The Effects of School Funding on the Quality of Environmental Education Amongst Seniors in Los Angeles County

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ABSTRACT

This study aims to examine the effects of school funding on the environmental education of high school seniors. Three primary factors were analyzed for their effect on the environmental knowledge of students: expenditures per pupil, class size, and school location. By deploying a survey across three Los Angeles County public schools, including one public charter school, 195 responses were analyzed. This study revealed there is a non-statistically significant positive trend between expenditures per pupil and environmental knowledge. There was found to be no relationship between environmental education and the location of the school. Increasing class size increased environmental knowledge. When students were asked where their environmental education came from, the most commonly cited were camping, gardening, and volunteering experiences. Environmental education in Los Angeles schools may be improved by increasing funding which thereby increases resources and opportunities as well as utilizing community-based learning and interdisciplinary curriculum. A major limitation of this study was its small sample size, but this offers room for future research into larger sample sizes as they may lead to statistically significant trends.

KEYWORDS

environmental literacy, pupil expenditures, environmental knowledge, environmental education, science education, school funding

INTRODUCTION

The world is facing environmental challenges never before seen, and future generations must be environmentally literate in order to tackle the complex problem of climate change head-on (Hollweg et al. 2011). Environmental education (EE) is the solution to improving environmental literacy (Hollweg et al. 2011); an environmentally literate person is "someone who, both individually and together with others, makes informed decisions concerning the environment; is willing to act on these decisions to improve the well being of other individuals, societies, and the global environment; and participates in civic life" (Hollweg et al. 2011). An environmentally literate person, for example, is capable of identifying and analyzing environmental issues as well as making personal judgments about these issues (Hollweg et al. 2011). EE aims to instill environmental knowledge, dispositions, competencies, and behavior in the people (Ardoin 2017). Although EE began to rise in the 1990s, minimal progress has been made in formally instilling it in schools over the past 30 years.

There are several benefits to implementing EE in schools outside of improving environmental literacy. EE is an interdisciplinary study, meaning it involves the sciences, mathematics, and social justice issues, and engaging in EE benefits student academic improvement in other subjects such as English and mathematics (Bartosh 2006). For example, air pollution is a chemistry concept but affects humans so it's important to understand how governments make decisions about air quality levels. Furthermore, student academic improvement may be related to the pedagogical and instructional nature of EE (Bartosh 2006). EE can take many forms, whether it appears in environmental science classrooms or integrated into other subjects such as history or science. Another benefit is students can pass "up" environmental knowledge to their parents if they learn it in schools, such as in the case of recycling and waste sorting (Evans 1996). Moreso, EE serves as a tool for generating green behavior (Varela-Candamio 2018). Despite the numerous benefits derived from EE, access to it varies across the United States.

Although federally mandated, EE in the United States does not appear in a uniform format across the nation. EE is not a formal graduation requirement in schools, but it is covered in certain curricula across different courses. States such as California and Texas require students to take a physical and life science course to graduate (California Department of Education, Texas Education Agency). Life and physical science courses may delve into topics related to EE such as California's

science standard, HS-LS2, which covers how the "long-term functioning and health of terrestrial, freshwater, coastal, and marine ecosystems are influenced by their relationships with human societies" (NGSS). EE may also appear as an Advanced Placement course, AP Environmental Science. However, the AP format limits the accessibility to this course because not all high schools offer AP courses, mostly because school districts must budget for teachers for this course. It is also important to note that not every student affords to take the exam, which may deter students from taking the course. AP is also mostly taken by honors and college-bound students aiming for STEM majors and a GPA boost, excluding students who are not as driven by the "AP" label. However, it is unclear how these disparities in access, funding, and curriculum contribute to differences in environmental literacy at the high school level.

The central research of this study is: how does public school funding affect the quality of EE for high school seniors in Los Angeles County? Specifically, I ask (1) How do public charter schools compare with public schools in regards to EE? (2) How does class size relate to the quality of EE of students? (3) How does the location of the school affect the knowledge of specific environmental science topics? And, (4) How do students' lived experiences affect their environmental knowledge? The third question addresses schools and student accessibility to green spaces or field trips. I expect schools with more funding will have a higher quality of EE as well as smaller class sizes. I also expect locations will prove to be an important factor in the knowledge of specific environmental topics. To answer these questions, I collected and analyzed data on school funding and location, class sizes, and environmental literacy.

LITERATURE REVIEW

Defining Environmental Education

Environmental education, environmental knowledge, and environmental literacy are all terms that fall under the same umbrella of environmental comprehension but are not interchangeable. The three terms work on a continuum, environmental education leads to the development of environmental knowledge and therefore environmental literacy. (Hollweg et al. 2011) (NEEA 1990).

The National Environmental Education Act (NEEA) of 1990 was passed with the intention of integrating environmental education into the American school system. The precise definition of environmental education defined in the legislature of NEEA is vague, defining it as "educational activities and training activities involving elementary, secondary, and post-secondary students" (NEEA 1990). NEEA established that federal and local governments along with educational institutions develop curricula, projects, and activities to "increase understanding of the natural and built environment and to improve awareness of environmental problems" (NEEA 1990). Ardoin et al. (2017) define the aim of environmental education: to instill environmental knowledge, dispositions, competencies, and behavior in the people. The United States EPA (2021) defines environmental education as a process of allowing individuals to "explore environmental issues, engage in problem solving, and take action to improve the environment."

Environmental education feeds into environmental knowledge because it provides information and awareness to students (Zsóka et al. 2013). Environmental knowledge is the amount of information individuals acquired about environmental issues as well as their ability to evaluate their impact on the environment and society (Gbadamosi & Chekima 2016). Environmental knowledge can be traced to traditional environmental (or ecological) knowledge (TEK), which is the knowledge obtained by indigenous peoples and passed down through generations (Morin-L'abatut & Akhtar 1992) and encompasses experiences that can be gained in different settings: outdoors, in schools, and at home (Gbadamosi & Chekima 2016).

Environmental knowledge leads to environmental literacy because it increases pro-environmental behavior in individuals (Zsóka et al. 2013). Hollweg et al. (2011) define an environmentally literate person as someone who "makes informed decisions concerning the environment; is willing to act on these decisions to improve the well being of other individuals, societies, and the global environment; and participates in civic life." Simultaneously, Hollweg et al. (2011) developed an environmental literacy framework, Framework for Assessing Environmental Literacy, which takes into consideration: context, knowledge, competencies, dispositions, and environmentally responsible behavior. Environmental literacy can be improved upon by environmental education which aims to increase environmental awareness (NEEA, 1990).

Contributing Factors in Learning Environments

Public charter schools are schools of choice where they are held accountable due to their reliance on families wanting to send their children to these schools (NCSRC). In 1988, Albert Shanker introduced the concept of public charter schools onto the educational landscape because he believed it would provide more innovative education to underserved students (NCSRC). The National Center for Education Statistics found that from fall 2009 to fall 2018, public charter school enrollment increased in the United States from 1.6 million to 3.3 million respectively (NCES 2021). Public charter schools are believed to be held to a higher standard because not only do they need a charter granted by state governments, but they also need local interest from parents in order to have students attend the school (NCSRC). Despite an overall increase in interest in public charter schools in the United States, questions remain about their effectiveness.

The level of achievement differs between students attending public charter schools and public schools. Advocates for charter schools argue that these learning environments would improve student achievement, however, there is wide variation between charter schools and their mean performance on state tests was even lower than public schools (Lin 2001). More recent research still supports these findings. Davis and Raymond (2012) concluded that charter school quality was found to be demographically and geographically uneven. In a study examining charter schools in Los Angeles Unified School District and San Diego Unified School District, charter schools had mixed overall effects on student achievement and did little to improve the achievement gap between minority and non-minority students (Zimmer 2006). Yet, there is still debate on the statistical methods used to study student achievement across charter and non-charter schools.

Research on class size may be a relevant factor in student achievement, however, it is unclear whether the class size is the cause or simply just a confounding variable. Early studies on class size conclude that there is a significant difference in achievement (Glass and Smith 1978). Yet, subsequent research argues that class size does not matter, but small groups and tutoring opportunities do (Odden 1990). Odden (1990) found research on class size and student achievement relies on dramatic class size reductions, to a level of only 1-3 students, in order for achievement gains to be significant. Even more recent research as of 2011 has found that small class size effects vary, with some positive and significant in some schools while non-significant and negative in others (Konstantopoulos 2011).

The State of Los Angeles County's Environmental Education

The current state of environmental education in Los Angeles County is far from uniform, but it exemplifies the various ways students learn about their environment. Students' lived experiences may affect their environmental knowledge, simply through where they live (Kudryavtsev et al. 2011). For example, in California, Standard 3-LS4 Biological Evolution: Unity and Diversity, requires 3rd-grade students to learn about adaptation, evolution, and more (NGSS). This curriculum is often adapted to connect to local surroundings; for example, students living by the coast would learn about how starfish have a bony exterior to protect them from predators (NGSS). Furthermore, the Los Angeles County Outdoor Science School (LACOSS) which is conducted through the Los Angeles County Office of Education offers outdoor science education to 5th and 6th-grade students (LACOSS). Students able to participate in this program learn environmental education outside the classroom in nature, developing their awareness of the environment (LACOSS).

Community Description: Los Angeles County

Los Angeles County is the largest county in the United States and one of the most diverse for a variety of reasons, starting with its demography (Census 2019). Los Angeles County is home to 10.04 million people, double the second largest county in the United States which has only 5.09 million people in Cook County, IL (Census 2019). The largest racial group in Los Angeles County is Hispanics or Latinos at 48.6% followed by 15.9% Asian or Pacific Islander, 9.0% African American, and 1.4% American Indian or Alaskan Native (Census 2019). The median household income is $68,044, but this value fails to show the distribution of wages across residents (Census 2019). For example, 13.6% of county residents' earned incomes range from $20K to $30K; the poverty level for a household of four is $35,600 (Census 2019). Yet the top 4.25% earned in excess of >$200K (Census 2019). Los Angeles County also educates a large portion of the United States' school population; in the 2019-2020 school year, 1.4 million students were enrolled in Los Angeles County's public schools across all districts (Census 2019).

Los Angeles County covers a variety of landscapes. The county stretches over 4,084 square miles, yet 2,638 square miles (64.6%) are unincorporated (Census 2019). The county is also home

to a diverse range of biomes including wetlands, kelp forests, chaparral, desert, beaches, and forests (Our County 2018) and 700,000 acres of the county are devoted to the Angeles National Forest (USDA Forest Service).

Los Angeles County is divided into eight regions; the regions' boundaries are defined by topography, population, as well as freeways (Figure 1, LAEDC). The county is defined as urban; however, sections of it are considered suburban (i.e. Agoura Hills) and rural (i.e. Littlerock) (California State Association of Counties).

Figure 1. Map of Los Angeles County and its Regions (LAEDC).

As a result of LA County's diverse landscapes and large population, the county is home to a range of environmental problems. From April 2017 to March 2018, there were 64 sewage spills that polluted beaches, rivers, or wetlands (Our County 2018). Wildfires are a common occurrence in Los Angeles County, partially accounted for by the expanse of chaparral biome (Barro and Conard 1991); wildfires are so common that the Los Angeles Times has a year-round wildfire map

online (Los Angeles Times). To exacerbate the problem, climate change is expected to increase the severity of wildfires in Los Angeles County because of increased temperatures and higher levels of evapotranspiration that increase drying in vegetation (Our County 2018). Los Angeles has the worst air quality in the United States, and is the city with the worst ozone pollution (American Lung Association 2021). This list is only a brief list of the environmental problems present.

Los Angeles County is also home to several environmental injustices (Lewis & Burd-Sharps 2017). Residents of South Los Angeles, with a median household income of $47,349, are expected to live around 12 years less compared to residents of Brentwood, who have a median household income of $133,032; these same residents experience higher rates of coronary heart disease, stroke, lung cancer, and diabetes (Lewis & Burd-Sharps 2017). In the City of Los Angeles, over 360,000 residents live within 500 feet of a major truck route or port as well as manufacturing, refinery, and chemical plants (Lewis & Burd-Sharps 2017). The communities most affected by waste treatment, storage, and disposal facilities are working-class communities of color located near industrial areas (Boer 1997). A common environmental justice tool for predicting environmental hazards is zip codes; the top 10% of the state's pollution burden cities are located in Los Angeles County (Lewis & Burd-Sharps 2017). These environmental injustices stress the importance of environmental education in creating solutions for these pressing problems, and highlight the crucial role economic factors such as school funding can play. With this study, I aim to better understand the current state of school funding and environmental education, and answer the following questions: (1) How do public charter schools compare with public schools in regards to EE? (2) How does class size relate to the quality of EE of students? (3) How does the location of the school affect the knowledge of specific environmental science topics? And, (4) How do students' lived experiences affect their environmental knowledge?

METHODS

Sample selection

I focus on high school seniors enrolled in Los Angeles County public schools. The environmental knowledge these students communicate can be indicative of the quality of environmental education they receive in their cumulative K-12 experience.

Because it was overreaching to assess every senior in Los Angeles County, I chose to sample select schools and select seniors within Los Angeles County. The Los Angeles County Office of Education provides a list of all public schools within the county. After filtering for high schools, public and charter, I had a definitive list of all 201 high schools in the county. From there, I categorized the schools into their specified regions and randomly selected one charter and one public school in each region. Resulting in a stratified random sample which is much more representative of Los Angeles County than just a random sample. The aim was to include 16 schools as samples, 8 charter and 8 public; however, not every region possessed a public charter high school, such as the case in Santa Clarita Valley.

Each region differs vastly from the next and by sampling within each region, I am ensuring coverage of each. If I were to do a simple random sample, I would risk the possibility of lacking samples in specific regions, thereby making my survey unrepresentative of Los Angeles County as a whole. Municipalities and schools within each region have more in common, in terms of the socioeconomic status of residents.

Once schools were selected, I reached out to teachers at the school via email. I contacted teachers who specifically taught seniors: English and government. Both subjects are A-G requirements in California but the classes offered in these two categories may be Advanced Placement, International Baccalaureate, etc. I sent an email to teachers explaining my study as well as an invitation to join my study by allowing me to administer the survey to their students. Only one English class at each school would need to be sampled. However, teachers may have opted to distribute the survey to all their students in order to maintain consistency in their daily lessons throughout their classes.

Due to non-response and time constraints, only teachers from three schools I reached out to took part in the study. The three schools were in three different regions: Santa Clarita Valley, Antelope Valley, and Gateway Cities. The school from the Antelope Valley was a public charter school, whereas the other two were public schools. As Santa Clarita Valley and the Antelope Valley are similar in surrounding geography and demographics, the two schools were compared in order to determine if there was a difference in performance between charter schools and public

schools. Schools are referred to as the region they are located in: Santa Clarita Valley, Antelope Valley, and Gateway Cities.

Data Collection

The primary method of data collection for this study was an online survey for students to fill out that was filled with multiple choice and free response questions aimed at assessing environmental education (Appendix A). Each multiple choice question had one *correct* and three *incorrect* answers; the free responses were more open-ended and asked for opinions and life experiences. Survey questions were based on the Advanced Placement Environmental Science curriculum and exam. This curriculum is the most widely accepted high school environmental science curriculum nationally. Neither the state of California, nor the County of Los Angeles have specific curriculum for environmental science courses in its high schools. The AP course is broken down into 9 units spanning topics such as biodiversity and atmospheric pollution (CollegeBoard 2021). Questions included in the survey covered each one of those units, and the survey could be completed during class in less than 10 minutes.

To determine the impact of funding on environmental education, I had to further my collection of data through school budget reports as well as information on class sizes. For public schools and charter schools, budget reports are publicly available via Local Control and Accountability Plans (LCAP) and were easily accessible. Information about the study body size, average class size, and teacher-to-student ratio were harder to find. I used cooperating teachers as a resource to learn more about this information. As for the location of the school, this information was already available due to my stratified random sample.

Data Scrubbing

Data scrubbing was performed to remove survey responses that were incomplete or outliers. The first step was removing incomplete data from the set and this was done by removing responses that declined on either the assent or consent form. The second step was removing responses where consent/assent was accepted but they did not answer any of the questions. Lastly, outliers were removed.

Outliers were determined by using the interquartile range. This set the lower limit of data points at 4 and the upper limit at 20. Since the highest score possible was a 17, only the lower limit was used to remove outliers on the lower end. In total, 6 responses were removed from the data set, leaving a total of 195 responses.

Statistical Analysis

To address my central research question, I tested for correlation between score averages collected through the survey from each school against funding on a scatterplot. By using a trendline, I calculated an R-squared value to properly assess whether or not there was a correlation between funding and average score. Funding was assessed using expenditures in dollars spent per pupil, a method used by the National Science Foundation.

In addressing my first subquestion, I used a 2-sample unpaired t-test to test if there was a significant difference between the average survey score of public charter schools and public schools. Since the sample size was small, and I was unable to sample a charter and a public school in the same region, I decided to compare across similar regions. For example, the Antelope Valley and Santa Clarity Valley are next to each other and are similar in demography, climate, and geography. The null hypothesis for my test was that there was no difference between the types of school ($\mu C = \mu R$); the alternative hypothesis was there was a difference ($\mu C \neq \mu R$). My degrees of freedom were $df = nC + nR - 2$; my significance level was 0.05.

My second subquestion dealt with class size and EE quality correlation. I tested the correlation between average class size and average survey score by using a scatterplot. A trendline and an R-squared value were generated to assess for correlation.

I addressed my third subquestion about the location through the use of an ANOVA test. I began by comparing the eight regions of Los Angeles County, I performed an ANOVA test to compare test averages. The two schools in each region were combined to create an average score for the region collectively. With a significance level of 0.05, I observed whether or not there was a significant difference in average scores across regions. I also performed ANOVA tests for individual questions to observe whether select locations led to better scores on certain topics.

Thematic Analysis

My fourth subquestion dealt with qualitative data, much better analyzed through thematics rather than numerical analysis. The last couple of questions asked students where they gained their environmental knowledge from, e.g. through courses taken in school or from experiences such as camping. Through these questions, I assessed whether certain responses were more frequent or if groups of certain responses occurred frequently together. These responses can be connected to students' environmental education by further assessing whether those with higher scores tended to have more lived experiences in their environment (e.g. beach visits). Free responses about lived experiences were categorized into themes to determine out which themes were most common as well as if any correlated to higher or lower survey scores.

RESULTS

Funding and Score Correlation

Across the three schools sampled, the range of spending per student was from $11,822.93 up to $19,274.52. Santa Clarita Valley had the lowest spending per student at $11,822.93. Gateway Cities was in the middle with roughly $13,041.86 spent per student. The charter school in the Antelope Valley had the highest amount of money spent per student at $19,274.52.

Comparisons between school funding and average survey score revealed a slight positive correlation between the two factors. The r-value that was calculated was 0.988 while the r-squared vale was 0.976. This means the relationship between spending per pupil and average survey score was strong for the three schools sampled. Figure 2 below displays the points scattered, showing a positive linear trend.

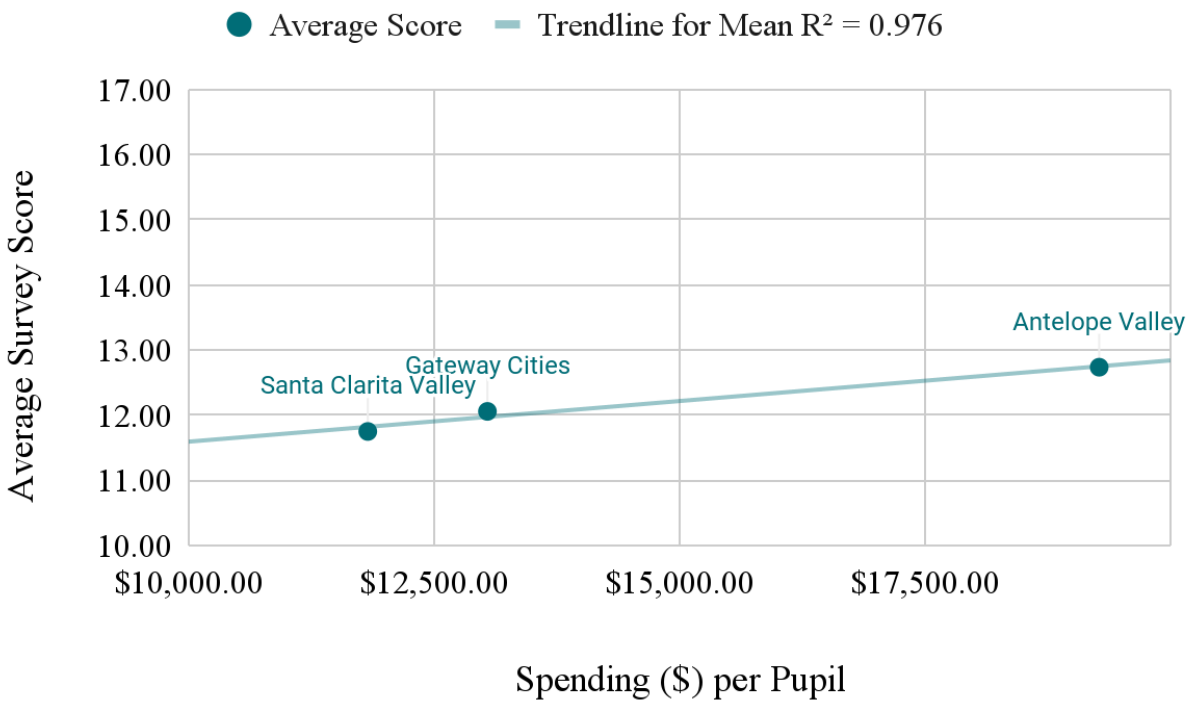

Figure 2. School Funding and Average Survey Score Across Schools.

Data was aggregated according to the category the school fell into: charter or public. Two schools were compared and while they are not from the same region, they are in regions next to each other with similar demographics, topography, and climate. For the box and whisker plot data for survey score range between the two schools, the distribution of scores differs; the charter IQR is from 11 to 14 while the public IQR is from 9.5 to 13 (Figure 3). The median score for the charter school (13) is higher than the median score for public school (11). However, a significance test comparing the two categories revealed that while there is a difference, it is not statistically significant. A generated p-value of 0.0861was not significant at a 0.05 significance level. The 95% confidence interval was found to be from -0.14329 to 2.12329.

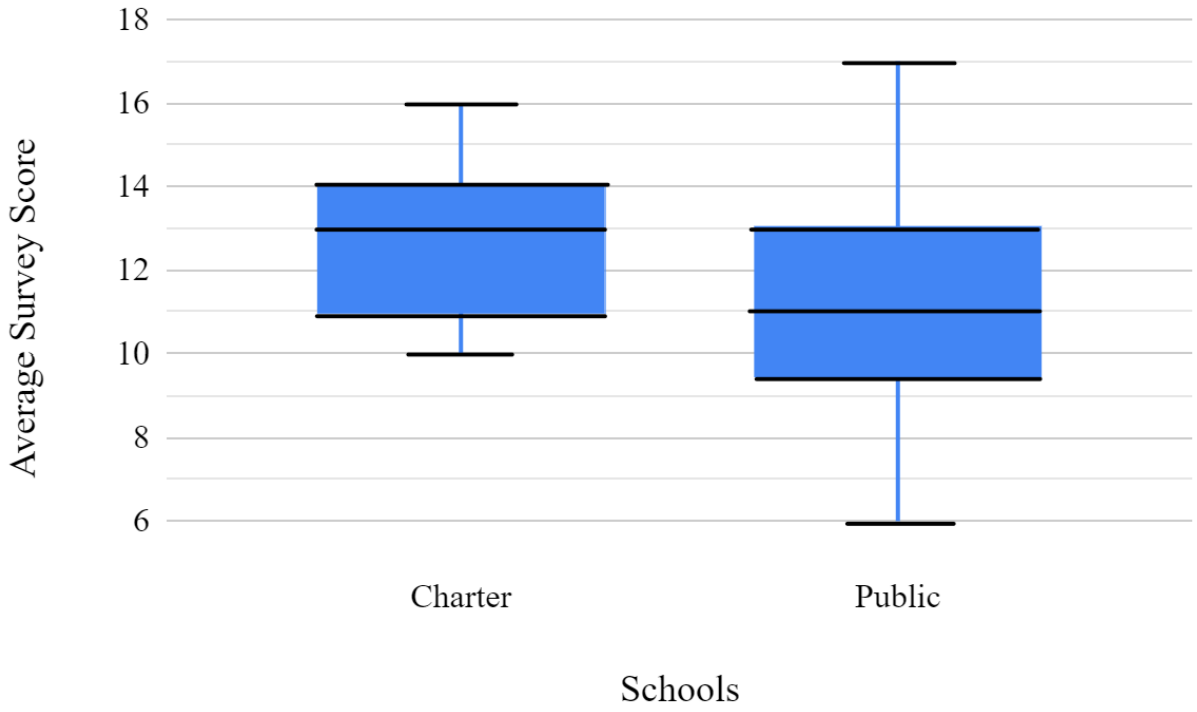

Figure 3. Charter and Public School Average Scores.

For my second subquestion I graphed the average class size against the average survey score at each school. Each plot point in Figure 4 represents a single school sampled. A linear positive trend was observed between the two factors; an r-value of 0.999 and an r-squared value of 0.998 shows a strong relationship between average student-teacher ratio and average survey score for the three schools.

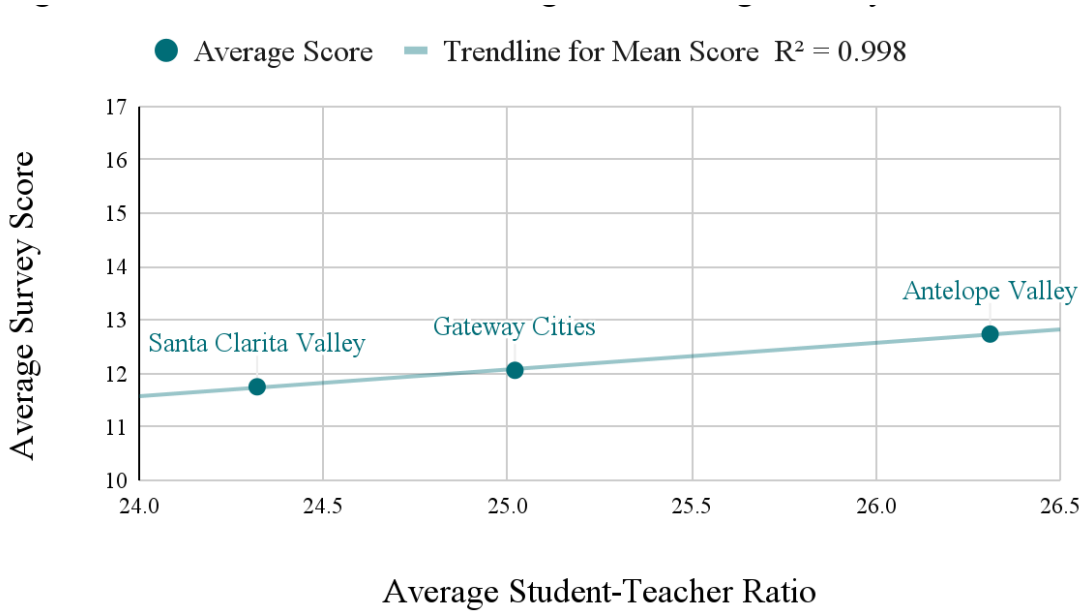

Figure 4. Student-Teacher Ratio Against Average Survey Score.

For the average score frequency across the regions, the data does not follow a Normal distribution and takes on more of a uniform distribution (Figure 5). Using an ANOVA test, a p-value of 0.072 at a significance level of 0.05 determined there was no statistically significant difference amongst the regions. The range of scores was greater in public schools than in the charter school.

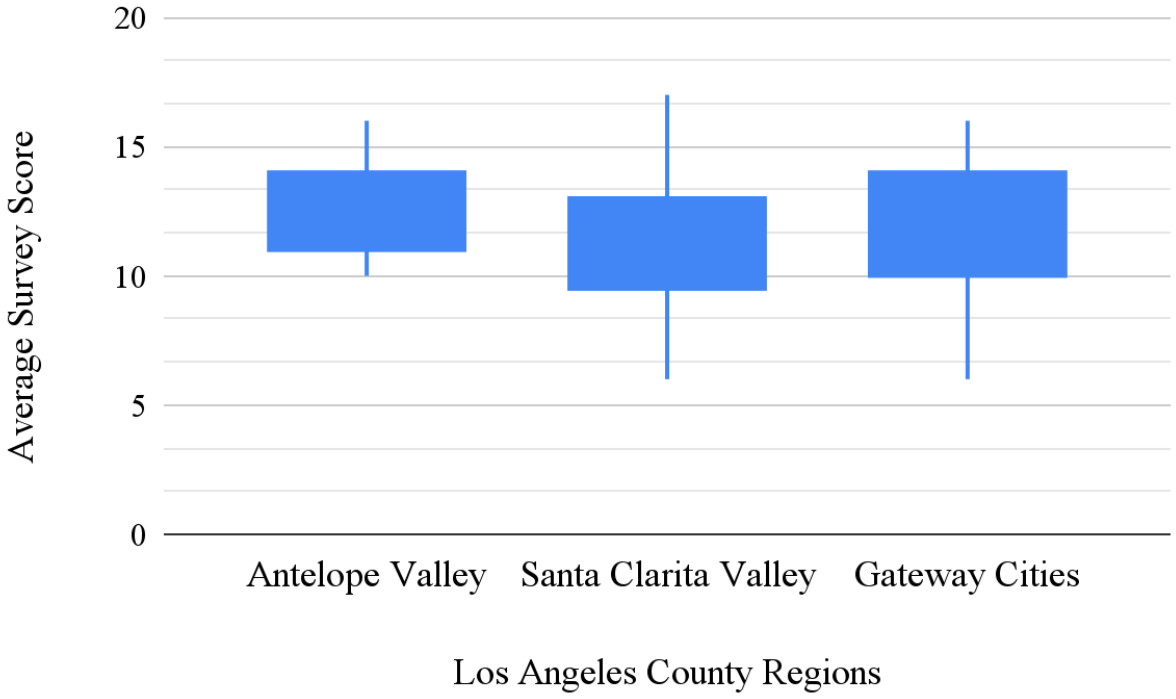

Figure 5. Region Survey Score Distributions.

When it came to answers to open-ended questions that were trying to elicit information on students' prior experiences, there were three primary themes that occurred with the most frequency: camping (31.58%), gardening (14.39%), and volunteering (13.33%) (Table 1). Camping was the most common theme mentioned 90 times across all responses. Gardening was the second most frequent theme with 41 mentions and spanned responses including school gardens and planting trees. Volunteering was right behind gardening with 38 mentions; volunteering included picking up trash at their school, volunteering in a summer camp, and volunteering at a shelter to promote environmental awareness.

Table 1. Themes frequently discussed by students as sources of their environmental education.

Theme	Relative Frequency
Camping	31.58%
Gardening	14.39%
Volunteer	13.33%
Beaches	12.98%
Education	8.77%
Organization	5.61%
Science School/Camp	2.46%
Other	10.88%

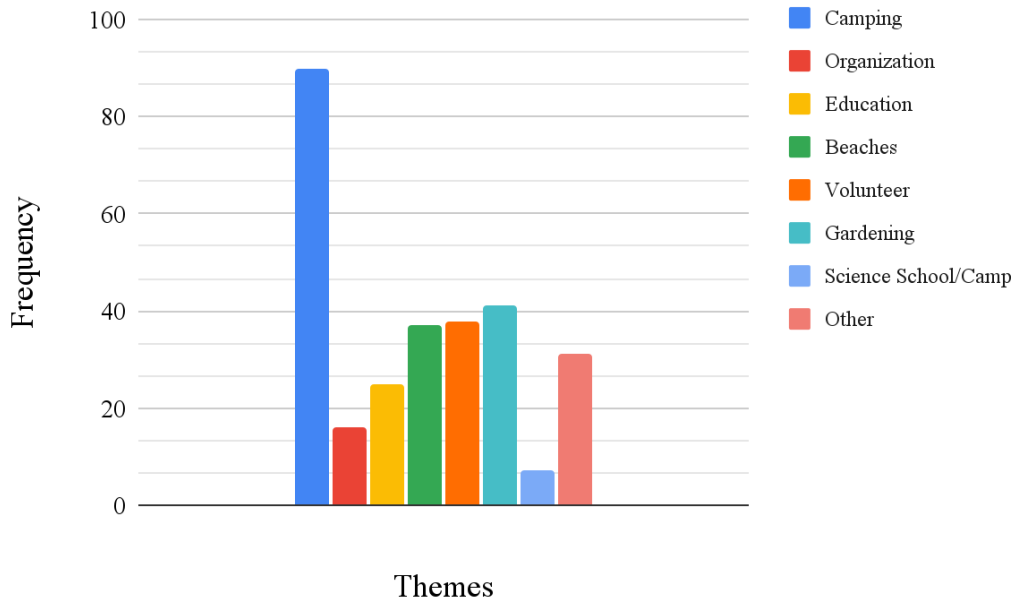

Figure 6. Environmental education experiences by theme frequency.

DISCUSSION

My study found that as expenditures per pupil increased, there was an increase in environmental knowledge. There was not a relationship between school status; charter and non-charter public schools still scored about the same. In regard to class size, the inverse trend was in contract to expected as there was an increase in environmental knowledge as class size increased.

The location of the school did not appear to have a relationship to the amount of environmental knowledge students held. As for the prior experience, there were several common themes that may serve as an avenue for making meaningful adjustments to current environmental education.

Survey Says…

Students surveyed showed a general understanding of several environmental science concepts. The survey averages ranged from 11.75 to 12.74 which is interpreted to show general proficiency amongst students. It is not so much their total score that matters as is their performance on select questions. Their survey scores offer insight into which concepts need to either be introduced or expanded on in schools.

Concepts most understood by students were identified as any question where more than 85% of students got the correct answer. The high success rate on a question was 90.26% and asked students "How have humans increased the rates of erosion?" This was a multiple-choice question where the correct answer was "All of the above." However, this begs the question if students picked this choice because they knew it was the answer or a common test taking tip is to pick "All of the above" as an option. The second question students scored well on was "An ecosystem is a location that includes" where the answer was "Both living and nonliving factors." This is a standard in NGSS: "LS2.A: Interdisciplinary Relationships in Ecosystems" which calls on students to not only define living and nonliving organisms in an ecosystem but how they limit the carrying capacity of an ecosystem (NGSS). It is not surprising that students correctly answered this question as it is an explicitly stated content standard in current curricula. Third place tied between the first law of thermodynamics and tree harvesting methods (86.15% correct). The first law of thermodynamics is also a NGSS standard (PS3.B: Conservation of Energy and Energy Transfer) that students most likely covered in their 9th grade physics course (NGSS). Thus, there is a pattern emerging that students were more likely to answer a question correctly if it aligned with an NGSS they covered in prior science courses.

The opposite stood true for questions that were seemingly the farthest removed from NGSS. Students had a passing rate of only 48.72% on a question asking them for the definition of the "tragedy of the commons." The most selected incorrect response was "When humans overuse natural resources" while the correct answer was "People use a shared resource for personal gain,

depleting the resource." The significance of this means that students understand the depletion of resources, but not that the resources are *shared*.

Students also missed a question asking them what a possible economic disadvantage was to hydroelectric energy (49.74% correct). Students misinterpreted the question and were selecting answers related to pollution and the accidental harming of fish populations. Hydroelectric energy is *preferred* due to its lack of pollution emissions. Students were also likely choosing the harm of fish populations because while it is a disadvantage, and a common one, it is an *environmental* disadvantage. This shows that students need clarification on the difference between environmental, economic, and human-health disadvantages.

Following the pollution trend, students also commonly missed a question asking them for "an example of water pollution from more than one source." While the correct answer was "local farms leaking pesticides into a river," students were likely to incorrectly guess "waste from a sewage treatment plant." This shows a misconception between the pollution concepts of point versus nonpoint source pollution sources.

The question students scored the worst on asked students to identify which federal law deals with cleaning up abandoned hazardous waste sites (45.13% correct). Across all schools, students were most likely to incorrectly select the Resource Conservation and Recovery Act (RCRA). The correct answer is the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA). This seems to indicate that students need to be educated on the environmental laws in place that are made to protect them and the environment.

Areas for Growth

By reviewing what students knew and didn't know in regards to their environmental knowledge, we can begin to understand what should be specifically implemented in environmental education. First and foremost, students should be educated on the Tragedy of the Commons (Hardin 1968). The Tragedy of the Commons is the most assigned article in environmental studies courses and may be viewed as a baseline for understanding natural resource management (Janssen et al. 2019). Developing a baseline understanding of a commons, a *shared* resource, is crucial to environmental literacy.

Students should also be educated on the terminology common to environmental studies. Academic language may be a barrier for students expressing their knowledge so it is important to remove this barrier. Students should learn there are advantages and disadvantages, but there are also categories: environment, economic, and health just to name a few. Environmental education should also focus on developing the distinction between point and nonpoint source pollution. In order to address pollution, we need to understand where it first comes from.

Environmental education should also emphasize solutions and actions that can be taken on an individual, community, and federal level. This is a proactive approach to environmental education that allows students to explore creative solutions.

In order to accomplish these goals, several options are discussed to improve the state of environmental education in Los Angeles County schools. First and foremost, the allocation of resources and increased expenditures per pupil may be a legislative approach to increase opportunities for environmental education and preparing teachers to teach it. Second, expanding on environmental experiences students addressed in their surveys may provide inexpensive curriculum changes.

Where should the money go?

My study found that while there was a slight positive correlation between expenditures per pupil and average score, there was not a statistically significant difference. This potentially implied that there was a correlation between school funding and the average survey score. Therefore, it should be expected that with more school funding, students would perform better on the survey implying a higher level of environmental education. While it is not believed that funding itself improves environmental education, it is *where* the money goes that matters. There are two primary avenues for improving environmental education: providing students with more opportunities and better preparing teachers to facilitate these opportunities.

Opportunities for students

By increasing the opportunities available to students, we can increase the opportunities for environmental education to take place. Such opportunities may include field trips to the outdoors

or science museums and volunteering activities such as school gardens or park beautification projects. Field trips specifically to science museums and the outdoors have been found to significantly increase science-related knowledge, especially ecology, amongst students (Knapp and Barrie 2001). Park beautification projects may call on students and their community to volunteer to remove litter from a park, which pushes students into the outdoors and teaches them about litter and the environment. School gardens are more of an investment but allow students to explore biogeochemical cycles, plant growth, and healthy eating.

Increasing opportunity may also manifest in increasing student discovery of green spaces. Proximity to green spaces has been shown to impact the environmental education activities of students (Wolsink 2014). In the context of this study, the school in the Gateway Cities had students who talked the most about visiting the beach as well as volunteering to clean the beach. Students in the Antelope Valley and Santa Clarita Valley did not cite this experience as much and this is likely due to the distance between their schools and beaches. Even if these schools aren't close to a beach, there are other green spaces worth exploring. For example, the Antelope Valley and Santa Clarita schools have access to Angeles National Forest, Golden Poppy Reserves, and the Mojave Desert. Field trips to such sites may allow students to explore new green spaces close to their school and home.

Teacher Preparation

If teachers are given environmental education training, then it is expected they'll be more likely to implement it in their classrooms and implement it in a meaningful way. The most common barriers to implementing environmental education according to teachers was a lack of time for preparation and a lack of materials and funding (Ham and Sewing 1988). Proposed methods for increasing teacher implementation of environmental education are professional development, resources, and mentoring.

Desimone and Garet's *Five-Feature Professional Development Framework* identifies five steps to an effective professional development (PD) (2015). PD was found to be most successful when it is explicitly linked to classroom lessons (Desimone and Garet 2015). In the context of environmental education, PD should focus on environmental education lessons that can be

implemented into classrooms (Desimone and Garet 2015). In general, the benefit of high-quality PD trickles down to students and their academic achievement (Fischer et al. 2018).

Teachers also require resources to implement environmental education. However, depending on the grade level and funding available, resources may vary. Kindergarteners will not require the same resources as sophomores in high school. In general, the older the student, the more abstract, and expensive, the tools at their disposal will be. 5th graders may begin exploring environmental education with an inquiry activity into what plants need to grow by placing plants in the dark/light, giving them water/gatorade, etc. 10th graders may do the same inquiry but instead can use a soil moisture meter to investigate the ideal soil moisture for growing a plant. The more resources teachers have at their disposal, the more investigative and creative the lessons can be.

Mentoring was found to be a crucial aspect of implementing environmental education in schools. Leadership plays a major role in supporting and encouraging teachers to implement new ideas and strategies they learned in PD (Desimone and Garet 2015). In an environmental education lense, mentoring of teachers implementing new material provides teachers with a sense of accountability, encouragement of reflection, personalized support, and assistance with navigating challenges (Ernst and Erickson 2018). The most effective mentors are those who are invested, flexible, and responsive to their mentees (Ernst and Erickson 2018). Mentors can help teachers grow out of their comfort zones in teaching and learning in environmental education.

Where environmental education grows

Although there was no statistically significant relationship between environmental knowledge and location, there were patterns between prior environmental experiences and location. The most obvious pattern was how students in the Gateway Cities talked the most about the beach compared to their counterparts.

Speaking broadly about location and environmental knowledge, my study aligns with prior literature that also had mixed findings. The type of location (suburban, rural, and urban) were found to have no effect on environmental knowledge (Ajitoni & Gbadamosi 2015). This aligns with my study as the schools sampled were from suburban and rural areas but this was not found to have an effect on environmental knowledge. However, Ali et al. (2017) found that there was a significant difference in environmental awareness amongst students from different locations of

schools. The relationship between location and environmental knowledge requires further research.

Learning outside the classroom may also be an enriching experience for students in terms of long-term memory and awareness. A study found that students who participated in a beach clean-up compared to those who only received a lecture had increased their knowledge and awareness of marine plastic pollution (Cecconi 2019). These students were also more likely to participate in future beach clean-ups (Cecconi 2019). As previously mentioned, schools in the Antelope Valley and Santa Clarita Valley are in proximity to Angeles National Forest and this may be an outlet worth exploring. Farmer et al. examined students who visited the Great Smoky Mountains National Park and how student experience and knowledge still persisted a year following the trip (2010). Even more so, students had developed a pro-environmental attitude (Farmer et al. 2010). This can be replicated to Angeles National Forest for these schools in Los Angeles County.

Even more local excursions beyond the classroom walls may be impactful. Monroe et al.'s (2008) *Framework for Environmental Education Strategies* cite four categories: convey information, build understanding, improve skills and enable sustainable actions. Building an understanding can be having students take nature walks in green spaces around their schools or even in their schools; there is a two-way transmission of information between students and their teacher that engages the audience (Monroe et al. 2008). If we want to improve skills, students can get involved in citizen science programs, volunteer service, and project based education (Monroe et al. 2008). These are only a few examples of environmental education at a local scale.

We see here that understanding where students are learning can provide examples of where environmental education can occur in meaningful ways outside the classroom. Students also do not necessarily need to go camping, despite it being a popular experience, but there are inexpensive alternatives that are just as enriching.

Disentangling class size

We have acknowledged outside of the classroom learning is important but it is also important to understand what occurs in classroom walls. As the teacher-student ratio increased, so did environmental knowledge. However, I believe this is a case of confounding variables. While

the literature debates the benefits and limitations of smaller class size, there is a lack of research into larger class sizes being beneficial to academic achievement (Glass & Smith 1978; Odden 1990; Konstantopoulos 2011). Class size must be disentangled from other variables at play.

One suspected causal factor is spending, particularly expenditures per pupil. The trendlines for expenditure per pupil and teacher-student ratio were similar with very close R-squared values. This may show that it wasn't class size, but rather expenditures per student. However, it is not so much spending that improves academic achievement, but where the money goes that matters the most (Lips et al. 2008). Increasing education budgets does not directly improve American students' academic achievement (Lips et al. 2008). Lips et al. (2008) recommended policymakers allocate resources according to needs of students and schools. In the case of environmental education, funding may be allocated to provide resources and PD.

There are also a set of confounding variables associated with class size. Mitchell et al. (1989) found administrative and political factors may control class size which may hold more of an influence over academic achievement. Why would schools want bigger class sizes? It may be economically effective to have larger class sizes rather than hiring more staff; thus, funding saved could ideally be put into other resources (Mitchell et al. 1989). One primary example of confounding variables is with Advanced Placement and honors courses which have smaller class sizes and higher academic achievement amongst students (Mitchell et al. 1989). However, is this due to the smaller class size or dependent on the types of students who are allowed to and *choose* to opt into more challenging classes (Mitchell et al. 1989). Student ability, interest, and family characteristics were also found to hold a strong influence on academic achievement (Mitchell et al. 1989). It cannot be said with complete certainty what confounding variables may be coinciding with class size and environmental knowledge.

Limitations & Future Directions

The first limitation of this study was the size and scope of the survey. The amount of students and schools sampled was incredibly small compared to the mere size of Los Angeles County and its senior body population. A larger, more representative sample would be needed to reach a 10% sample of the population. A larger sample may also find statistically significant differences across the eight regions of Los Angeles County.

Secondly, questions on the survey were limited as they were mostly multiple choice. This was a design decision based on the principle that analysis of student responses would be easier with correct and incorrect answers. If I were to repeat the survey however, I would change several questions into short answers or free responses. This would give students more opportunity to showcase their "less-scientific" environmental knowledge and potentially lower the influence of (a lack of) familiarity with scientific terms; an example would be how a student gardening at home knows it's better to water the grass in the morning compared to during the day during peak temperatures.

I also want to reflect on my survey method choice as it can be combined with other methods to provide a more holistic view of environmental education. For example, I could observe classrooms teaching environmental education or interview teachers and students regarding their experiences with environmental education.

Broader Implications

This study finds that school funding has an effect on the quality of environmental education high school seniors experience in Los Angeles County. Increased funding in schools can increase student opportunity as well as teacher preparedness and resources available. Opportunities provided to students may include field trips to science museums and the outdoors or even hands-on learning via labs or volunteer work.

The implementation of interdisciplinary curriculum in Los Angeles County schools can also make strives in environmental education. If environmental science cannot be its own mandated school subject, then perhaps it can be implemented into courses that are mandatory. For example, U.S. history is a mandatory subject for all high schoolers. The formation of National Parks can be a segway for environmental education as students can investigate how National Parks were formed, who they were formed for, and why. Chemistry is yet another mandated subject, especially chemical reactions and combustion. This is another avenue for environmental education as students can learn about gas combustion in cars contributing to climate change via the increased emissions of greenhouse gasses. Environmental education is *meant* to be built into an already existing curriculum.

Environmental education may also be implemented by means of community based learning. Community based learning combines student learning with community engagement. One way of doing so is through projects. An example of this would be students noticing the park near their school is always covered in litter. A community based learning project could be developed that requires students to recruit community members to pick up litter around the park. Students can then research the environmental effects of litter, particularly plastic pollution. As a final step, students can make posters for the park encouraging their community to keep the park clean by showing their findings on plastic pollution. Projects that involve communities help students learn about their communities while simultaneously developing environmental awareness.

Environmental education can take numerous forms across grade levels, location, and availability of resources. However, big or small actions taken within classroom walls or at a legislative level can make strides in developing the future generations' environmental literacy.

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Appendix A: Survey Questions

Environmental Education Survey

An ecosystem is a location that includes *

- ◯ Nonliving factors
- ◯ Living factors
- ◯ Both nonliving and living factors
- ◯ Neither

Which of the following is NOT an example of a benefit to humans provided by the environment? *

- ◯ Water filtering
- ◯ Erosion reduction
- ◯ Carbon capture
- ◯ Beavers dams next to a neighborhood

The first law of thermodynamics states ____ *

- ◯ Energy cannot be created nor destroyed
- ◯ Energy can be created and destroyed
- ◯ Energy can never leave or enter a system
- ◯ None of the above

What is meant by a "carrying capacity?" *

- ◯ The number of humans an ecosystem can support
- ◯ The number of humans the earth can support
- ◯ The number of living things the earth can support
- ◯ The number of living things an ecosystem can support

Which of the following best describes conditions when El Nino hits the Southern US and Peru? *

- ◯ Increased rainfall
- ◯ Droughts
- ◯ Colder winters
- ◯ Forest fires

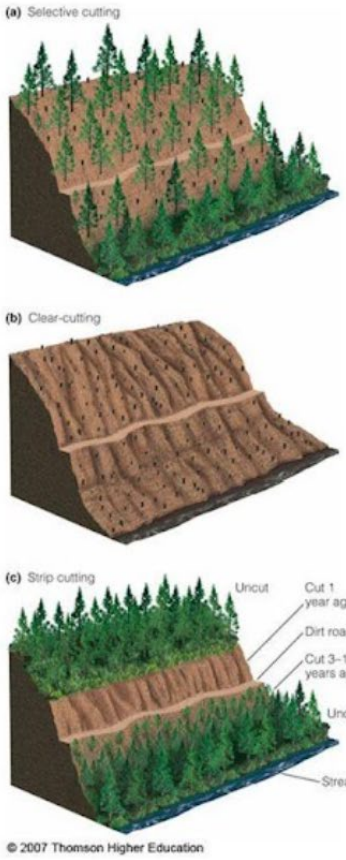
How have humans increased the rates of erosion? *

- ◯ Destroying forests
- ◯ Overgrazing
- ◯ Mining
- ◯ All of the above

What is the "tragedy of the commons?" *

- ◯ People use a shared resource for personal gain, depleting the resource
- ◯ When humans overuse natural resources
- ◯ When plants and animals compete for space, resources, and/or food
- ◯ A group of people share a common resource

Which of the following type of tree harvesting is the most harmful to the environment? *



Harvesting Methods

- Harvested individually from diverse forests (selective cutting)
- Entire forest can be cut down (clear cutting)
- Portion of forest harvested (strip/stand cutting)

Figure 10-9

- ◯ Selective cutting
- ◯ Clear cutting
- ◯ Strip cutting

What is a possible economic disadvantage to hydroelectric energy? *

- ◯ Creates a lot of pollution
- ◯ High start up cost
- ◯ Accidental harming of fish populations
- ◯ Low functional lifespan

When supplies of an energy type are limited, it is called _____ *

- ◯ Renewable resource
- ◯ Non-depletable resource
- ◯ Nonrenewable resource
- ◯ Potentially renewable resource

Which of the following causes acid rain? *

- ◯ Carbon dioxide
- ◯ Methane
- ◯ Chlorofluorocarbons
- ◯ Sulfur dioxide & nitrogen oxides

What is the greenhouse effect? *

- ◯ Gases in the atmosphere create smog
- ◯ Gases destroy the ozone layer, heating the earth
- ◯ Gases in the atmosphere trap sun radiation, heating the earth
- ◯ Gases in the atmosphere cause breathing problems (asthma, coughing)

Which is an example of water pollution from more than one source? *

- ◯ Hot water discharges from a nuclear power plant
- ◯ Petroleum refinery releases ammonia in a river
- ◯ Local farms leaking pesticides into a river
- ◯ Waste from a sewage treatment plant

Which federal law deals with the cleanup of abandoned hazardous waste sites? *

- ◯ Resource Conservation and Recovery Act
- ◯ Not In My Backyard
- ◯ Comprehensive Environmental Response, Compensation, and Liability Act (Superfund)
- ◯ Safe Drinking Water Act

What is meant by the term, "global climate change?" Identify one human cause of global climate change. *

Your answer

What are some solutions to worldwide climate change and environmental damage? *

Your answer

What individual actions could you take or have you taken to address environmental problems? *

Your answer

Select which science courses you are currently taking or have taken in high school. *

- [ ] Biology
- [ ] Chemistry
- [ ] Physics
- [ ] Health
- [ ] Environmental Science
- [ ] AP Biology
- [ ] AP Chemistry
- [ ] AP Environmental Science
- [ ] AP Physics (Any)
- [ ] Other: _____

Last Question! Please list any relevant experience you have had with environmental education, science, etc. Some examples include camping, volunteering, gardening. *

Your answer