Examining The Impact Of A Field Trip In Nature On Students' Environmental Perceptions And Feelings Of Empowerment: A Case Study From The Acmes Stem Summer Camp.

Archana Prasad[1,2], Pankaj Lal[1,2], Bernabas Wolde[3], Michelle Zhu[4], Bharat Kumar Samanthula[4], Nicole Panorkou[5]

Abstract

Nearly 80% of the total American population lives within the urban sprawl, where rapid urbanization has contributed to an immense reduction of green space. Loss of woods, fields, and other green areas, in conjunction with adolescent preference for indoor and screen-based activities, has led to decreased time spent outdoors. However, studies show that time spent outdoors can lead to reduced rates of depression and anxiety, measurable decreases in blood pressure, and improvements in mood and confidence. With an increase in rates of anxiety seen in adolescents over the past decade, spending time in the wilderness may prove to be an accessible method of anxiety mitigation. This study uses data collected from pre-post surveys (n=41) conducted during a STEM summer day camp field trip to Stokes State Forest in northwestern New Jersey to determine how exposure to nature contributes to adolescents' environmental perceptions and feelings of empowerment, while also addressing critical methodological gaps that exist in previous studies. Respondents, who were of ages 10-13 at the time of data collection, were asked about their previous experiences of participating in nature-based activities, feelings of being in the natural environment, and concerns about the future. Results show that after the field trip ended, students felt more optimistic about the future and that they believed more strongly that human activity damaged the environment. A regression analysis indicates positive relationships between feelings of optimism and empowerment after the day in the forest, grade, and week attended, suggesting that younger children benefitted more than older children and that their camp mentor expertise played a large influence on the campers. These results can be helpful for recognizing the value of adolescent's nature-based experiences in improving their environmental perceptions.

Keywords: environmental perception, adolescent empowerment, adolescent optimism, nature-based field trips, pre-post survey, nominal regression

Introduction

Studies show that interaction with the natural environment can mentally, physically, and emotionally benefit children. These benefits are measurable, with research linking exposure to natural elements with longer sleeping hours, improved health noted by parents, and lower blood pressure numbers in children (Chawla, 2015). A 2003 study conducted in upstate New York found that children with more exposure to nature viewed it as a positive buffer between difficult events and stress management (Wells & Evans, 2003). The impacts of nature on children have been investigated, with studies also showing that collaborative efforts between adolescents and their peers can further improve environmental awareness (Karahan & Roehrig, 2015). This can be encouraged through activism as an extracurricular afterschool activity, playtime outside during recess, or even in a classroom laboratory setting (Ashraf, 2013).

There is a direct positive correlation between the amount of time spent in nature and mood. Even brief interactions with nature (as short as 5 to 15 minutes per day to up to an hour) can reliably improve physical, mental, and emotional health for all ages, ranging from adolescents, to college-aged students, and older adults (Hohashi & Kobayashi, 2013; Neill et al., 2019; Hamann, & Ivtzan, 2016). An Australian study found that a minimum of 30 minutes actively spent in green spaces was linked to a 7% reduction in depression and a 9% reduction in blood pressure in the sample population (Shanahan et al., 2016). These studies are becoming increasingly important in the United States, where 8.1% of adults and 7.1% of children suffer from depression and anxiety respectively (Center for Disease Control, 2019; Center for Disease Control, 2018).

The benefits of short-term nature interventions on adolescents have often been assessed through repeated observations over the course of a few days to a few weeks (Jelalian et al., 2011; O'Brien & Lomas, 2017; Furman & Sibthorp, 2014). Benefits of these short-term interventions include various mental, physical, and social gains, including improved self-perception, self-efficacy, and social improvements (Mygind et al., 2019). Studies in which participants repeatedly participate in outdoors activities over the course of a few weeks, however, can be difficult to naturally replicate in an increasingly urbanized world, where children may rely on others to bring them from place to place. Therefore, single-exposure nature-intervention studies are especially useful literature in assessing impacts of similar programs on urban and suburban children. Connelly (2012) found that a day with adolescents in nature improved self-efficacy, stress management, and leadership qualities, amongst several other improvements. Hohashi & Kobayashi (2013) found their sample population of 12-14 year-old adolescent girls to have experienced more relaxed moods and decreased stress and fatigue after an hour walk as part of a single-exposure study. While all these studies focus significantly on the important health-based improvements on children and have found tangible benefits regardless of frequency of data collection, there exists a gap in the literature regarding the impact of these interventions on respondent's feelings regarding the physical space in which they have unlocked these different benefits.

As urbanization continues to grow, the natural spaces in which these benefits are encouraged become less available. In already urbanized areas, children have less easy access to the wilderness, and they may therefore lack frequent opportunities to obtain those benefits. Therefore, adolescents' single-exposure incidences with nature warrant further investigation. This importance of single-exposure nature interventions is exacerbated by the growing prominence of urban residence, as these areas suffer from lower accessibility to nature; increasingly sprawling urban areas are home to 80% of the total population (U.S.

1 Department of Earth and Environmental Studies, Montclair State University, 1 Normal Ave, Montclair NJ 07043
2 Clean Energy and Sustainability Analytics Center, Montclair State University, 1 Normal Avenue, Montclair NJ 07043
3 Air Pollution Control Division, Colorado Department of Public Health and Environment 4300 Cherry Creek Drive South, Denver, CO 80246
4 Department of Computer Science, Montclair State University, 1 Normal Ave, Montclair NJ 07043
5 Department of Mathematics, Montclair State University, 1 Normal Ave, Montclair NJ 07043

Census, 2016). The urbanization of New Jersey has led to a near 7% decline in upland forested areas and a 5.4% decline in wetlands (Rutgers Center for Remote Sensing and Spatial Analysis, 2012). As more natural area is lost, more children lose everyday interaction with the natural world, which is compounded by a preference for the indoors and screen-based activities (Karsten & Vliet, 2006; Larson et al., 2018). This may cause a disconnect between awareness of and concern for environmental issues (Lovelock et al., 2016). As such, it is critical to understand the factors contributing to the relationship children have with nature, as it can further be of interest in the future of climate change impact mitigation efforts. Children's identification and understanding of the benefits associated with nature could help improve the urgency of preservation and conservation efforts (Escobar, 2019; Woods, 2018). An example is adolescent activist Greta Thunberg, who has inspired global climate protests not only amongst adults but also hundreds of thousands of teenage "Gretas" who organized and participated in their own grassroots-level climate strikes (Alter, 2019).

Literature also supports the need for children to be guided by adults while exploring the wilderness from an urban or suburban background. Whether that is from a community-supported endeavor or by individual educators, research reinforces the need for adult guidance in nature intervention programs (Burgess & Mayer-Smith, 2011; White et al., 2018). Teacher expertise can drastically improve positive interactions students have in the classroom up until the first few years, after which point, teacher improvement has diminishing marginal returns (Boyd et al., 2008). Given that adolescent perceptions of being in nature can change if children experience more exposure to nature with experienced adult guides, this study aims to determine the factors that contribute to children's perceptions of being in and engaging with the natural environment. In this study, the camp mentors accompanying the respondents throughout the sessions throughout the week were doctoral students with limited experience with teaching children. While the mentors were not always responsible for teaching the lessons during the sessions, they were often at a minimum accompanying the campers throughout the day. We hypothesize that teacher/camp mentor expertise increased as the weeks passed, improving respondents' experiences during the camp.

Studies showing the positive effects of exposure to nature tend to focus on the improvements in participants' views of nature, with considerations for the demographic and locational background (Aaron & Witt, 2011; Lekies et al., 2015). Similar studies take into account the nature-based experiences that participants bring with them to the study as childhood exposure to wilderness can positively influence the way that adolescents value nature (Burgess & Mayer-Smith, 2011; Van Velsor & Nilon, 2006). Acknowledging that participants come into the camp experience and field trip with different opinions and perceptions of nature is extremely important in helping overcome any prior obstacles in nature they may have, such as associating nature with fear and or danger, or finding nature to be "disgusting" (Lekies et al., 2015). Therefore, in this study, we assess the levels of participation in nature that respondents may have had with a questionnaire asking respondents to identify amounts of different types of exposure to the natural environment, such as participating in fishing activities, collecting edible berries, or even reading about nature or science in books and magazines. It is possible that previous exposure to nature can affect the impact such a program can have on its participants.

Benefits of nature-based field trips, especially for urban adolescents, include overcoming fear of the unfamiliar sights and sounds in nature (Bixler et al., 1994). There is sometimes an accompanying sense of wanting to protect nature (Lekies et al., 2015). Adolescent and teenaged respondents also cited the tranquility of nature, a newfound respect for wildlife, and viewing nature as less dangerous as some of the many different reasons that they enjoyed spending time in nature (Lekies et al., 2015). Aaron and Witt (2011) found that their 5th grade respondents also felt a sense of personal responsibility towards protecting nature. In this study, we try to understand respondents' feelings of personal responsibility a step further and look at the feelings of empowerment over the potential courses of action in nature conservation or preservation.

To assess the impact that a day spent in nature could have on New Jersey adolescents and to understand the potential factors that might play a role in those effects, researchers from the Assimilating Computational and Mathematical Thinking into Earth and Environmental Science (ACMES) STEM Summer Camp took students entering grades 6-8 on a day-long field trip to the New Jersey School of Conservation (NJSOC) located at Stokes State Forest in western New Jersey. Campers engaged in a 2-mile hike and a stream ecology session and were asked about their feelings before and after these experiences. This study incorporates data from the pre-post surveys conducted before and after visiting the forest site into a cluster analysis, which is then used to inform a regression analysis. The regression gives insight into the factors most relevant in student perceptions of nature.

Methods

2.1 Field Trip Site

For their field trip, campers visited the New Jersey School of Conservation (NJSOC). NJSOC occupies approximately 240 acres of land within Stokes State Forest in northwestern New Jersey. It is located within the Kittatinny Mountain range and is open to visitors throughout the year. The NJSOC was founded in 1949 and is considered to be the first University-operated environmental education center in the United States, with research publications issued as early as 1959.

NJSOC also provides educational experiences towards "cultivating environmentally responsible behaviors that will encourage scientists, teachers, students and citizens to promote sustainable practices in their communities" (New Jersey School of Conservation, 2019). The school provides a wide range of environmentally-based experiences through interactive hikes, water ecology activities, and music camps, among nearly 40 other workshops. These workshops are held specifically to encourage learning in informal atmospheres outside of a classroom environment under the guidance of staff, graduate students, and affiliated partners.

2.2 Field Trip Activities

The field trip was scheduled to be at the New Jersey School of Conservation (NJSOC), located in Stokes State Forest. A total of 41 campers participated over the course of the 3 weeks. Four mentors were available to guide the campers during the field trip.

Rather than conduct a nature intervention of five full days of being in the outdoors, a single-exposure day-long visit to the forest was included as part of the summer camp. We believed that the results from a single, day-long field trip to the natural outdoors—about an hour drive away from the start location—would be more applicable of the type of activity that local children belonging to urban and suburban homes might be able to do. We also believed that results from collecting data at weekly intervals for our sample population would not generally be reflective of the benefits that children in the area could get from spending time in nature.

During the field trip, students were separated into different group activities upon arrival at NJSOC. Half the campers attended a 2-mile hike, while the other half of the group simultaneously attended a water ecology session. Campers would switch sessions after lunch. Each session was led by an NJSOC instructor, accompanied by a camp mentor. Students participating in the hike were given an introductory lesson on terrestrial ecology and learned how to identify interesting flora and fauna with special characteristics. The session included a brief on issues that affect ecosystem health, such as the increase in invasive species because of human alterations. Roads were cited as one potential reason for shifts in forest ecology; as more pollutants enter the soil from runoff, biodiversity could decrease as the more resilient invasive species thrive while the native species decline. These issues were additionally addressed later on in the hike, when the ecologist pointed to invasive vine species suffocating oak trees.

Campers participating in the water ecology session were exposed to concepts of pollution and stream health, with the aquatic ecologist introducing participants to different insects and benthic invertebrates that were indicator species. Students were provided rubber wading boots and were asked to collect benthic macroinvertebrate species. After an hour of wading through an onsite stream

1a. 1b.

Figure 1. Camper holds a frog found (Figure 1a, left), and campers reconvene after their water ecology session to identify and discuss species found in the stream (Figure 1b, right).

Survey Questions	1	2	3	4	5
Threats to the environment are not my business.					
Environmental problems make the future of the world look bleak.					
Environmental problems are exaggerated.					
STEM can solve all environmental problems.					
I am willing to have environmental problems solved even if this means sacrificing many goods.					
I can personally influence what happens with the environment.					
We can still find solutions to our environmental problems.					
People worry too much about environmental problems.					
Environmental problems can be solved without big changes to our way of life.					
People should care more about protecting the environment.					
It is the responsibility of rich countries to solve the environmental problems of the world.					
I think each of us can make a significant contribution to environmental protection.					
Environmental problems should be left to the experts.					
I am optimistic about the future.					
Animals should have the same right to life as people.					
It is right to use animals in medical experiments if this can save human lives.					
Nearly all human activity is damaging to the environment.					
The natural world is sacred and should be left in peace.					
Nature is uncomfortable because of heat, bugs etc.					
Nature is inspiring because of the colors, peace and bird songs.					
My family does not have transportation to go to a natural area.					
There are no natural areas (parks, gardens) anywhere near our home or school.					
I am not interested in spending any time in nature.					
Gangs or crime make natural areas unsafe.					
There is too much risk of getting hurt in natural areas (I could fall, get lost, be attacked by animals, etc.)					
I do not feel welcomed by other people in parks and other natural areas.					
Personal health issues stop me from participating in nature activities.					
It is too expensive for me and my family to participate in nature activities.					
My family will not let me spend time outdoors in natural areas.					

Table 1. Survey questions provided to respondents. For each statement, respondents were asked to choose if they (1) strongly disagreed, (2) disagreed, (3) had no opinion, (4) agreed, or (5) strongly agreed.

with strainers and yogurt cups to collect their specimens, campers reconvened to discuss their findings (see Figure 1). Through an interactive session with peers and mentors to identify their invertebrates, campers determined the level of stream health given the types of fauna discovered like frogs, lizards, and caddisflies found. Campers concluded that the species they found were indicators of healthy streams, and, with some reservation, decided that the stream at NJSOC was relatively clean. The specimens were released back into the water after the session. These observations are used as supporting, anecdotal evidence in our analysis.

2.3 Survey

Before and after the excursion to Stokes State Forest, campers were asked to fill out surveys in person. We relied on existing literature to determine the nature of questions to consider in our survey (Bell, 2007; Bixler et al., 2002). We did not find any single validated instrument that fit the purposes of our research, and we therefore created our own survey to administer to respondents (see Table 1). Before administering the selected set of questions, we also performed rounds of peer review, focus group discussions, and a pilot test to improve the survey's completeness and ease of understanding. Mentors were available to help if respondents needed clarification concerning any of the questions. Surveys included Likert-scale questions in which respondents were asked to report the level of their agreement or disagreement concerning their feelings about nature, with answers as "strongly disagree," "disagree," "neutral," "agree," or "strongly agree". These questions included exploring the relationship between respondents and their feelings that threats to the environment were their concern, if environmental problems were exaggerated, if they could personally influence what happens with the environment, if they as individuals could make significant contributions towards environmental protection, if they felt optimistic about the future, and how damaging they thought human activity was towards the environment.

To provide researchers with an idea of the campers' backgrounds, the survey included nominal-response questions about activities they could have done at home (or with parents), school, or at both locations. Responses were available in the form of "Not done," "Done at home," and/or "Done at school" (see Table 2).

Background information was also obtained through the survey. The relevant questions asked for demographic information such as gender, age, and ethnic background. In this part of the survey, the camp mentor expertise was also noted. Expertise, in this study, does not refer to the level of education or years teaching, but the number of full-length camp sessions mentors has had with the campers. It is possible that the mentors' expertise levels can affect the impact such a program can have on its participants. Therefore, if the respondent participated in week 1, this also indicated that the camp mentors were in their first week of managing the camp. The camp mentor expertise was noted with values between 1 and 3.

2.4 Statistical data analysis

A list of potential experiences that adolescents bring with them to the excursion program was populated and entered into the regression analyses to firstly isolate the effect of the field trip, and to secondly determine how much of the reported result is attributable to the previous experience itself. Given that the list of experiences was long, a clustering analysis was considered for reducing the data without losing much of the variability in it. Similarly, the level of expertise of mentors was entered into the regression analyses. The regression method of data analysis helped accurately measure the effect of the field trip itself as well as indicate the importance of mentor selection for other similar programs.

To study the effect of intrinsic factors or the explanatory variables on the change in the participants' perception towards the environment, we subtracted the values of the pre-survey from the post-survey for the questions

Nature Activities	I have not done this.	I have done this at school.	I have done this at home.
Tried to find star constellations in the sky.			
Collected different stones or shells.			
Watched (not on TV) an animal being born.			
Cared for animals on a farm.			
Visited a zoo.			
Milked animals like cows, sheep or goats.			
Read about nature or science in books or magazines.			
Watched nature programs on TV/tablet/cinema.			
Collected edible berries, fruits, mushrooms or plants.			
Participated in hunting.			
Participated in fishing.			
Planted seeds and watched them grow.			
Made compost of grass, leaves or garbage.			
Camped outdoors in a tent or shelter.			
Sorted garbage for recycling or for appropriate disposal.			
Taken herbal medicines or had alternative treatments.			

Table 2. Survey questions provided to respondents to assess exposure to nature before attending the field trip to Stokes.

of interest. This method could effectively determine the change in perception; by subtracting the pre-survey values from those of the post-survey, where responses were assigned numeric values from 1 to 5 in survey analysis, we could create a matrix to represent the changes in respondent perception.

2.4.1 Cochran-Armitage trend test

The Cochran-Armitage trend test is applicable for binomial factors across a single variable ("Cochran Armitage Trend Test," 2019). This test can be used for nominal response questions against a 2-level variable to determine for significant statistical trends. The Cochran-Armitage trend test was run twice: (1) to determine how optimistic respondents felt about the future given the time they spent in nature, and (2) determine the negative impact that respondents felt humans caused on the environment. These were assessed using changes between the pre- and post-surveys.

2.4.2 Cochran-Mantel-Haenszel (CMH) Test

The Cochran-Mantel-Haenszel (CMH) test is used for factors in a 2x2 table to test for independence, multiple experiments done several times, and a third repeating nominal variable (McDonald, 2015). The CMH test was used to determine the differences in perception broken down by grade.

2.4.3 Cluster analysis

Cluster analysis is a data exploration tool to systematically group several variables together. In this study, it is used to group opinions about respondents' feelings of being in nature by association. Cluster analysis identifies patterns among variables and helps to identify a given member of a cluster as a representative version of that cluster by evaluating the proportion of the variation each cluster member contributes to its respective cluster. By identifying the respective representative cluster component for all clusters, a shorter list of items that represent the larger dataset can be determined. While this analysis allows us to assess if there is a pattern of sorting in the variables that can benefit from a targeted approach, identifying representative cluster components allows us to deal with a fewer number of variables without necessarily losing the insight of the long list of variables ("Cluster Variables," 2019).

2.4.4 Ordinal logistic model

An ordinal logistic model was used to analyze the data in this study due to the ordinal-response questions posed in the survey. This model interprets data and determines the order between the levels in the data. It is an efficient method of data analysis that requires less input than nominal models. The ordinal logistic model uses parallel logistic curves to all the probabilities, but with separate intercepts (JMP, 2018). Each respective curve can be specified as:

$$P(y \leq k) = F(\alpha k + \beta X) \text{ for } k = 1, \ldots, r-1 \quad (1)$$

$$F(x) = \frac{1}{(1+e^{-x})} = \frac{e^{x}}{(1+e^{x})} \quad (2)$$

where P is the probability function, y is the dependent variable, k represents the number of levels, is the intercept for number of levels and β is the coefficient for the X, which is the independent variable for Eq. (1). Eq. (2) shows F(x) as the function for the standard logistic cumulative distribution function. The regression is used to incorporate camp mentor expertise with other factors such as grade, gender, ethnicity, and chosen variables from the cluster analysis.

Results

This study is based on survey data from 41 respondents, each of whom took the pre-survey in the morning before boarding the bus to go to Stokes State Forest and the post-survey immediately before boarding the bus to go back to campus. Data from the pre-survey were removed if respondents did not answer corresponding questions in the post-survey and vice-versa. The week that respondents attended the camp was noted for this study, which was marked as a method to also track the experience of the camp mentors.

3.1 Demographic and Background Information

Over a quarter of the respondents (27%) identified as Asian, while fewer (20%) respondents identified as Caucasian. There was almost an equal number of campers of Mixed ethnicities (15%) as there were Hispanic (17%). The rest of the respondents chose either "Other" or to not respond to the question. Respondents were also asked to answer questions about their parents' occupations. 37% of respondents had parents without a STEM-based profession, while 63% of respondents had at least one guardian that occupied in a STEM-based profession.

Each week, there were two mentors available to help the participants. Participants were familiar with the mentors from previous days in the camp. The mentors were both of Asian ethnicity. They were both doctoral students in the Department of Earth and Environmental Sciences. Mentors were randomly assigned to different groups for the stream and terrestrial ecology portions of the day.

3.2 Statistical Analysis

3.2.1 Contingency Analysis, Cochran Armitage test, and Cochran-Mantel- Haenszel (CMH) test

Running the contingency analysis and the Cochran-Armitage test shows a significant relationship between respondents and the ordinal-response questions *"I am optimistic about the future"* and *"Nearly all human activity is damaging to the environment"* (see Figure 2). These results show a positive impact in the way the respondents felt after the field trip to Stokes State forest, with the Cochran-Armitage test comparing the pre- and post-survey data against normalized data concerning the emotions students felt in the woods. Figure 2a shows that students in the post-survey felt more optimistic about the future after having spent the day in nature, with no students disagreeing that they felt optimistic about the future in the post-survey. While there were no differences between those who felt neutral or strongly agreed about their optimism, there was an increase in students who agreed (value 4) that they felt optimistic. The Cochran-Armitage Trend test, with a z statistic of 0.097, indicates a significance in the relationship between respondents feeling more optimistic about the future after the excursion.

Students also felt more strongly that nearly all human activity was damaging to the environment after the field trip (Figure 2b). Initially, more students strongly disagreed or disagreed (indicated by values "1" and "2" on the x-axis) about the impact of human activity on the natural world,

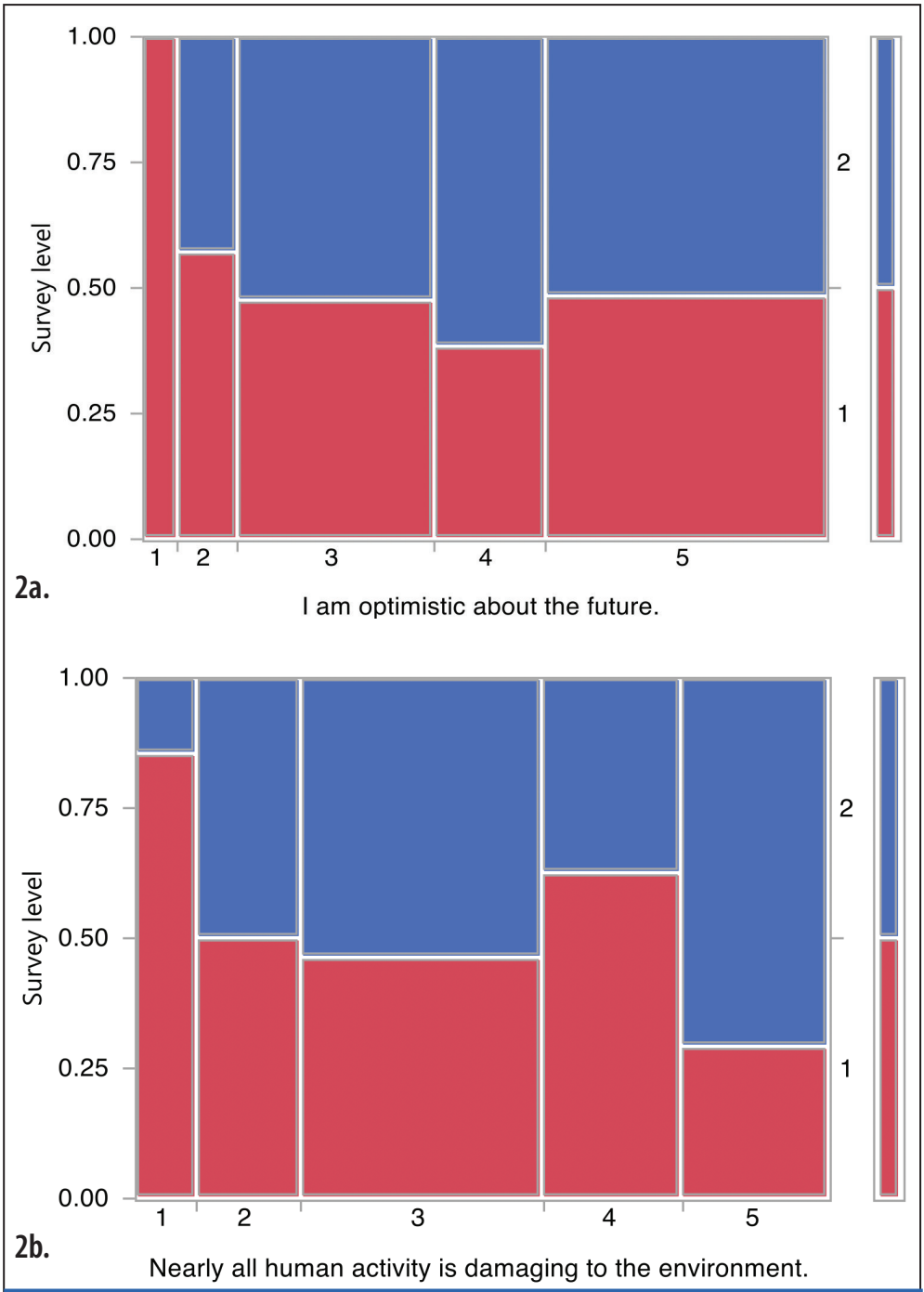

Figure 2. Significant results from the Cochran-Armitage trend test. "1" (in red) represents responses from the pre-survey while "2" (in blue) represents the post-survey. Values 1-5 on the horizontal axis represent beliefs ranging from 1 ("Strongly disagree") to 5 ("strongly agree").

with only a few students strongly agreeing with the statement. However, in the post-survey, there is a noticeable difference in the opinions of the respondents, with the post-survey showing an increase in responses strongly agreeing with human activity damaging the environment. Furthermore, the contingency analysis provided a likelihood ratio of 0.088, indicating that attitude towards human contribution to environmental problems varies with grade. With a significant Cochran-Mantel- Haenszel (CMH) test statistic of 0.097, the test shows respondents in grade 6 strongly felt that human activity damaged the environment more than those in grades 7 and 8. These relationships are further explored in the regression analyses.

3.2.2 Nominal Regression

To understand if respondents felt empowered by their time at Stokes State Forest, we ran an initial nominal regression analysis. For this regression, we used grade, gender, ethnicity, whether or not respondents' parent/guardian(s) worked in STEM fields, and the birth and education of parent/guardian(s) against the survey question *"I think each of us can make a significant contribution to environmental protection."* With this initial nominal regression, a p-value of 0.05 indicates that, in this model, school grade presents the most statistically significant relationship with the way students feel about the impact they would individually have on environmental protection, thus indicating a feeling of personal empowerment (see Table 2). 6th graders felt more strongly that they could make significant contributions than their older counterparts. Surprisingly, gender (p=0.39), ethnicity (p=0.81), the parents' education and birth (p=0.96) and working background (p=0.68) had little to no impact on respondent's feelings of contributions towards environmental protection.

To determine if these results from the initial regression model held against a more refined model, where the camper's and mentor's experiences are accounted for, we then replicated the regression after running a cluster analysis to determine and isolate the most significant indicators of all participants' experience with nature.

3.2.3 Cluster Analysis and Nominal Regression

Because of the large number of questions in our survey, we ran a cluster analysis to select the representative response variables from the list of 16 questions. Specifically, we ran a principal component analysis followed by cluster analysis, which allowed us to choose responses that most explained the maximum variance in the data.

The cluster analysis resulted in four clusters that represented over 57% of the variance in data, but because the last two clusters could only explain 11% and 7% of the total variance, respectively, we focused on the first cluster represented by whether respondents had collected edible berries, fruits, mushrooms, or plants (see Table 3). Cluster

Term	Estimate	Std Error	ChiSquare	Prob>ChiSq
Intercept [-1]	2.79	2.96	0.89	0.34
Intercept [0]	5.77	3.12	3.41	0.06
School Grade*	-0.83	0.43	3.79	0.05*
Gender	0.54	0.63	0.72	0.39
Ethnicity	0.03	0.12	0.06	0.81
Parents birth/education	-0.01	0.41	0.00	0.96
Parents work in STEM	0.19	0.48	0.17	0.68

Table 3. Results from nominal regression, showing a significant relationship between school grade and feelings of empowerment

Cluster	Number of Members	Most Representative Variable	Cluster Proportion of Variation Explained	Total Proportion of Variation Explained
2	5	Collected edible berries, fruits, mushrooms or plants.	0.48	0.15
1	5	Read about nature or science in books or magazines.	0.45	0.14
3	4	Sorted garbage for recycling or for appropriate disposal.	0.47	0.11
4	2	Participated in fishing.	0.57	0.07

Table 4. Cluster analysis showing different variances of representative variables.

2 was chosen as the most relevant group, with the representative variable explaining 48% of the cluster variation and 15% of the total variation. Therefore, Cluster 2 was used as the dependent variable in the regression.

The variable was then chosen to be part of a regression against the same factors run in the initial regression—school grade, gender, ethnicity, whether or not their parents worked in a STEM field, and if their parents had been born and educated in the United States—with an additional variable of the week during which they participated. This factor was introduced as a method of understanding how much the mentors' experience with camp over the course of the three weeks impacted the students' time at camp.

This regression model shows the significance of three variables (see Table 4). With a p-value of 0.06, the week that students attended the camp had the most significance on students' feelings of personal empowerment with regards to environmental protection. This indicates that the more expert the mentors were in running the camp, the more positively students felt at the end of the day in the forest. Grade and gender also contribute to how students might feel they can personally positively impact environmental protection.

These results suggest that at this stage, adolescents aged 10-13 are more open to new experiences that allow them to feel empowered.

4. Discussion

Our research suggests that after the trip to Stokes State Forest, respondents were more optimistic about the future (Cochran-Armitage trend test, $z = 0.097$) and more strongly agreed that humans negatively impacted the environment by grade, with those in grade 6 more strongly agreeing with the statement than those in grades 7 and 8 (Cochran-Mantel-Haenszel (CMH) test statistic, $z = 0.09$; Contingency Analysis, with likelihood ratio of 0.088). These findings reflect the results of previous studies done, in which results showed positive improvements in the mental health of children (Bixler, Carlisle, Hammitt, & Floyd, 1994; Lekies et al., 2015; Shanahan et al., 2016). This study contributed to existing research by showing that this positive improvement might be largely linked to the experiences of engaging in various activities in nature throughout the day.

Before the trip, responses in the survey indicated that respondents did not feel very strongly that humans negatively impacted the environment, whereas the post-survey saw a change in this attitude. Anecdotal evidence from camp mentors observing the participants supports this change in opinion. Students on the hike were observed to be particularly engaged when they interacted with unique plants, such as Symplocarpus foetidus, which is more commonly known as "skunk cabbage" for its malodorous scent emitted from leaves. Likewise, they were particularly interested when faced with examples of invasive species. For instance, when the terrestrial ecologist pointed out signs of invasive species on the hike, students asked many questions about the severity of the risks and from these interactions they understood that these impacts can very often be traced back to human activities. Black bears were spotted on one of the hikes as well, and as the bear cubs scampered away from the hike, many of the campers were exposed to the concept of bears being frightened by humans—another thought towards the impact of humans on the natural world.

A comparable sense of curiosity was observed during the water ecology activity. After students spent an hour collecting different benthic macroinvertebrate species in an onsite stream, they were asked to identify the different species they had collected to determine the environmental health status of the stream. If the stream was home to certain indicator species, it could be identified as healthy. Some campers chanced upon caddisfly larvae and their cocoons, which instructors said were typically made from gravel and caddisfly secretions. However, some of the cocoons found were amassed from plastics and glass, surprising nearly all of the campers. For many of the campers, this was a first experience showing the tangibility of pollution on the natural world; plastic water bottles, which many students had carried with them to the woods that same day, could impact flora and fauna so far removed from them, months—or years—later if not properly disposed through recycling. Activities like field trips have been proven to help students better understand the severity of environmental problems (Dori & Tal., 2000). This study contributed to literature by re-enforcing that a nature-based field trip, specifically one in which students can engage in hands-on activities, can help children understand the varying impacts of human activities on the natural world.

These experiences most likely contributed to students' changing feelings of human activity negatively impacting the environment. The contingency analysis ($z = 0.09$ with a likelihood ratio of 0.088) also showed that these feelings differed by grade, and that students in the lower grades felt more strongly about the impact of humans on the environment, suggesting that the methodology used in the camp is more effective on younger campers. This could contribute to changes for future camps, where different methods could be explored for older students. Perhaps older students can benefit from more intensive environmental exposure; studies show that academic level and maturity can influence the understanding of issues (Johnstone, 1970; Means & Voss, 1996).

Campers felt that humans had more of a damaging impact on the environment after the field trip; however, they also felt more optimistic about the future. This result informed our regression analyses, where we used the survey question *"I think each of us can make a significant contribution to environmental protection"* as an indicator of personal empowerment towards environmental issues. We initially used the variable of personal empowerment against respondent background information to replicate methods used in similar studies and found grade to be the best indicator of personal empowerment in environmental issues. However, after having repeated the regression using a cluster analysis to inform the regression, we found that a deeper analysis led to a more significant relation-

Term	Estimate	Std Error	ChiSquare	Prob>ChiSq
Intercept [-1]	3.26	3.07	1.12	0.28
Intercept [0]	6.53	3.27	3.98	0.04
School Grade*	-0.79	0.44	3.11	0.07*
Gender*	1.17	0.73	2.55	0.11*
Ethnicity	0.05	0.13	0.16	0.69
Parents birth/education	-0.04	0.42	0.01	0.90
Parents work in STEM or not	0.30	0.52	0.35	0.55
Week*	-0.91	0.50	3.30	0.06*
Collected edible berries, fruits, mushrooms or plants.	-0.20	0.75	0.07	0.78

Table 5. Regression results using representative response "Collected edible berries, fruits, mushrooms, or plants" from cluster analysis with "I think each of us can make a significant contribution to environmental protection."

ships between respondent background of grade, gender, and previous experience—whether they had foraged for edible plants and berries before camp—and the experience brought in by the mentors themselves. While we thought mentor experience would contribute to campers' feelings of being in nature, that the level of camp mentor's expertise would significantly impact camp participants' camp experience ($p = 0.06$) was surprising to the research team, since the students were primarily led by ecologists and accompanied by the mentors for most of the field trip. Overall, we found a significant change in student's environmental perceptions. Students were less impacted by their backgrounds and their parents' backgrounds and were more influenced by the activities they participated in during the day. This suggests that fun, educational activities—which, in our study, were the responsibility of camp mentors—are impactful in improving environmental perceptions.

5. Conclusions and Future Study

We found that the methods used in this study have been most impactful for children heading into grade 6. Opinions of the 7th and 8th graders comparatively remained relatively stable, suggesting that an alternative and more intensive—and perhaps immersive—camp experience would be more beneficial to older students. Similar intervention programs might also benefit from targeting younger participants, as fostering relationships with nature have the most impact in earlier childhood years (Chawla, 1988).

Overall, campers were more optimistic about the future and more strongly agreed that humans negatively impacted the environment after the field trip, suggesting that the ACMES camp may be helpful in environmental education as well as helping participants feel better about themselves after the field trip. We believe that field trips can provide a hands-on, alternative method of learning not easily obtained for children that are used to exclusively indoor learning.

This study demonstrates that participants to nature intervention projects have varied backgrounds and opinions of nature, and that it is of particular importance to address the experiences participants bring in with them. If participants lack experience in the outdoors, proper adult guidance and mentoring are required to help them explore nature and enjoy it. Because our findings indicate camp mentor expertise to have significance towards participant experience, we recommend that similar intervention programs train mentors with those who have more expertise.

Actively partaking in nature can improve feelings of empowerment in adolescents. The ACMES STEM Summer camp has found this to be true for our respondents, who felt more empowered after spending a day in nature. While this study is able to contribute to the literature of child-nature intervention programs, there were limitations to the work. Respondents of this program were local to the university, and we were not able to reach out to the full demographic of students that would have been represented a fuller picture of the diversity in New Jersey. Overall, the ACMES STEM summer camp can be incredibly helpful for educators and guardians to empower their students and children towards better mental health management strategies, as well as for researchers designing similar STEM education programs.

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References

Aaron, R. F., & Witt, P. A. (2011). Urban students' definitions and perceptions of nature. *Children Youth and Environments, 21*(2), 145-167. DOI: 10.7721/chilyoutenvi.21.2.0145

Alter, C. H., Suyin; Worland, Justin. (2019). 2019 Person of the Year - Greta Thunberg. *Time.* Retrieved from https://time.com/person-of-the-year-2019-greta-thunberg/

Ashraf, S. (2013). Raising environmental awareness through applied biochemistry laboratory experiments. *Biochemistry and Molecular Biology Education, 41*(5), 341-347. DOI: https://doi.org/10.1002/bmb.20717

Bell, A. (2007). Designing and testing questionnaires for children. *Journal of Research in Nursing, 12*(5), 461-469.

Bixler, R., Carlisle, C., Hammitt, W., & Floyd, M. (1994). Observed Fears and Discomforts among Urban Students on Field Trips to Wildland Areas. *The Journal of Environmental Education, 26,* 24-33. DOI: https://doi.org/10.1080/00958964.1994.9941430

Bixler, R. D., Floyd, M. F., & Hammitt, W. E. (2002). Environmental socialization: Quantitative tests of the childhood play hypothesis. *Environment and behavior, 34*(6), 795-818.

Boyd, D., Lankford, H., Loeb, S., Rockoff, J., & Wyckoff, J. (2008). The narrowing gap in New York City teacher qualifications and its implications for student achievement in high-poverty schools. *Journal of Policy Analysis and Management: The Journal of the Association for Public Policy Analysis and Management, 27*(4), 793-818. DOI: https://doi.org/10.1002/pam.20377

Burgess, D. J., & Mayer-Smith, J. (2011). Listening to children: Perceptions of nature. *Journal of Natural History Education and Experience, 5*, 27. DOI: https://cedar.wwu.edu/secondaryed_facpubs/3

Center for Disease Control. (2018). *Prevalence of Depression Among Adults Aged 20 and Over: United States, 2013–2016*. Retrieved from https://www.cdc.gov/nchs/products/databriefs/db303.htm

Center for Disease Control. (2019). *Data and Statistics on Children's Mental Health.* Retrieved from https://www.cdc.gov/childrensmentalhealth/data.html

Chawla, L. (1988). Children's concern for the natural environment. *Children's Environments Quarterly, 5*(3), 13-20. Retrieved January 16, 2020, from www.jstor.org/stable/41514681

Chawla, L. (2015). Benefits of Nature Contact for Children. *Journal of Planning Literature, 30*(4), 433–452. Cluster Variables. (2019). Retrieved from https://www.jmp.com/support/help/14-2/cluster-variables.shtml

Cochran Armitage Trend Test. (2019). Retrieved from https://www.jmp.com/support/help/14-2/cochran-armitage-trend-test.shtml

Connelly, J. (2012). Adventure-Based Counseling and Self-Efficacy with High School Freshmen: Regent University.

Dori, Y. J., & Tal., R. T. (2000). Formal and informal collaborative projects: Engaging in industry with environmental awareness. *Science Education, 84*, 95-113. DOI: https://doi.org/10.1002

Escobar, H. (2019). Amazon fires clearly linked to deforestation, scientists say. *Science, 365*(6456), 853. DOI: 10.1126/science.365.6456.853

Furman, N., & Sibthorp, J. (2014). The development of prosocial behavior in adolescents: a mixed methods study from NOLS. Journal of Experiential Education, 37(2), 160-175.

Hamann, G. A., & Ivtzan, I. (2016). 30 minutes in nature a day can increase mood, well-being, meaning in life and mindfulness: effects of a pilot programme. Social Inquiry into Well-Being, 2(2), 34-46.

Hohashi, N., & Kobayashi, K. (2013). The effectiveness of a forest therapy (shinrin-yoku) program for girls aged 12 to 14 years: A crossover study. *Stress Science Research, 28*, 82-89.

Jelalian, E., Sato, A., & Hart, C. N. (2011). The effect of group-based weight-control intervention on adolescent psychosocial outcomes: Perceived peer rejection, social anxiety, and self-concept. *Children's Health Care, 40*(3), 197-211.

Johnstone, J. W. (1970). Age-grade consciousness. *Sociology of Education* , 56-68. https://www.jstor.org/stable/2112059

JMP v14 Multivariate Methods; SAS Institute Inc.: Cary, North Carolina, United States, 2018.

Karahan, E., & Roehrig, G. H. (2015). Constructing Media Artifacts in a Social Constructivist Environment to Enhance Students' Environmental Awareness and Activism. *Journal of Science Education and Technology, 24*(1), 103-118. DOI: https://doi.org/10.1007/s10956-014-9525-5

Karsten, L., & Vliet, W. v. (2006). Children in the City: Reclaiming the Street. *Children, Youth and Environments, 16*(1), 151-167. http://www.colorado.edu/journals/cye/

Larson, L. R., Szczytko, R., Bowers, E. P., Stephens, L. E., Stevenson, K. T., & Floyd, M. F. (2018). Outdoor Time, Screen Time, and Connection to Nature: Troubling Trends Among Rural Youth? *Environment and Behavior, 51*(8), 966-961. DOI: https://doi.org/10.1177%2F0013916518806686

Lekies, K. S., Yost, G., & Rode, J. (2015). Urban youth's experiences of nature: Implications for outdoor adventure recreation. *Journal of Outdoor Recreation and Tourism, 9*, 1-10. DOI: https://doi.org/10.1016/j.jort.2015.03.002

Lovelock, B., Walters, T., Jellum, C., & Thompson-Carr, A. (2016). The Participation of Children, Adolescents, and Young Adults in Nature-Based Recreation. *Leisure Sciences, 38*(5), 441-460. DOI:10.1080/01490400.2016.1151388

McDonald, J. H. (2015). Cochran–Mantel–Haenszel test for repeated tests of independence. In *Handbook of Biological Statistics* (pp. 94-100). Baltimore: Sparky House Publishing.

Means, M. L., & Voss, J. F. (1996). Who reasons well? Two studies of informal reasoning among children of different grade, ability, and knowledge levels. *Cognition and instruction, 14*, 139-178. https://www.jstor.org/stable/3233749

Mygind, L., Kjeldsted, E., Hartmeyer, R., Mygind, E., Bølling, M., & Bentsen, P. (2019). Mental, physical and social health benefits of immersive nature-experience for children and adolescents: A systematic review and quality assessment of the evidence. *Health & Place, 58*, 102136.

New Jersey School of Conservation. (2019). Retrieved from https://www.montclair.edu/school-of-conservation/

Neill, C., Gerard, J., & Arbuthnott, K. D. (2019). Nature contact and mood benefits: contact duration and mood type. *The Journal of Positive Psychology, 14*(6), 756-767. DOI: https://doi.org/10.1080/17439760.2018.1557242

O'Brien, K., & Lomas, T. (2017). Developing a Growth Mindset through outdoor personal development: can an intervention underpinned by psychology increase the impact of an outdoor learning course for young people? Journal of Adventure Education and Outdoor Learning, 17(2), 133-147.

Rutgers Center for Remote Sensing and Spatial Analysis. (2012). *Urban Growth Animation: 1986-2012 and Results.* Rutgers. https://crssa.rutgers.edu/projects/lc/urban_growth.html

Shanahan, D. F., Bush, R., Gaston, K. J., Lin, B. B., Dean, J., Barber, E., & Fuller, R. A. (2016). Health Benefits from Nature Experiences Depend on Dose. *Scientific Reports*, 28551. DOI: https://doi.org/10.1038/srep28551

U.S. Census. (2016). *New Census Data Show Differences Between Urban and Rural Populations.* Retrieved from https://www.census.gov/newsroom/press-releases/2016/cb16-210.html

Van Velsor, S. W., & Nilon, C. H. (2006). A Qualitative Investigation of the Urban African-American and Latino Adolescent Experience with Wildlife. *Human Dimensions of Wildlife, 11*(5), 359-370. DOI: https://doi.org/10.1080/10871200600894944

Wells, N. M., & Evans, G. W. (2003). Nearby Nature: A Buffer of Life Stress among Rural Children. *Environment and Behavior, 35*(3), 311-330. DOI: https://doi.org/10.1177/0013916503251445

White, R. L., Eberstein, K., & Scott, D. M. (2018). Birds in the playground: Evaluating the effectiveness of an urban environmental education project in enhancing school children's awareness, knowledge and attitudes towards local wildlife. *PLoS ONE, 13*(3), 1-23. DOI: https://doi.org/10.1371/journal.pone.0193993

Woods, N. D. (2018). Why conservatives abandoned conservation. *Science, 362*(6415), 647. DOI: https://doi.org/10.1126/science.aav2324

Archana Prasad

Archana is a researcher with Montclair State University's Clean Energy and Sustainability Analytics Center (CESAC) working on projects ranging from STEM education to climate change and the energy market. Archana is currently a PhD candidate at Montclair State University in the Department of Earth and Environmental Sciences modeling land use changes and climate extremes, and exploring the impact these changes may have on bumblebees.

Pankaj Lal

Dr. Lal is founding director of Clean Energy and Sustainability Analytics Center and Professor in the Department of Earth and Environmental Studies. He undertakes research that explores interconnections among society and the environment. He has been focusing on environmental and energy economics, human dimensions of ecosystem management, natural resource policy, Dr. Lal climate change. He has received more than $12 million in grants and contracts for his research. He was awarded Presidential Award for Scientists and Engineers (PECASE) by President Obama, the highest honor bestowed by the U.S. government on outstanding scientists and engineers beginning their independent careers.

Bernabas Wolde

Bernabas Wolde is an economist in the Climate Change Program of Colorado's Department of Public Health and Environment. He has a PhD in Environmental Management as well as MS and BS in Natural Resource and Environmental Economics. His work assesses the economic impacts of proposed environmental regulations, determines the socioeconomic drivers/impacts of clean energy options, and aims to drive decarbonization in the industrial, transportation, and other sectors of the economy.

Michelle Zhu

Dr. Zhu joined Montclair State University as an associate professor from Southern Illinois University Carbondale, where she was a tenured associate professor and director of undergraduate program in the department of Computer Science. Prior to that, she completed her dissertation in the Computer Science and Mathematics division of Oak Ridge National Laboratories (ORNL). Her research areas focuses on parallel and distributed computing and big data systems. She has published about 100 peer-reviewed articles in various journals and conferences. She received a total of over $2 million in grants towards research and education from various agencies.

Bharat Kumar Samanthula

Dr. Samanthula's primary research interests span across Applied Cryptography, Information Security, Data Mining, and Big Data. His current work centers around the development of privacy-enhanced techniques for various distributed data management and analysis tasks in the fields of Online Social Networks, Cloud Computing, Wireless Sensor Networks and Smart Grids. Additionally, he is investigating novel approaches to improve STEM education in local schools via computational thinking tools.

Nicole Panorkou

Dr. Panorkou is an Associate Professor in the department of Mathematical Sciences and completed her PhD in Mathematics Education at the UCL Institute of Education. After earning her PhD, Nicole was awarded a Fulbright scholarship and worked as a post-doctoral researcher in multiple NSF-funded projects as part of the GISMO team at North Carolina State University. Nicole's research interests include development and validation of learning trajectories for K-8 mathematics; student learning of geometry, algebra and rational number reasoning; and a focus on the ways that technology and modeling can foster the utility of mathematical concepts.