alive" on an island. The students discussed the concept of a filter in the environment, such as a wetland, and then the educator spoke about how the people in our lives could be filters too. The educator engaged the students in a discussion about being a positive filter, who the filters were in their lives, if they were a positive filter to someone else, and whether or not they were a positive filter during the game. The educator did a masterful job of making a seemingly irrelevant game extremely relevant for these students and broached complex issues such as protecting the environment and building a stronger community at home.

<b>Schoolteacher/ chaperone positive behavior</b>	The school teacher got into the wetlands with the students to collect data and walked around to each group to make sure they didn't need any help collecting data. The teacher also asked each student group questions about what they were finding and reminded them to write down their data. The NorthBay educator remained on the bridge by the wetlands yelling out things to the students, who ignored their directions the majority of the time. The school teacher was instrumental in helping the students collect good data and stay on task.
<b>Role modeling</b>	The educator taught the students how to identify and remove invasive exotic Japanese stiltgrass for their action project. This work was intensive with students on their knees or bent over pulling out these exotic weeds from along a forest trail. The educator challenged the students to fill three large trash bags. She got on the ground with them and pulled exotic plants for almost 15 minutes. The educator praised the students along the way and moved around to pull plants with each student group that had formed. The educator said she comes here all of the time to pull these weeds, even when no one else is looking, and with the help of the students, they were able to make a significant positive impact on the environment.

**Discussion**

This study sought to explore the relationships between educator characteristics, teaching approaches, and schoolteacher/chaperone behaviors on student outcomes of environmental literacy at NorthBay. Five variables were significantly and positively associated with environmental literacy across the entire sample. Further analysis of the characteristics of the most successful lesson (action) revealed an additional five variables positively associated with student outcomes. Although data collection, sensory-based, and fact-based approaches were negatively associated with environmental literacy in our analysis of the action lesson versus all other lessons, we caution readers against inferring that these teaching approaches are unimportant. Instead, we focus on the characteristics that enhanced the environmental literacy outcome. We summarize these findings within the following two key themes: relevant issues-based education with a meaningful conclusion and emotional and social connections.

**Relevant issues-based education with a meaningful conclusion**

This theme is comprised of the following variables: relevance; environmental issue-based; quality of conclusion; reflection (group and individual); and holistic storytelling. The importance of real-world, environmental issue-based approaches has been widely supported in the literature (Ballantyne and Packer 2009; Jacobson et al. 2006; Rickinson 2001; Smith-Sebasto and Walker 2005; Stern, Powell, and Hill 2014). Lessons that were relevant to the students and linked content back to students' lives at home were more successful. NorthBay uses key themes to link ecological concepts and experiences to students' lives at home in the constructivist spirit. The inclusion of locally relevant issues and topics is considered an essential best practice of effective EE (NAAEE 2010) and supported by research in numerous fields (Ballantyne and Packer 2009; Gardner and Stern 2002; Stern and Powell 2013; Stern, Powell, and Hill 2014).

Effective conclusions that contain meaningful reflection can be a valuable mechanism to reinforce the salience of locally relevant issues. Sometimes, educators in the study would provide

a quick conclusion as an afterthought. This was often seen with larger student groups, having a negative influence on outcomes for these students. In a few cases, the educators ran out of time, and provided no conclusion at all. The most consistently successful educator we observed allowed fifteen minutes at the end of every lesson for group reflection and a clear conclusion about how the lesson might connect back to students' lives back at home. The success of the Action lesson further supports the importance of a powerful and relevant conclusion. The Action lesson tied together all of the preceding lessons during the week. Educators were observed in this lesson providing a clear take home message by explicitly linking students' experiences during the week to their home lives, giving them an opportunity to perform service learning projects to enhance the ecosystems they had been investigating, and supporting students' planning of ways to take positive action when returning home.

Numerous studies in the EE and environmental interpretation literature have suggested the importance of holistically addressing a relevant issue and supporting it with a strong conclusion to enhance student outcomes (Ballantyne and Packer 2009; Hungerford and Volk 1990; Stern and Powell 2013; Stern, Powell, and Hill 2014). Student reflection (individual or group) was most often incorporated at the end of lessons, but also sometimes at different intervals throughout the lessons. Providing students an opportunity to reflect on their experiences and newfound knowledge and perspectives is a key component of the experiential learning cycle (Kolb 1984) and has been long been considered an important component of effective EE (Hungerford and Volk 1990).

Good storytelling also helped to enhance the relevance of lessons for students and provided a more holistic framing for information, games, or hands-on activities during lessons. Effective storytelling examples range from educators framing lessons around stories of their own successes and failures in life to having students become migrating birds traveling across the country, encountering the issue of wetland lost firsthand. Findings in this study associated with storytelling parallel those found in effective environmental and cultural interpretation, where storytelling is a central vehicle for connecting audiences to deeper meanings associated with the subject matter of the program (Stern and Powell 2013; Tilden 1957). Stories also typically ensure the presence of a meaningful conclusion.

### **Emotional and social connections**

This theme is comprised of the following variables: affective messaging; cooperative/group experiences; role modeling; and schoolteacher/chaperone positive behaviors. Educators that conveyed their love for the place and expressed care and concern for the environment and their students, may have been better able to transfer these emotions to the students, or at least make them accessible. Students appeared more inclined to consider and share their feelings and emotions about key issues affecting the natural environment and their lives at home if the educator shared affective-based messages of their own. Many argue that the affective domain is a critical entry point for building environmental literacy (Iozzi 1989a; 1989b; Hungerford and Volk 1990; Reis & Roth 2017), and research provides some empirical support for this (Stern & Powell 2013). Placing a greater emphasis on emotions (e.g., attitudes and values) during conclusions and reflection has also been linked to promoting emotional development, nature affinity, and possibly pro-environmental attitudes and behaviors (Ballantyne and Packer 2009; Bergman 2016; Cheng and Monroe 2012; Kals, Schumacher, and Montada 1999; Hungerford and Volk 1990; Nisbet, Zelenski, and Murphy 2009).

Cooperative/group experiences were linked to more positive outcomes as well. Social cognitive theory suggests that people learn by observing and engaging with others (Bandura 1977; 1986), and studies in EE have shown that cooperative group learning can result in greater achievement and retention than competitive and individualistic learning approaches (Jacobson et al. 2006). Cooperative group learning, particularly teambuilding challenges and service learning projects that occurred in the action lesson, highlighted the important role each student can play in the group's success. Educators that allowed time for reflection on these successes or failures and linked these to students' lives tended to achieve higher environmental literacy outcomes.

Educators often serve as role models for the students. Educators who were willing to immerse themselves alongside the students were more likely to experience positive student outcomes. This extended into the personal stories educators shared of making tough choices in their lives that impacted the environment or their community. In the current study, schoolteachers and parent chaperones who demonstrated positive behaviors during were associated with enhanced student outcomes. Their positive support likely provided some familiarity and security by serving as links between the students' home environment this novel natural environment (Ardoin et al. 2016; James and Bixler 2008; Linzmayer and Halpenny 2014; Vygotsky 1978). A recent study found when students reported known adults, especially teachers and parents, as their role models, they also reported stronger outcomes associated with environmental literacy (Stern et al. 2017). This study also found that the educational program had an influence on who students' identified as the role models in their lives.

### **Limitations of the Study**

This case study is limited by the small sample size of lessons observed (N = 81), which precluded our ability to perform more complex multivariate analyses. Our observations of only one program provider (NorthBay) limit the generalizability of the findings. While many of the variables we found to be most strongly related to positive environmental literacy outcomes have been found in other studies as well, other variables, such as the sharing of multiple viewpoints or investigation-focused approaches, which did not vary in this study, might also be predictive elsewhere.

This study gathered student data through immediate post-experience surveys which limits our understanding of any longer-term implications of these findings. The strength of this study lies in its comparative nature and the isolation of specific lesson characteristics to investigate their relationships with student outcomes. The students looked forward to being able to respond in real time, immediately following each lesson to provide data on these outcomes.

### **Conclusion**

This study has aimed to add to the rather sparse evidence about what works best in EE. We identified ten lesson characteristics that were consistently associated with higher environmental literacy scores at NorthBay, which we summarized in two overarching themes: relevant issues-based education with a meaningful conclusion and emotional and social connections. The results suggest that high quality EE moves beyond the mere sharing of information and beyond traditional classroom teaching techniques toward helping students to feel something about an issue, place, or even each other. Emotions may indeed be a key entry point for environmental literacy.

This study makes a number of additional contributions as well. We have developed a novel methodology for linking many lesson characteristics with student outcomes. We also

provide a simple survey of environmental literacy that might be useful to practitioners and other researchers hoping to measure similar outcomes, particularly within time constraints. While we conducted this study at only one site, these methods could apply across a much wider array of programs, where characteristics of lessons and EE experiences could be observed and study surveys used to compare their effectiveness. Such a study could reveal potentially powerful practical implications to enhance program design and delivery. We are currently conducting a first study of this type on EE field trips across the United States (NSF AISL grant #1612416; [https://www.nsf.gov/awardsearch/showAward?AWD\\_ID=1612416](https://www.nsf.gov/awardsearch/showAward?AWD_ID=1612416)), and we hope others may build on our early efforts here.

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## **Chapter 4**

### **Does student engagement really matter? An investigation of the links between student engagement and environmental literacy outcomes in a residential setting.**

B. Troy Frensley, Marc J. Stern, and R. B. Powell

#### **Abstract**

It is unclear the extent to which student engagement, self-reported or observed, influences outcomes, especially in novel EE settings. We developed a novel methodology to explore the influence of student engagement on students' environmental literacy outcomes at the NorthBay Adventure Center (NorthBay), a residential environmental education (EE) program serving diverse middle school students. We observed 80 lessons and 17 different NorthBay educators, observing six measures related to student engagement. We also administered surveys to measure students' self-reported levels of engagement and environmental literacy outcomes. Only self-reported student engagement was significantly associated with enhanced environmental literacy outcomes. While observations of student engagement may be valid indicators of enjoyment or satisfaction and also provide cues to the educator for adjustment, results from this study suggest that observed engagement are not valid indicators of learning outcomes. We discuss the methodological challenges and potential biases (e.g., social desirability bias) associated with measuring student engagement and learning outcomes in novel EE settings and opportunities for future research.

#### **Introduction**

Prior research suggests that higher levels of student engagement can result in improved academic performance and outcomes (Fredricks, Blumenfeld, and Paris 2004; Klem and Connell 2004; Skinner, Wellborn, and Connell, 1990). A few studies have explored aspects of student engagement in the environmental education (EE) (Ballantyne, Fien, and Packer 2000; 2001; Emmons 1997; Sivek 2002) and the interpretation fields (Skibins, Powell, and Stern 2012; Stern and Powell 2013), yet it is still unclear the extent to which student engagement influences outcomes, especially in novel EE settings. In our experience, environmental educators often make the assumption that observable positive student engagement, (e.g., active participation, smiles and laughter) is linked to better student outcomes. However, there are many reasons to believe this might not be the case. Most educators have had the experience of being surprised by the performance of a student on a project or test who seemed to not be paying attention during class. Similarly, the student who smiles and nods throughout a lesson may not be paying meaningful attention. Mismatches in observable student cues and actual learning may be at least partially based on the fact that cognitive engagement cannot be readily observed (Fredricks, Blumenfeld, and Paris 2004), and other forms of engagement may or may not be indicative of actual learning or producing other student outcomes. This raises some important questions for EE practitioners and researchers. Are students who appear to be doing the work and enjoying themselves actually meeting intended programmatic outcomes? What is the best way to measure engagement? How much do different forms of engagement really matter to achieving objectives?

There is a general consensus that student engagement consists of cognitive, affective, and behavioral components (Fredricks, Blumenfeld, and Paris 2004). Student engagement can vary in

intensity and duration, and students may demonstrate positive engagement, negative engagement, or apathetic non-engagement (Trowler 2010). *Cognitively engaged* students are invested in their learning, appreciate being challenged, and seek to go beyond basic requirements during learning tasks and activities (Appleton and Lawrenz 2011; Boekarts, Pintrich, and Zeidner 2000; Connell and Wellborn 1991; Fredricks, Blumenfeld, and Paris 2004). Because cognition cannot be readily observed, standard methods of data collection consist of student self-report measurements (Fredricks, Blumenfeld, and Paris 2004). *Affective engagement* can be defined as the students' emotions towards educators, classmates, the curriculum, and the learning setting (Connell and Wellborn, 1991; Fredricks, Blumenfeld, and Paris 2004; Trowler, 2010). Affective engagement is presumed to foster the bond between the student, educator, and learning site and influence a student's willingness to work (Connell and Wellborn 1990; Finn 1989; Fredricks, Blumenfeld, and Paris 2004). Affectively engaged students demonstrate a sense of belonging (e.g. feeling of being important), sense of value (e.g. appreciation of success), and positive emotional response to learning and the learning setting (e.g. interest, happiness, etc.) (Appleton & Lawrenz, 2011; Connell & Wellborn, 1991; Christenson et al. 2008; Fredricks, Blumenfeld, and Paris 2004; Stipek 2002). Affective engagement can be measured either through observations or self-reporting. *Behavioral engagement* can be defined as the level of participation and involvement in the learning task at-hand and is considered essential for achieving positive academic outcomes (Connell and Wellborn, 1991; Finn 1989, Fredricks, Blumenfeld, and Paris 2004). Behaviorally engaged students demonstrate effort, persistence, concentration, and on-task behaviors. They may also ask and answer questions and contribute to discussions (Appleton et al. 2006; Finn & Rock 1997; Fredricks, Blumenfeld, and Paris 2004; Skinner and Belmont 1993). Behavioral engagement can be measured either through observations or self-reporting.

## **Research question**

***Is student engagement, observed or self-reported, positively associated with environmental literacy?***

We developed a novel methodology where researchers observed 80 EE lessons delivered at a residential EE program and recorded data on six student engagement variables. Student engagement variables were categorized as: negative engagement (frustration and disruption); non-engagement (detachment); and positive engagement (attention, enjoyment, effort). Students also completed a short survey following each lesson observed to self-report their own levels of engagement (four survey items) and environmental literacy outcomes (eight survey items). We provide more details about the study site below prior to providing a detailed explanation of the study's methods.

## **Study site**

NorthBay Adventure (NorthBay) hosts five-day long residential programs for 50 to over 400 visiting middle school students each week from inner-city urban areas (Baltimore, Washington D.C., and Philadelphia) as well as suburban and rural areas across the state of Maryland. Students are subdivided into smaller groups onsite and are accompanied by their teachers and parent chaperones as they participate in daily EE lessons, meals, afternoon free-time, and live multi-media theater performances each evening. Two-hour long EE lessons take

place during the morning and afternoon of students' three full-days onsite (Tuesday, Wednesday, and Thursday) in a variety of habitats across the over 90-acre campus located on the shore of the Chesapeake Bay. These lessons serve as the focus of this study.

NorthBay's EE curriculum has been developed in conjunction with the Maryland State Department of Education and is based on Hungerford et al.'s (2003) 'investigating and evaluating environmental issues and actions' (IEEIA) model and the 'better environmental education, teaching, learning, and expertise sharing' (BEETLES) project model (BEETLES 2014). During the two-hour lessons, students commonly make observations and collect data in the natural environment, work collaboratively, and investigate relevant environmental issues. NorthBay educators strive to link content and experiences back to students' lives at home by journaling and engaging in group reflections and discussions. The final EE lesson each week is a culmination of the entire weeklong learning process where students complete a service learning project (e.g., beach cleanup) and an action plan for when they return home to positively address issues related to the environment, their school, and their community. NorthBay employs a diverse team of educators, counselors, adventure activity staff, and live evening show performers that interact with the diverse student population attending the program. The NorthBay educators represent a range of races, ages, genders, personalities, and prior experiences. With only a few minor exceptions for a single lesson here or there, one educator is assigned to one student group to conduct the all of the two-hour lessons for that group during the week.

## Methods

### Sampling

Two researchers conducted all field research. Nine weeks were purposefully selected from February 2015 to November 2015 to reflect the diverse student demographics attending the NorthBay program. Fifteen student groups were observed from 17 different schools. Twelve schools were classified as suburban, three as urban, and two as rural according to the National Center for Education Statistics (NCES 2017). Three of the schools were private schools (one rural and two suburban), and the remaining were public. Each week, the NorthBay educators and their student groups were selected at random. In total, 17 educators were observed delivering 81 lessons. Student group sizes ranged from 11 to 29 students. Each researcher stayed with the same student group during their weeklong visit, observing each EE lesson delivered by their educator(s). This resulted in two student groups being observed each week. Eight student groups were entirely female and seven student groups were entirely male; each was matched with a same-gender instructor.

### Measurement

#### *Environmental literacy & student engagement indexes*

Survey items were developed to measure environmental literacy, the dependent variable in this study, based on key literature (Hollweg et al. 2011, McBeth et al. 2011; McBride et al. 2013; Table 4-1). Response categories were comprised of a five-point Likert-type scale ranging from: (1) not at all; (2) a little; (3) somewhat; (4) a lot; (5) a huge amount. Survey items measuring positive cognitive, affective, and behavioral engagement were developed based on prior research (Fredricks, Blumenfeld, and Paris 2004, Trowler 2010; Table 4-2). Response categories were comprised of a five-point Likert-type scale ranging from: (1) not at all; (2) slightly; (3) somewhat; (4) mostly; (5) a great deal.

As a part of this same study, Frenshley et al. (2018a) conducted confirmatory factor analysis on individual student survey responses (N = 1,298) and confirmed these six survey

items comprise a statistically valid environmental literacy index and these four items comprise a statistically valid student engagement index (S-B  $\chi^2/df= 0.17$ ; S-B CFI = 0.97; S-B RMSEA = 0.06; S-B TLI = 0.96; SRMR = 0.04). An analysis of internal consistency resulted in a Cronbach's alpha score of 0.90 for the environmental literacy index and 0.72 for the self-reported student engagement index which are above the 0.70 threshold for scale development (DeVellis 2003). Each index was computed by taking the mean of their respective survey items for each lesson (Frensley et al. 2018a).

Table 4-1. Environmental literacy survey items.

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

Table 4-2. Student engagement survey items.

<b>Survey Question</b>	<b>Student Engagement Outcomes</b>
I enjoyed the lesson.	Affective
The lesson really made me think.	Cognitive
I tried hard during the lesson.	Behavioral
I paid attention during the lesson.	Behavioral

### *Observed student engagement*

Student engagement was also measured through program observation. Observations of student engagement focused only on aspects of behavioral and affective engagement, as cognitive engagement is difficult to ascertain from observation alone (Fredricks, Blumenfeld, and Paris 2004). Observations were conducted during each distinct activity within the lesson (e.g., lecture, data collection, game, and conclusion) and then a final score was given representing the engagement across the entire two-hour lesson. Most lessons had between four and six distinct activities. A total of six student engagement observation items representing negative, non-, and positive student engagement were developed based on prior research (Ballantyne and Packer 2009; Roehrig and Christesen 2010; Shapiro, E. S., n.d.; Skinner et al. 2008; Skinner et al. 2009; Trowler 2010). The operationalization of each observed student engagement item uses a five-point Likert-type scale ranging from 'almost none' to 'almost all' to record the proportion of the student group that exhibited these behaviors throughout the lesson (Table 4-3).

Table 4-3. Indicators of negative, non-, and positive student engagement.

Negative Engagement	Non-engagement	Positive engagement
<p data-bbox="367 359 492 386"><b>Disruption</b></p> <ul style="list-style-type: none"> <li>• Out of seat</li> <li>• Touching another student/adult</li> <li>• Talking at inappropriate times</li> <li>• Making inappropriate off-task remark/sound</li> <li>• Disrupts the lesson</li> <li>• Off-task behaviors</li> <li>• Not following instructions</li> </ul>	<p data-bbox="756 359 862 386"><b>Detached</b></p> <ul style="list-style-type: none"> <li>• Lack of attention</li> <li>• Looking around</li> <li>• Staring away</li> <li>• Fidgeting</li> <li>• Disinterested or distracted</li> <li>• Emotionless, numb</li> <li>• Bored</li> </ul>	<p data-bbox="1149 359 1260 386"><b>Attention</b></p> <ul style="list-style-type: none"> <li>• Writing</li> <li>• Reading aloud</li> <li>• Raising hand</li> <li>• Talking about lesson when asked</li> <li>• Talking to peers about lesson when appropriate</li> <li>• On-task behaviors</li> <li>• Following directions</li> </ul>
<p data-bbox="367 680 492 707"><b>Frustration</b></p> <ul style="list-style-type: none"> <li>• Vocalizing or expressing frustration</li> <li>• Frowning</li> <li>• Crying</li> <li>• Yelling</li> <li>• Violent outbursts</li> </ul>		<p data-bbox="1170 680 1243 707"><b>Effort</b></p> <ul style="list-style-type: none"> <li>• Active participation in all lesson activities</li> <li>• Student perseveres through challenge</li> <li>• Completes activity/task</li> </ul>
		<p data-bbox="1143 873 1268 900"><b>Enjoyment</b></p> <ul style="list-style-type: none"> <li>• Vocalizing or expressing enjoyment</li> <li>• Smiling</li> <li>• Laughing</li> <li>• “oohs and ahhs”</li> <li>• Clapping</li> </ul>

**Pilot testing**

The two researchers spent four weeks at NorthBay to refine the study methodology and enhance the reliability of their measurements. Together, they observed 18 lessons taught by eight different NorthBay educators. Extensive discussions allowed for further refinement of observation techniques and the surveys. For our observations, we used five-point Likert-type scales to maximize the potential range of scores while maintaining inter-rater reliability. Once the definitions and scoring for each variable were finalized, the two researchers continued to observe lessons at the study site until an interrater reliability of 0.9 was obtained for all student engagement items. The average measure ICC was 0.90 with a 95% confidence interval from 0.693 to 0.983 ( $F(5, 55) = 8.38, p < .001$ ). ICC estimates and their 95% confidence intervals were calculated using SPSS 23 based on average measures using absolute-agreement and a two-way mixed-effects model.

Pilot testing also informed the refinement of the student survey, with the aim of producing easily understanding survey items which could be completed in five minutes or less. The researchers led conversations with the students following each survey administration to identify appropriate revisions that would promote consistent understanding of the items.

**Analyses**

*Data cleaning*

Any student surveys missing more than 50% of data (Tabachnick and Fidell 2007) and

responses failing the inversely worded validity check (agreement on both “I disliked the lesson” and “I enjoyed the lesson”) were removed.<sup>4</sup> This screening process resulted in the removal of 77 student surveys, reducing the sample size to 1,392 individual student surveys from 81 lessons. Data were also screened for multivariate outliers using Mahalanobis Distance; which resulted in the removal of an additional 94 student surveys (Tabachnick and Fidell 2007). This reduced our sample to 1,298 student surveys from 81 lessons. To be able to compare our group-level observations to self-reported survey measures, we aggregated all individual student scores to the group level by taking the mean of all student scores from each lesson. Before doing so, we examined the intraclass correlation coefficients (ICC(1)) for students’ responses on the environmental literacy outcome index to determine validity of this aggregation. ICC(1) scores calculated on the dependent variable offer a measure of non-independence and aid in answering the question of whether or not outcomes are impacted in some way by group membership (Bliese 2000; Byrk and Radenbush 1992; Kreft and DeLeeuw 1998). Analysis revealed an ICC(1) score of 0.27. Any score above 0.25 is considered a large effect, suggesting a great deal of the variance occurred at the group level and not at the individual level (Bliese 2000; Byrk and Radenbush 1992). ICC(1) analysis on the self-reported student engagement index was 0.23, also indicating a meaningful effect of group membership on student engagement survey data. The small number of student groups in this study (N = 15) precluded the use of more complex multi-level modeling (Mass and Hox 2005).

Student mean scores for the aggregated environmental literacy and self-reported student engagement survey items were then checked for skewness and kurtosis. All lessons except for one were below the threshold for concern ( $\pm 0.6$ ; Schumacker and Lomax 2004). Data were then screened for multivariate outliers using Mahalanobis Distance. This same lesson was confirmed as an outlier and was subsequently removed from the sample (Tabachnick and Fidell 2007). This resulted a final sample size of 80 lessons.

#### *Principal component analyses: observed student engagement*

A principal component analysis (PCA) and a subsequent reliability analysis were conducted to explore the relationships between the six observed student engagement measures. We did not perform CFA for these data because they are observed formative variables representing a specific practice or characteristic that is hypothesized to directly influence student engagement. We report the Kaiser-Meyer-Olkin (KMO) measure to confirm sampling adequacy and Bartlett’s test of sphericity to confirm that the correlations between variables are not too small. The KMO measure should be above 0.5 with a sample size less than 100 (MacCallum et al. 1999) and the Bartlett’s test of sphericity should be statically significant ( $p < 0.05$ ) (Field 2013). We provide additional details on the criteria for extracting factors, the method of rotation used, the proportion of variance that each factor explains (with eigenvalues), the Cronbach’s alpha values for each index, and a table with rotated factor loadings.

#### *Comparison of observed versus self-reported student engagement*

To investigate the validity of observed student engagement measures, we performed bivariate correlation analyses between the two observed student engagement indexes and the self-reported student engagement index. A statistically significant correlation would indicate that observed measurements were in fact related to self-reported measurement, providing some

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<sup>4</sup> The survey item, “I disliked the lesson” was removed from the final self-reported student engagement index during confirmatory factor analysis (see Frensley et al. 2018a).

triangulation of the measures. The Spearman rho statistic was used due to the ordinal nature of these observed and self-reported measures (Field 2013).

*Is student engagement, observed or self-reported, positively associated with environmental literacy?*

To answer the research question, we conducted bivariate correlation analyses to determine whether or not observed and/or self-reported student engagement measures were significantly correlated with student environmental literacy outcomes. Spearman correlation coefficients between the observed and self-reported student engagement indexes and environmental literacy outcomes provide insights into the strengths of the relationships between these forms of student engagement and student outcomes. The Spearman rho statistic was used due to the use of ordinal variables in this study (Field 2013).

## Results

### Data reduction

#### *Principal component analysis: observed student engagement*

PCA was conducted with the six observed student engagement variables. The Kaiser-Meyer-Olkin measure confirmed the sample adequacy for the analyses (KMO = 0.9) and all individual KMO values were greater than 0.6 which is above the acceptable limit of 0.5 with a sample size less than 100 (MacCallum et al. 1999). Bartlett's test of sphericity was significant at < 0.001, and the determinant value was non-significant 0.039 which are both acceptable (Field 2013). We forced the extraction of two factors based on the point of inflexion in the scree plot and on Jolliffe's criteria to retain factors with eigenvalues greater than 0.7 (Jolliffe 1987). We present the factor loadings and associated eigenvalues, % of variance explained and Cronbach's alpha scores for the two resulting student engagement indexes of *observed positive student engagement* and *observed non-positive student engagement* (Table 4-4). Only the items in bold are a part of each index.

Table 4-4. Summary of principle component analysis results for the observed student engagement items (N = 6).

Item	Rotated Factor Loadings	
	Observed Positive Student Engagement	Observed Non-Positive Student Engagement
Effort	<b>.91</b>	-.51
Attention	<b>.89</b>	-.62
Enjoy	<b>.80</b>	-.33
Detached	-.84	<b>.45</b>
Frustration	-.41	<b>.91</b>
Disruption	-.57	<b>.81</b>
<b>Eigenvalues</b>	3.72	.82
<b>% of variance</b>	61.96	13.58
<b>Cronbach's <math>\alpha</math></b>	.84	.71
<b>Mean</b>	3.94	1.76
<b>SD</b>	0.71	0.48

Note: Items retained in factor and associated Cronbach's alpha score are in bold; Mean and SD (Standard Deviation) scores are on a five-point Likert-type scale.

### Comparison of observed versus self-reported student engagement

Table 4-5 summarizes bivariate correlation analyses between observed student engagement items and their corresponding self-reported student engagement survey items. Spearman correlation coefficients indicate statistically significant relationships for each of the matching observed and self-reported student engagement measures.

Table 4-5. Spearman correlation between observed student engagement indexes and self-reported student engagement index.

Observed Student Engagement Indexes	Self-Reported Student Engagement Index
Observed positive student engagement index	<b>.470**</b>
Observed non-positive student engagement index	<b>-.372**</b>

Note: \*\*  $p < .01$  (two-tailed)

### Which measures of student engagement, observed or self-reported, are significantly associated with environmental literacy outcomes?

Table 4-6 summarizes Spearman correlation coefficients between engagement measures and environmental literacy. Only self-reported positive student engagement is statistically significantly correlated with student environmental literacy outcomes.

Table 4-6. Spearman correlation coefficient between observed and self-reported student engagement indexes and student environmental literacy scores (N = 78).

Index	Environmental Literacy
Self-reported student engagement index	<b>.663**</b>
Observed positive student engagement index	.173
Observed non-positive student engagement index	-.070

Note: \*\*  $p < .01$  (two tailed)

## Discussion

This study sought to explore the relationships between student engagement and environmental literacy outcomes. The findings indicate that only students' self-reported measures of engagement were significantly correlated with outcomes of environmental literacy. Observed measures of student engagement were not associated with these outcomes. These findings support the notion that observations of student engagement are unreliable indicators of student learning outcomes and build upon decades of research in the educational psychology field which have found that self-reported student engagement is a predictor of enhanced student learning and achievement (e.g., Fredricks, Blumenfeld, and Paris 2004; Furlong and Christenson 2008; National Research Council (NRC) 2004). We thus caution environmental educators from jumping to conclusions about the success of their programs based on the observed reactions of students.

Observations of student engagement do provide important cues for the educator during the delivery of the lesson. Prior research suggests that educators who are effective in managing observed negative or non-engagement in their class and are sensitive and responsive to their

students' needs are more likely to support student engagement and learning (Fredricks, Blumenfeld, and Paris 2004; Wong & Wong 2005; Wurdinger 2005).

Self-reported engagement was found to be more related to environmental literacy outcomes than observations of student engagement and there are several possibilities why this may be the case. First, one cannot observe cognitive engagement, so self-reported engagement is a more complete measure of student engagement in that cognitive, behavioral, and affective measures can be collected. Second, there is social desirability bias in that students may have a tendency to present themselves in a favorable light reporting higher levels of engagement than they really had (Podsakoff et al. 2003). The survey items were written in such a way that may have reflected student engagement as being more socially desirable, thus enhancing this effect. Third, measuring both student engagement and self-reported engagement items on the same short survey may have resulted in consistency bias, as all of the survey items within the two constructs used five-point Likert-type scales (Podsakoff et al. 2003). Finally, statistically significant Spearman correlation values between matching observed and self-report student engagement items does provide some evidence these self-reported measures of engagement are valid. The students did look forward to being able to respond in real time, immediately following each lesson to provide anonymous data on these outcomes and their levels of engagement. This demonstrated a lack of evaluation apprehension which possibly reduced some of these method biases, particularly social desirability (Podsakoff et al. 2003).

While this study was on just a single single case, which may limit generalizability of our findings, our efforts have produced simple survey items measuring self-reported student engagement that might be useful to practitioners and other researchers. We encourage others to make use of these measures and to improve upon them in the process.

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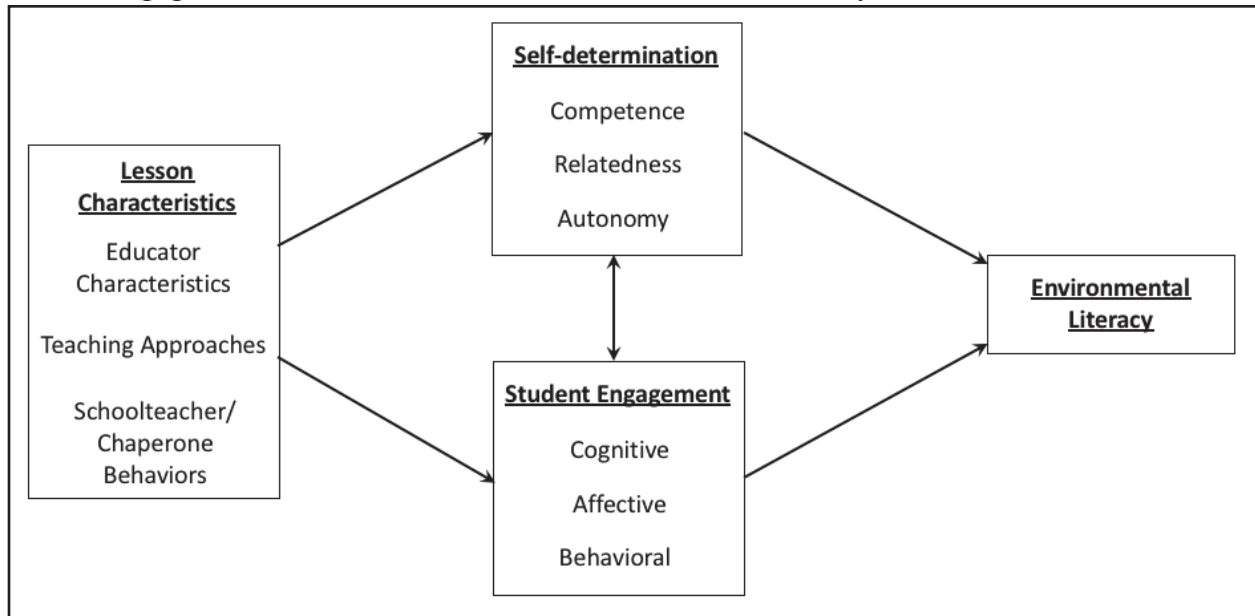
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## Chapter 5

### **Conclusion**

In this research, I explored the links between lesson characteristics, student engagement, self-determination theory, and environmental literacy outcomes (Figure 5-1). Chapter 2 examined the influence of self-reported student engagement and also the influence of elements of self-determination (e.g., competence, autonomy, and relatedness) on environmental literacy outcomes. The findings suggest that self-determination factors, specifically autonomy and competence, mediate the relationship between student engagement and environmental literacy, accounting for 62% of the variance in this outcome (compared to 49% with just student engagement as the sole predictor). Findings from Chapter 3 indicated ten lesson characteristics were consistently and positively associated with environmental literacy outcomes. Chapter 4 investigated the influence of observed and self-reported student engagement on environmental literacy outcomes and found only self-reported student engagement was associated with the outcome. In light of these findings, the links presented in Figure 5-1 are not completely accurate. Self-determination, specifically autonomy and competence, more directly influence environmental literacy and student engagement (and relatedness), while important, have a more indirect effect on the outcome.

Figure 5-1. Conceptual model depicting the hypothesized links between lesson characteristics, student engagement, self-determination, and environmental literacy outcomes.



Self-determination theory (SDT) provides a theoretical framework for examining nuances of student motivation and engagement arising from the learning context (Deci and Ryan 1985; Klem and Connell 2004; Reeve 2012; Ryan and Deci, 2000a, 2000b). The findings from this study suggest that researchers may wish to consider focusing measurement on these factors, particularly autonomy and competence, as mediating variables between lessons characteristics (e.g., specific teaching approaches, educator characteristics, student characteristics, contextual factors), student engagement, and outcomes (e.g., environmental literacy measures). SDT factors were statistically significant predictors of learning outcomes, supporting prior research and theory inferring that EE programs would benefit from explicit program designs and educator trainings to specifically to enhance these factors in students (Darner 2009).

I conducted additional analyses to determine the lesson characteristics in this study that were most consistently associated with enhancing students' levels of competence, autonomy, relatedness as well as these characteristics that enhance student engagement to provide a holistic conclusion to the study. I followed the same procedure for bivariate correlation analysis (using the Spearman rho statistic) outlined in Chapter 3 on educator characteristics, teaching approaches, and schoolteacher/chaperone behaviors and students' levels of competence, autonomy, and relatedness. Table 5-1 summarizes the descriptive statistics for the elements of self-determination and the Spearman correlation values between competence, autonomy, relatedness and the environmental literacy outcome. Table 5-2 provides a summary of the Spearman correlation values for only those independent variables with statistically significant correlations with students' competence, autonomy, relatedness, and self-reported student engagement. Full correlation tables with all independent variables are provided in Appendix B. I also provide the variables statistically significantly correlated with environmental literacy from Chapter 3 in this table to serve as a holistic summary for the entire study.

Table 5-1. Means and standard deviations of elements of self-determination and Spearman correlation values with the environmental literacy outcome.

<b>Variable</b>	<b>Means (SD)</b>	<b>Environmental Literacy</b>
Competence	4.53 (.24)	<b>.500**</b>
Autonomy	4.07 (.38)	<b>.627**</b>
Relatedness	4.27 (.32)	<b>.432**</b>

Note: \*\*  $p < .01$

Table 5-2. Statistically significant Spearman correlation values between the lesson characteristics, student engagement, students' competence, autonomy, and relatedness, and environmental literacy.

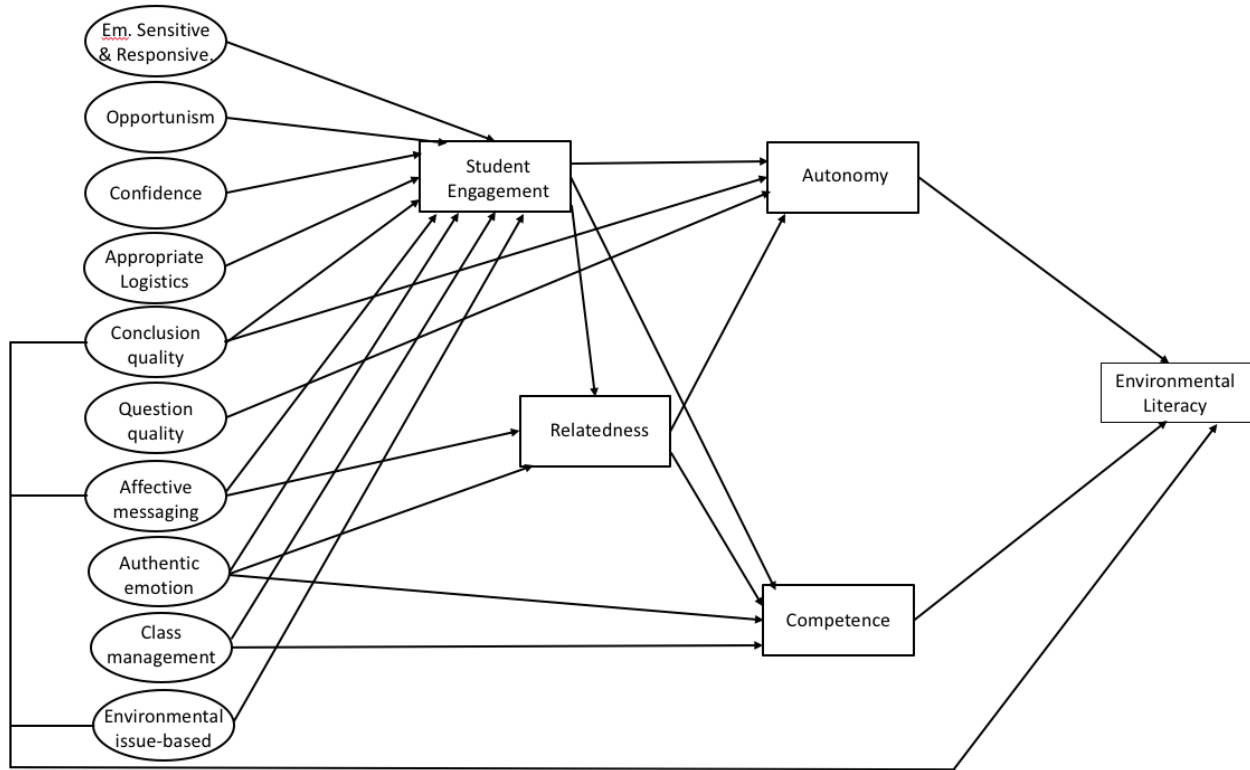
<b>Variable</b>	<b>Env. Lit.</b>	<b>Stu. Eng.</b>	<b>Competence</b>	<b>Autonomy</b>	<b>Relatedness</b>
Affective messaging	<b>.356**<sup>a</sup></b>	<b>.380**<sup>a</sup></b>	.249*	<b>.299**</b>	<b>.378**<sup>a</sup></b>
Quality of conclusion	<b>.347**<sup>a</sup></b>	<b>.424**<sup>a</sup></b>	.256*	<b>.457**<sup>a</sup></b>	.084
Role modeling	.245*	<b>.318**</b>	.233*	.184	.248*
Environmental issue-based	<b>.362**<sup>a</sup></b>	<b>.349**<sup>a</sup></b>	.142	<b>.330**</b>	.205
Authentic emotion index	.137	<b>.407**<sup>a</sup></b>	<b>.386**<sup>a</sup></b>	.103	<b>.341**<sup>a</sup></b>
Confidence index	.095	<b>.430**<sup>a</sup></b>	.272*	.210	.240*
Appropriate logistics	.207	<b>.373**<sup>a</sup></b>	.213	.228*	.178

Class management	.113	<b>.340**<sup>a</sup></b>	<b>.382**<sup>a</sup></b>	.125	<b>.300**</b>
Teacher/chaperone positive	.275*	-.006	-.155	.082	.030
Emotional sensitivity and responsiveness index	.114	<b>.396**<sup>a</sup></b>	.280*	.173	.188
Non-positive class management techniques index	-.049	-.171	<b>-.367**<sup>a</sup></b>	.001	-.014
Time management	.171	.271*	.279*	-.014	.102
Positive class management technique	-.045	.242*	.239*	-.025	-.014
Question quality	.115	<b>.331**</b>	.171	<b>.385**<sup>a</sup></b>	.164
Opportunism	.146	<b>.411**<sup>a</sup></b>	.214	<b>.310**</b>	.127
Group reflection	.199	.158	.113	<b>.289**</b>	.066
Relevance	.196	.222*	.051	.226*	.149
Free exploration	.130	.114	.046	.275*	.059
Play-based	.040	.290*	.137	.189	-.146

Note: \*\*  $p < .01$ ; \*  $p < .05$  (two-tailed); <sup>a</sup> =  $p < .003$  (Bonferroni correction)

While I did not have the sample size necessary to perform structural equation modeling and fully test a revised conceptual model, I did develop a hypothesized diagram based on the results of the bivariate correlation analyses in this research. I used a more stringent statistical significance cutoff with a Bonferroni correction ( $p < .003$ ) to ensure a more parsimonious and robust model (Figure 5-2).

Figure 5-2. Hypothesized diagram for the links between meaningful lesson characteristics positively associated with elements of student engagement, self-determination, and environmental literacy outcomes.



### What leads to enhanced environmental literacy outcomes?

Certain lesson characteristics seem to directly influence environmental literacy and others are only directly related to specific elements of self-determination and student engagement. Environmental literacy is most directly influenced by the self-determination elements of competence and autonomy along with the lesson characteristics of conclusion quality, environmental issue-based approaches, and affective messaging. Autonomy was the strongest mediating variable and the characteristics' most consistently associated with enhancing autonomy include conclusion quality and question quality. Authentic emotion and class management were the two characteristics most positively associated with enhancing students' levels of competence. Relatedness, although more indirectly influencing environmental literacy, is enhanced by affective messaging and authentic emotion.

#### *Authentic emotion*

Authentic emotion was associated with enhancing both students' competence and relatedness. This is in line with prior research in the EE and environmental interpretation fields suggesting the authentic emotions of the educator (e.g., passion, charisma, sincerity) were strongly associated with positive programmatic outcomes (Ballantyne, Fien, and Packer 2001; Ham and Weiler 2002; Stern and Powell 2013; Stern, Powell, and Hill 2014).

### *Class management*

Effective class management variable was associated with enhanced competence and relatedness. The interpersonal relationships that the educator builds, or breaks down, through their management of the class matters, especially as it pertains to these elements of self-determination (Fredricks, Blumenfeld, and Paris 2004). In this study, we observed educators who consistently threatened students with punishments (e.g., loss of free time) which likely resulted in students' feeling like they didn't belong (lack of relatedness). Students who didn't understand information being delivering in the lesson or how perform certain tasks being asked of them, seemed to demonstrate less positive engagement, likely due to a lack of competence. Studies have shown that educators who are effective in managing negative or non-engagement in their class and are sensitive and responsive to their students' needs are more likely to support student engagement and learning (Fredricks, Blumenfeld, and Paris 2004; Skinner & Belmont 1993).

### *Affective messaging*

Affective messaging was directly associated with enhancing environmental literacy outcomes and students' relatedness and autonomy. The affective domain has been posited by some researchers (Iozzi 1989a; 1989b; Hungerford and Volk 1990) as a critical entry point for building environmental literacy, which these findings support. Educators that used affective messages and conveyed their love for the environment and the place they were in, and expressed care and concern about the issues facing these environments, seemed to result in students' willingness to consider their own feelings. Placing greater emphasis on emotions, especially during conclusions and reflections has been linked to a suite of outcomes (e.g., emotional development, nature affinity, pro-environmental attitudes and behaviors) (Ballantyne and Packer 2009; Bergman 2016; Cheng and Monroe 2012; Nisbet, Zelenski, and Murphy 2009).

### *Question quality*

Question quality was directly related to enhancing students' sense of autonomy. Educators that used ongoing questions that facilitated student inquiry, discussion, and deeper exploration of the issues, and students' own feelings towards it, were more successful. Here is an example of a high-level of question quality observed from one educator:

*Early in the bird lesson, the educator asks questions to sharpen and awaken students observational skills. Examples include, "what type of seed do they [the birds] eat?;" "how do they eat it?;" and what color is that bird?" These questions do not feel routine and the educator legitimately seems to want to know the students' answers. The educator vacillates from specific questions (e.g., "who knows chick-a-dee sounds?" and "what patterns are on their head?") to more broad questions that facilitated discussion (e.g., "what do you notice?"). At one point the educator almost names a species by saying, "I could call out to that Os...oops, I almost said it!" but wants to hold open the process for the students and not tell them the answer. The educator is responsive to the student's interests and uses an on-going questioning dialogue (of both specific and broad questions) throughout the lesson instead of just during a set time. The educator is receptive to differing viewpoints and ideas and often poses questions that are more open-ended and don't have any single "correct" response. The educator consistently praises students' differing viewpoints and responses.*

### *Environmental issue-based*

The use of real-world environmental issue-based approaches was directly associated with enhancing environmental literacy outcomes and student autonomy. Numerous studies in the EE and environmental interpretation literature have suggested the importance of having a relevant issue to enhance student engagement and outcomes (Ballantyne & Packer 2009; Hungerford & Volk 1990; Stern & Powell 2013; Stern et al. 2014). Our study corroborates these findings. For example, we observed the same lesson about wetlands taught in two distinct ways. The first was focused entirely on collecting water quality and species data in a man-made vs. natural wetland. The data was summarized and the lesson ended. The second involved promoting kids to wonder about the differences they might find between a manmade and a natural wetland on the NorthBay campus – particularly through the lens of the role they might play as filters in the environment. They also talked about watershed level and local level threats to wetlands and the negative impacts of losing wetlands to the environment. In this way, the students developed informal hypotheses, and their data collection felt more meaningful.

### *Conclusion quality*

A strong conclusion at the end of each lesson was positively associated with directly enhancing environmental literacy outcomes and student autonomy. Many of the same studies highlighting the importance of issue-based approaches also promote the use of meaningful conclusions (Ballantyne & Packer 2009; Hungerford & Volk 1990; Stern & Powell 2013; Stern et al. 2014). Educators that provided a clear “so what?” and an opportunity for students to reflect on that meaning in a way that mattered to them achieved greater learning outcomes and enhanced students’ sense of autonomy. For example, in the wetland lesson scenario provided above, an educator who developed a discussion that linked the role of wetlands as a filter for the environment to role models as a positive filter in students’ lives provided a strong take home message that students could relate to.

### **What characteristics are associated with more positive student engagement?**

Similar to relatedness, student engagement appears to have a more indirect effect on environmental literacy outcomes. Nine lesson characteristics were associated with enhanced student engagement: emotional sensitivity and responsiveness; opportunism; confidence, appropriate logistics; conclusion quality; affective messaging; authentic emotion; class management; and environmental issue-based. Of these nine characteristics, only four exclusively enhanced student engagement: emotional sensitivity and responsiveness; opportunism; confidence; and appropriate logistics.

### *Emotional sensitivity and responsiveness*

Educators that responded to students emotional needs and interacted with the students and responded to their verbal and non-verbal cues appeared to be able to better maintain positive student engagement and potentially enhanced outcomes. For example, we observed one educator who kept students seated for over 70 minutes while delivering facts and information, despite the fact that over half of the students in the group were detached and visibly frustrated within 30 minutes. This lack of emotional sensitivity and responsiveness led to decreased levels of positive student engagement and potentially outcomes. Research suggests that higher degrees of emotional sensitivity and responsiveness may lead to enhanced student engagement (Fredricks, Blumenfeld, and Paris 2004; Skinner and Belmont 1993). A study by Stern and Powell (2013)

highlighted the importance of these educator characteristics outside the formal classroom context with ranger-led programs at National Parks across the United States.

### *Opportunism*

Opportunism highlights the importance of educators' meaningfully incorporating the outdoors in their lessons, even when unexpected events occurred. Opportunism was positively associated with enhanced student autonomy. This is unsurprising given that an educator who was opportunistic in the environment and responsive to unexpected student questions, curiosities, and encounters with animals or plants promoted students sense of freedom. We observed educators encouraging students to get off the trail, find interesting things and point them out, or even pick up frogs, shells, or flowers that caught their eye during the lessons. Contrast this to educators that used the hiking trails as mere hallways from one location to another, focusing only on getting students to the next location to continue the lesson. Studies have found that place-based pedagogies and opportunities for student freedom when exploring the natural world are linked to enhanced engagement and outcomes (Ballantyne and Packer 2009; Louv 2006; Sobel 2012) and possibly longer-term environmental behaviors (Chawla 1999; Chawla and Derr 2012). Consider this example from an observation of an educator demonstrating high levels of opportunism:

*During the vulture lesson, students were walking through an open field trying to spot vultures flying in the sky when one student came across a dead snake. The educator excitedly gathered all students around, picked up the snake, and identified it as a rat snake. One student asked if a vulture might eat the dead snake and the educator engaged the students in a discussion about how vultures are great scavengers and that it likely would eat a dead snake like this. A few minutes later, several students found a pile of bones and screamed with excitement as the educator and rest of the class ran over. The educator asked the students if they thought a vulture had eaten this animal or not. A lively discussion ensued and the educator masterfully incorporated content and key messages from the lesson to this real-world example of an animal having been eaten by scavengers, possibly even vultures.*

### *Confidence*

Educators who appeared knowledgeable about the information and environment(s), seemed comfortable in their delivery of the lesson, and spoke clearly were more likely to enhance positive engagement in their students. A study on ranger-led programs in National Park Service units across the United States indicated the importance of confidence to learning outcomes (Stern and Powell 2013). In this case, confidence is directly associated with enhancing positive student engagement and during our observations, educators who were confident appeared fully in control of the lesson, the timing and breadth of information they were sharing, and were able to answer relevant questions from students without hesitation or visible uncertainty.

### *Appropriate logistics*

Educators who executed well-planned and appropriate logistics for the lessons was important. Ensuring students' safety and social needs are met prior to engaging them in the learning activities is clearly important, especially in this novel outdoor setting (Maslow 1970; Smith-Sebasto and Walker 2005). For example, educators who made the students sit for unreasonably long periods of time achieved less positive student engagement and environmental

literacy outcomes. Meanwhile, educators who took the students' needs into consideration ensuring they were comfortable and had the necessary resources and equipment to do the work being asked achieved more positive environmental literacy scores. Good organization and appropriate logistics were also found to be important factors leading to success in a nationwide study of interpretive ranger programs at National Parks across the United States (Stern and Powell 2013).

### **Limitations of the study**

While we are confident in our findings in light of support in the literature, this research is limited by our observations of a single program provider, which constrain our ability to generalize any findings. This study has powerful implications for the NorthBay program and also in that it is, to my knowledge, the first to attempt to isolate and investigate the characteristics of EE lessons that may be more positively associated with enhanced learning outcomes. Future research can build upon this novel method of observation and survey administration to compare a broader suite of EE programs and reveal potentially powerful implications to enhance EE program design, delivery, and research. I recommend further testing of the hypothesized diagram presented in Figure 5-3. A larger sample size would enable researchers to perform multi-level modeling and structural equations modeling thus providing more powerful insights into the links between lesson characteristics, self-determination, and environmental literacy. Qualitative comparative analysis (QCA) also offers potential for examining causality in mixed-methods studies, particularly case studies like this with a small number of cases and high number of independent variables (Ragin 2000). I aim to explore the QCA technique with these data in the coming months. This study also resulted in the development of measures of environmental literacy and positive student engagement which would may be beneficial for future use and testing by researchers and practitioners alike.

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## Appendix A

### *Principal Component Analysis: Educator Characteristics*

PCA was conducted with the remaining four educator characteristics (emotional sensitivity, responsiveness, clarity, opportunism). The Kaiser-Meyer-Olkin measure confirmed the sample adequacy for the analyses (KMO = 0.7) and all individual KMO values were greater than 0.6 which is above the acceptable limit of 0.5 with a sample size less than 100 (MacCallum et al. 1999). Bartlett's test of sphericity was significant at <.001 and the determinant was non-significant 0.13 which are both acceptable measures (Field 2013). We forced the extraction of two factors based on the point of inflexion in the scree plot and on Jolliffe's criteria to retain factors with eigenvalues greater than 0.7 (Jolliffe 1987) and rotated using direct oblimin. Two educator characteristics, emotional sensitivity and responsiveness, with factor loadings of 0.99 and 0.94 respectively, revealed a latent variable. This single factor had an Eigenvalue of 2.56 and explained 64.08% of the variance. We created an index by taking the mean of each item and subsequently calling it *Emotional Sensitivity and Responsiveness*.

The other two educator characteristics, opportunism and clarity, had factor loadings of .43 and -.07 respectively on this index, but were not included in this factor as they reduced the Cronbach's alpha to below the 0.7 threshold. The Cronbach's alpha value for these two variables, when considered as a second factor, was also not above the 0.7 threshold to justify a coherent latent construct.

### *Principal Component Analysis: Teaching Approaches*

The Kaiser-Meyer-Olkin measure confirmed the sample adequacy for the analyses (KMO = 0.7) and after removing the positive class management techniques all individual KMO values were greater than 0.6. Bartlett's test of sphericity was significant at <.001 and the determinant was 0.46. Only one factor was extracted, so no rotation was performed. We present the factor loadings, associated eigenvalues, % of variance, and Cronbach's alpha scores for this factor (Table A-1). We called this factor the *Non-positive class management techniques index* and followed the same procedure as above in the creation of this index.

Table A-1. Summary of principal component analysis results for the class management techniques (N = 79)

<b>Factor Loadings</b>	
<i>Item</i>	<i>Non-Positive Class Management Techniques</i>
Redirect	<b>.80</b>
Request	<b>.85</b>
Negative	<b>.78</b>
<b>Eigenvalues</b>	2.06
<b>% of variance</b>	51.44
<b>Cronbach's <math>\alpha</math></b>	.74

## Appendix B

Table B-1. Spearman correlation values of the educator characteristics and students' competence, autonomy, relatedness, and positive student engagement.

Variable	Competence	Autonomy	Relatedness	Positive Student Engagement
Authentic emotion index	<b>.386**</b>	.103	<b>.341**</b>	<b>.407**</b>
Emotional sensitivity and responsiveness index	.280*	.173	.188	<b>.396**</b>
Confidence index	.272*	.210	.240*	<b>.430**</b>
Opportunism	.214	<b>.310**</b>	.127	<b>.411**</b>
Clarity	.070	-.008	.084	.197

*Note: All items on a 1 to 4 Likert-type scale; \*\* p-value < 0.01; \*p-value < 0.05*

Table B-2. Spearman correlation values of the teaching approaches and students' competence, autonomy, relatedness, and positive student engagement.

Variable	Competence	Autonomy	Relatedness	Positive Student Engagement
Class management	<b>.382**</b>	.125	<b>.300**</b>	<b>.340**</b>
Non-positive class management techniques <sup>+</sup>	<b>-.367**</b>	.001	-.115	-.171
Time management	.279*	-.014	.102	.271*
Quality of conclusion	.256*	<b>.457**</b>	.084	<b>.424**</b>
Affective messaging	.249*	<b>.299**</b>	<b>.378**</b>	<b>.380**</b>
Positive class management technique <sup>+</sup>	.239*	-.025	-.014	.242*
Role modeling	.233*	.184	.248*	<b>.318**</b>
Appropriate logistics	.213	.228*	.178	<b>.373**</b>
Transitions	.209	.094	.010	.197
Question quality	.171	<b>.385**</b>	.164	<b>.331**</b>
Environmental issue-based	.142	<b>.330**</b>	.205	<b>.318**</b>
Play-based	.137	.189	-.146	.290*
Group reflection	.113	<b>.289**</b>	.066	.158
Cooperative/group	.056	.029	-.018	.011
Relevance	.051	.226*	.149	.222*
Free exploration	.046	.275*	.059	.144
Storytelling	.027	.105	.100	.144
Data collection	.005	-.129	-.004	.117
Hands-on	-.030	.094	.059	.055
Sensory focus	-.035	.163	-.098	.093
Quality of introduction	-.035	.039	-.028	.031
Fact-based	-.086	-.081	-.107	.002

Individual reflection	-.135	.071	.002	-.089
Guided inquiry	-.157	-.011	-.069	-.119

*Note: + items on a 3-point Likert-type scale (0 to 2); All remaining items on a 1 to 4 Likert-type scale; \*\* p-value < 0.01; \*p-value <0.05*

Table B-3. Spearman correlation values with schoolteacher/chaperone variables and students' competence, autonomy, relatedness, and positive student engagement.

<b>Variable</b>	<b>Competence</b>	<b>Autonomy</b>	<b>Relatedness</b>	<b>Positive Student Engagement</b>
Teacher/chaperone positive	-.155	.082	.020	-.006
Teacher/chaperone negative	-.114	-.179	-.185	-.180

*Note: All items on a 1 to 4 Likert-type scale*

## Appendix C

### Institutional Review Board Approvals



Office of Research Compliance  
Institutional Review Board  
North End Center, Suite 4120, Virginia Tech  
300 Turner Street NW  
Blacksburg, Virginia 24061  
540/231-4606 Fax 540/231-0959  
email [irb@vt.edu](mailto:irb@vt.edu)  
website <http://www.irb.vt.edu>

#### MEMORANDUM

**DATE:** November 10, 2015  
**TO:** Marc J Stern, Brandon Troy Frensley  
**FROM:** Virginia Tech Institutional Review Board (FWA00000572, expires July 29, 2020)  
**PROTOCOL TITLE:** Pilot-NorthBay Engagement Study  
**IRB NUMBER:** 15-915

Effective November 9, 2015, the Virginia Tech Institutional Review Board (IRB) Chair, David M Moore, approved the New Application request for the above-mentioned research protocol.

This approval provides permission to begin the human subject activities outlined in the IRB-approved protocol and supporting documents.

Plans to deviate from the approved protocol and/or supporting documents must be submitted to the IRB as an amendment request and approved by the IRB prior to the implementation of any changes, regardless of how minor, except where necessary to eliminate apparent immediate hazards to the subjects. Report within 5 business days to the IRB any injuries or other unanticipated or adverse events involving risks or harms to human research subjects or others.

All investigators (listed above) are required to comply with the researcher requirements outlined at:

<http://www.irb.vt.edu/pages/responsibilities.htm>

(Please review responsibilities before the commencement of your research.)

#### PROTOCOL INFORMATION:

Approved As: Expedited, under 45 CFR 46.110 category(ies) 7  
Protocol Approval Date: November 9, 2015  
Protocol Expiration Date: November 8, 2016  
Continuing Review Due Date\*: October 25, 2016

\*Date a Continuing Review application is due to the IRB office if human subject activities covered under this protocol, including data analysis, are to continue beyond the Protocol Expiration Date.

#### FEDERALLY FUNDED RESEARCH REQUIREMENTS:

Per federal regulations, 45 CFR 46.103(f), the IRB is required to compare all federally funded grant proposals/work statements to the IRB protocol(s) which cover the human research activities included in the proposal / work statement before funds are released. Note that this requirement does not apply to Exempt and Interim IRB protocols, or grants for which VT is not the primary awardee.

The table on the following page indicates whether grant proposals are related to this IRB protocol, and which of the listed proposals, if any, have been compared to this IRB protocol, if required.

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**MEMORANDUM**

**DATE:** February 23, 2016  
**TO:** Marc J Stern, Brandon Troy Frensley, Michael Blackwell  
**FROM:** Virginia Tech Institutional Review Board (FWA00000572, expires January 29, 2021)  
**PROTOCOL TITLE:** NorthBay Engagement Study  
**IRB NUMBER:** 15-915

Effective February 23, 2016, the Virginia Tech Institution Review Board (IRB) Chair, David M Moore, approved the Amendment request for the above-mentioned research protocol.

This approval provides permission to begin the human subject activities outlined in the IRB-approved protocol and supporting documents.

Plans to deviate from the approved protocol and/or supporting documents must be submitted to the IRB as an amendment request and approved by the IRB prior to the implementation of any changes, regardless of how minor, except where necessary to eliminate apparent immediate hazards to the subjects. Report within 5 business days to the IRB any injuries or other unanticipated or adverse events involving risks or harms to human research subjects or others.

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<http://www.irb.vt.edu/pages/responsibilities.htm>

(Please review responsibilities before the commencement of your research.)

**PROTOCOL INFORMATION:**

Approved As: Expedited, under 45 CFR 46.110 category(ies) 7  
Protocol Approval Date: November 9, 2015  
Protocol Expiration Date: November 8, 2016  
Continuing Review Due Date\*: October 25, 2016

\*Date a Continuing Review application is due to the IRB office if human subject activities covered under this protocol, including data analysis, are to continue beyond the Protocol Expiration Date.

**FEDERALLY FUNDED RESEARCH REQUIREMENTS:**

Per federal regulations, 45 CFR 46.103(f), the IRB is required to compare all federally funded grant proposals/work statements to the IRB protocol(s) which cover the human research activities included in the proposal / work statement before funds are released. Note that this requirement does not apply to Exempt and Interim IRB protocols, or grants for which VT is not the primary awardee.

The table on the following page indicates whether grant proposals are related to this IRB protocol, and which of the listed proposals, if any, have been compared to this IRB protocol, if required.

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**MEMORANDUM**

**DATE:** July 7, 2016  
**TO:** Marc J Stern, Brandon Troy Frensley, Michael Blackwell  
**FROM:** Virginia Tech Institutional Review Board (FWA00000572, expires January 29, 2021)  
**PROTOCOL TITLE:** NorthBay Engagement Study  
**IRB NUMBER:** 15-915

Effective July 7, 2016, the Virginia Tech Institution Review Board (IRB) Chair, David M Moore, approved the Amendment request for the above-mentioned research protocol.

This approval provides permission to begin the human subject activities outlined in the IRB-approved protocol and supporting documents.

Plans to deviate from the approved protocol and/or supporting documents must be submitted to the IRB as an amendment request and approved by the IRB prior to the implementation of any changes, regardless of how minor, except where necessary to eliminate apparent immediate hazards to the subjects. Report within 5 business days to the IRB any injuries or other unanticipated or adverse events involving risks or harms to human research subjects or others.

All investigators (listed above) are required to comply with the researcher requirements outlined at: <http://www.irb.vt.edu/pages/responsibilities.htm>

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**PROTOCOL INFORMATION:**

Approved As: **Expedited, under 45 CFR 46.110 category(ies) 7**  
Protocol Approval Date: **November 9, 2015**  
Protocol Expiration Date: **November 8, 2016**  
Continuing Review Due Date\*: **October 25, 2016**

\*Date a Continuing Review application is due to the IRB office if human subject activities covered under this protocol, including data analysis, are to continue beyond the Protocol Expiration Date.

**FEDERALLY FUNDED RESEARCH REQUIREMENTS:**

Per federal regulations, 45 CFR 46.103(f), the IRB is required to compare all federally funded grant proposals/work statements to the IRB protocol(s) which cover the human research activities included in the proposal / work statement before funds are released. Note that this requirement does not apply to Exempt and Interim IRB protocols, or grants for which VT is not the primary awardee.

The table on the following page indicates whether grant proposals are related to this IRB protocol, and which of the listed proposals, if any, have been compared to this IRB protocol, if required.

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**MEMORANDUM**

**DATE:** October 28, 2016  
**TO:** Marc J Stern, Brandon Troy Frensley, Michael Blackwell  
**FROM:** Virginia Tech Institutional Review Board (FWA00000572, expires January 29, 2021)  
**PROTOCOL TITLE:** NorthBay Engagement Study  
**IRB NUMBER:** 15-915

Effective October 28, 2016, the Virginia Tech Institutional Review Board (IRB) Chair, David M Moore, approved the Continuing Review request for the above-mentioned research protocol.

This approval provides permission to begin the human subject activities outlined in the IRB-approved protocol and supporting documents.

Plans to deviate from the approved protocol and/or supporting documents must be submitted to the IRB as an amendment request and approved by the IRB prior to the implementation of any changes, regardless of how minor, except where necessary to eliminate apparent immediate hazards to the subjects. Report within 5 business days to the IRB any injuries or other unanticipated or adverse events involving risks or harms to human research subjects or others.

All investigators (listed above) are required to comply with the researcher requirements outlined at: <http://www.irb.vt.edu/pages/responsibilities.htm>

(Please review responsibilities before the commencement of your research.)

**PROTOCOL INFORMATION:**

Approved As: Expedited, under 45 CFR 46.110 category(ies) 7  
Protocol Approval Date: November 9, 2016  
Protocol Expiration Date: November 8, 2017  
Continuing Review Due Date\*: October 25, 2017

\*Date a Continuing Review application is due to the IRB office if human subject activities covered under this protocol, including data analysis, are to continue beyond the Protocol Expiration Date.

**FEDERALLY FUNDED RESEARCH REQUIREMENTS:**

Per federal regulations, 45 CFR 46.103(f), the IRB is required to compare all federally funded grant proposals/work statements to the IRB protocol(s) which cover the human research activities included in the proposal / work statement before funds are released. Note that this requirement does not apply to Exempt and Interim IRB protocols, or grants for which VT is not the primary awardee.

The table on the following page indicates whether grant proposals are related to this IRB protocol, and which of the listed proposals, if any, have been compared to this IRB protocol, if required.

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 North End Center, Suite 4120  
 300 Turner Street NW  
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 email [irb@vt.edu](mailto:irb@vt.edu)  
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**MEMORANDUM**

**DATE:** March 10, 2018  
**TO:** Marc J Stern, Brandon Troy Frensley, Michael J. Stacy Blackwell  
**FROM:** Virginia Tech Institutional Review Board (FWA00000572, expires January 29, 2021)  
**PROTOCOL TITLE:** NorthBay Engagement Study  
**IRB NUMBER:** 15-915

Effective October 18, 2017, the Virginia Tech Institution Review Board (IRB) approved the Continuing Review request for the above-mentioned research protocol.

This approval provides permission to begin the human subject activities outlined in the IRB-approved protocol and supporting documents.

Plans to deviate from the approved protocol and/or supporting documents must be submitted to the IRB as an amendment request and approved by the IRB prior to the implementation of any changes, regardless of how minor, except where necessary to eliminate apparent immediate hazards to the subjects. Report within 5 business days to the IRB any injuries or other unanticipated or adverse events involving risks or harms to human research subjects or others.

All investigators (listed above) are required to comply with the researcher requirements outlined at: <http://www.irb.vt.edu/pages/responsibilities.htm>

(Please review responsibilities before the commencement of your research.)

**PROTOCOL INFORMATION:**

Approved As: **Expedited, under 45 CFR 46.110 category(ies) 7**  
 Protocol Approval Date: **November 9, 2017**  
 Protocol Expiration Date: **November 8, 2018**  
 Continuing Review Due Date\*: **October 25, 2018**

\*Date a Continuing Review application is due to the IRB office if human subject activities covered under this protocol, including data analysis, are to continue beyond the Protocol Expiration Date.

**FEDERALLY FUNDED RESEARCH REQUIREMENTS:**

Per federal regulations, 45 CFR 46.103(f), the IRB is required to compare all federally funded grant proposals/work statements to the IRB protocol(s) which cover the human research activities included in the proposal / work statement before funds are released. Note that this requirement does not apply to Exempt and Interim IRB protocols, or grants for which VT is not the primary awardee.

The table on the following page indicates whether grant proposals are related to this IRB protocol, and which of the listed proposals, if any, have been compared to this IRB protocol, if required.

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## Appendix D

### NorthBay Adventure Parent Consent Form



#### PARENT / GUARDIAN CONSENT AND LIABILITY RELEASE FORM

*At NorthBay, health, safety and supervision are paramount. The approach to safety and risk management is accompanied with competence, judgment and purposeful sound programming. The children's safety and well-being is everyone's concern. As a policy of NorthBay we require that a Release of Liability Form be signed as a requirement to attend camp.*

I am the parent or legal guardian of \_\_\_\_\_ (the "Camper") from (school name) \_\_\_\_\_ who wants to attend camp and participate in activities sponsored by NorthBay, LLC ("NorthBay"). I agree to sign this *Consent and Liability Release Form* so my child can attend camp. I promise the information given on this Health Form is complete and accurate as far as I, the undersigned parent or guardian, know. It is true that the Camper has had all immunizations required by the Maryland DHMH Recommended Childhood Immunization Schedule and that the school has these records.

**LIABILITY RELEASE** - I understand that participating in some of the activities sponsored by NorthBay, including canoeing, kayaking, boating, water skiing, hiking, swimming, snorkeling, tubing, fishing, rock climbing, zip line, sport activities, nature activities, and the ropes course, involve certain risks, including the risk of serious injury. I give my permission for the Camper to participate in all of the activities while at NorthBay and agree on behalf of the Camper that I and the Camper assume all risks. I understand that certain camp activities may include traveling in NorthBay owned and operated passenger vehicles. I also agree both for myself and on behalf of the Camper to release NorthBay, its employees, agents, and related entities from and against any and all claims, injuries, and liabilities of any kind that happen while the Camper attends camp, doing any activity connected in any way to the NorthBay program, or caused by any inappropriate behavior on the part of the camper. However, NorthBay will be responsible for claims caused by the gross negligence or intentional misconduct of NorthBay. At NorthBay, we are always trying to improve our programs to provide the best possible experience for our visiting students. As part of this effort, an external evaluation team periodically conducts research on campus. This research involves observing our programs and conducting simple surveys with visiting students. All data are kept strictly confidential. Students are not held responsible for any of their survey responses. The research occasionally results in publications that report on the accomplishments of our programs and what we are learning, so that other programs like ours can learn from our work. By signing this permission form, you are consenting to allowing your son/daughter to participate in this research. Students maintain the right on campus to refuse to take any survey with no fear of any consequences or penalties.

**HEALTH CONSENT** - I have legal authority to consent to medical treatment for the Camper and grant permission for the Camper to engage in all camp activities except as noted. If I cannot be reached while my child is at camp, I give permission to the medical personnel selected by NorthBay to provide routine health care or emergency treatment and to release any records necessary for treatment, billing, referral or insurance purposes. I understand that NorthBay personnel will notify me immediately of any illness or injury that requires significant medical attention or hospitalization or that significantly diminishes the Camper's ability to have a successful camp experience. In the event that I cannot be reached in an emergency, I hereby give permission to the physician selected by the Camp to treat him/her for any injury/illness. I understand medical information about my child is confidential and protected under state and federal law. I give permission for the Camp medical personnel to discuss my child's medical information with his/her health care provider if my child is ill, injured, have any medical or psychological concerns, or take medications. I give permission for the camp medical personnel to share information about my child with his Camp teachers, counselors, and dining when the student brings to camp with them in accordance with Maryland law. I understand that I am responsible for any medical expense occurred while at camp for emergency transport, hospital treatment or medications needed while at camp. I understand that the Camp is not responsible to submit any insurance or prescription claims to my insurance provider.

**AUTHORIZATION FOR OVER-THE-COUNTER MEDICATIONS** - In the event your child experiences minor discomforts during camp, we would like the opportunity to make your child as comfortable as possible. Therefore, below is a list of over-the-counter medications that can be administered by NorthBay personnel with your authorization. These medications are approved by the NorthBay Medical Director using the recommended doses from the manufacturers. This service is provided to alleviate your child's minor discomforts and avoid being sent home early from camp. The below approved medications are intended for occasional use only. If your child requires any medication on a regular basis, you must have a medication authorization form completed by your health care provider and supply the medications. I consent to the administration of the below indicated over-the-counter medications to my child while at NorthBay (check all that apply). If they are NOT checked they WILL NOT be given to the Camper.

- |   |  |
|---|--|
| <input type="checkbox"/> Acetaminophen (generic for Tylenol)      | <input type="checkbox"/> Antibiotic Cream (for minor cuts/scrapes) |
| <input type="checkbox"/> Ibuprofen (generic for Advil and Motrin) | <input type="checkbox"/> Loratadine (generic for Claritin)         |
| <input type="checkbox"/> Calamine Lotion (for itching)            | <input type="checkbox"/> Diphenhydramine (generic for Benadryl)    |
| <input type="checkbox"/> Hydrocortisone Cream (for itching)       |  |

I do not want over-the-counter medications given to my child

**PUBLICITY RELEASE** - I give permission to NorthBay the right to use, reproduce, and/or distribute photographs, films, video-tapes, and sound recordings of my child, without payment or approval rights. For use in materials created for promoting NorthBay.

The laws of the State of Maryland shall govern the rights and obligations of the parties to this Release and the interpretation, construction, and enforceability thereof. I agree on behalf of the Camper and myself that any lawsuit brought against NorthBay shall be brought solely in the Circuit Court for Cecil County, Maryland and, in connection with any such lawsuit, I agree on behalf of myself and the Camper that the trial will be conducted and determined by the Judge assigned to such trial, and voluntarily waive any right the Camper or I may have to a jury trial.

Signature of parent/guardian: \_\_\_\_\_ Date: \_\_\_\_\_

Printed name of parent/guardian: \_\_\_\_\_



Revised 5/2012

## Appendix E

### Verbal Consent Script

#### First survey

*I am a researcher from Virginia Tech, and we are asking you to be in a research study. In this research study, we want to learn more about how students feel about NorthBay lessons. We are asking you to complete a short survey that should take no more than 10 minutes. No harm will come to you if you choose not to participate in this study. All of your survey answers will be kept private, and no one outside the research team will be able to see your answers. If you are uncomfortable answering any of the questions, you may skip them. If you do not want to participate in the survey you may simply sit quietly until others finish. If you are willing to participate, turn your surveys over and wait for further instructions to begin.*

#### Subsequent surveys

*Similar to last night, we are asking you to complete another survey as a part of our research. Just as before, this survey should take no more than 10 minutes of your time. No harm will come to you if you choose not to participate in this study. All of your survey answers will be kept private, and no one outside the research team will be able to see your answers. If you are uncomfortable answering any of the questions, you may skip them. If you do not want to participate in the survey you may simply sit quietly until others finish. If you are willing to participate, turn your surveys over and wait for further instructions to begin.*

## Appendix F

### Student Survey

Please select the response that best describes how you feel about the lesson you just had.

	Not at all	A little	Somewhat	A lot	A huge amount
This lesson made me appreciate nature more than I did before.	1	2	3	4	5
This lesson made me feel more connected to nature than I ever have before.	1	2	3	4	5
This lesson taught me something that <u>will be useful to me</u> after I leave.	1	2	3	4	5
This lesson helped me understand how my actions affect the environment.	1	2	3	4	5
This lesson made me feel I can make a difference in my community at home.	1	2	3	4	5
This lesson made me want to spend more time in nature after I leave here.	1	2	3	4	5
This lesson made me want to learn more about environmental issues.	1	2	3	4	5
This lesson made me want to do something to take care of the environment.	1	2	3	4	5

	Not at all	Slightly	Somewhat	Mostly	A great deal
I felt free to learn in my own way during the lesson.	1	2	3	4	5
I was able to understand the lesson.	1	2	3	4	5
I enjoyed the lesson.	1	2	3	4	5
I tried hard during the lesson.	1	2	3	4	5
I felt comfortable with the group during the lesson.	1	2	3	4	5
I disliked the lesson.	1	2	3	4	5
I paid attention during the lesson.	1	2	3	4	5

1. What was happening in the lessons today when you felt most excited and paid attention?

2. Which of today's two lessons (morning or afternoon) did you like better and why?



Passion	1 2 3 4	Redirect	0 1 2	Play-based	1 2 3 4	Teacher-led	1 2 3 4
Charisma	1 2 3 4	Request	0 1 2	Storytelling	1 2 3 4	Student-led	1 2 3 4
Sincerity	1 2 3 4	Positive	0 1 2	Sensory Focus	1 2 3 4	Data Collection	1 2 3 4
App. Knowledge	N/A 1 2 3 4	Negative	0 1 2	Cooperative/group	1 2 3 4	Hands-on	1 2 3 4
Ed. Comfort	1 2 3 4	Reflection	1 2 3 4	Multiple Viewpoints	1 2 3 4	Free Exploration	1 2 3 4
Eloquence	1 2 3 4	Group	1 2 3 4	Relevance	1 2 3 4	Student-led Learning	1 2 3 4
Aud. Comfort	1 2 3 4	Individual	1 2 3 4	Role modeling	1 2 3 4	Time mgmt.	1 2 3 4
Emotional Sensitivity	1 2 3 4	T/C #1 Positive	1 2 3 4	Env. Issue-based	1 2 3 4	Qual. Introduction	1 2 3 4
Responsiveness	1 2 3 4	T/C #1 Negative	1 2 3 4	Fact-based	1 2 3 4	Qual. Conclusion	1 2 3 4
Opportunism	N/A 1 2 3 4	T/C #2 Positive	1 2 3 4	Teacher-led Q&A	1 2 3 4	Transitions	1 2 3 4
Clarity	1 2 3 4	T/C #2 Negative	1 2 3 4	Question Quality	1 2 3 4	Overall Lesson Quality	1 2 3 4 5 6 7 8 9 10
Class mgmt.	1 2 3 4	Affective-based	1 2 3 4	Investigation	1 2 3 4		
Educator Primary Identity (circle one): Friend Coach Authority Figure Walking Encyclopedia Other:							

Negative Engagement					
Almost All	Most	Half	Some	Almost None	Disruption
Almost All	Most	Half	Some	Almost None	Frustration
Non Engagement					
Almost All	Most	Half	Some	Almost None	Detached
Positive Engagement					
Almost All	Most	Half	Some	Almost None	Attention
Almost All	Most	Half	Some	Almost None	Effort
Almost All	Most	Half	Some	Almost None	Enjoyment
Overall Student Engagement					
1 2 3 4					