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Evaluating the Effects of Nature in the City on 5th grade Students' Environmental Literacy in the Syracuse City School District

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Evaluating the Effects of *Nature in the City* on 5th grade Students' Environmental Literacy in the Syracuse City School District

by

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Abstract

Baltimore Woods Nature Center's *Nature in the City* school programs provides K-6 students in the Syracuse City School District with hands-on learning experiences that connect them with their environment. To improve the quality of Baltimore Woods Nature Center's *Nature in the City (NITC)* program, as well as assess changes in 5th grade students' environmental literacy, assessments were conducted in all participating schools. Assessments were given before and after *NITC* programs in each 5th grade classroom. Pre- and post-assessments scores were calculated for each student, and these scores were used to compute statistics for individual schools and the overall district. Paired t-tests were run at a 95% level of confidence ($\alpha = 0.05$). Following data analysis it was found that the overall participating students showed a significant increase from pre- to post-scores (percent change of 46.3%). Ten out the 12 schools in this report showed an individual significant increase. Results from Delaware and Porter suggest there is room for improvement in the program. When asked, "will you change your habits to save energy in your daily life," and "do you your actions impact the environment," the initial response was positive with >40% answering "yes," or "I already do." This positive response increased by a small margin of 1 and 3% from pre- to post-scores. The overall findings of this report show that the *Nature in the City* program is effective at increasing participants' environmental literacy. This positive change in opinions about the environment, and the significant increase of scientific knowledge, will equip students who participated in the *NITC* program with the tools they will need to make environmentally conscious decisions and act in its favor. This not only benefits the global environment, but also helps Baltimore Woods Nature Center meet their goal of increasing students' knowledge and engaging them in hands-on activities.

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ACKNOWLEDGMENTS

I would like to thank staff at Baltimore Woods Nature Center, Becky Wilson and Emily Van Ness, for providing me with the opportunity to work with their organization to complete this project. I would also like to thank Kyle Teufle for her guidance and assistance. Statistical assistance from Jacob P. O'Connell was very helpful in completion of this project. The guidance and encouragement from my advisors, Dr. Rick Beal and Dr. Valerie Luzadis, has played a crucial role in the development of this project and myself as an academic scholar.

Introduction

There is no doubt that anthropogenic activities are causing environmental destruction on a global scale. The human species is altering the planet's chemistry and physics which is in turn changing its biology (Mitchell). The human population is growing exponentially, with a recorded 7.4 billion people as of May 1st, 2016 (Worldometers), and is projected to reach 9.6 billion by the year 2050 (United Nations). With an increasing population, there is a growing need for clean water, space, energy, and food. The security of these resources is threatened by the altering of the global environment. Such changes have also begun to have negative effects on the economy, such as the impacts of overfishing in coastal communities and the effects of climate change on agriculture all over the world (Hogwell et.al).

Humans need to be prepared to deal with the environmental changes that are currently occurring and will only continue to intensify. Access to water, food, and energy resources requires work with humans and the natural world and requires a broad range of skills (Hogwell et al). An environmentally literate citizen is an individual who is capable of making informed decisions regarding the environment, and is willing to act on such decisions to improve the well-being of other individuals, societies, and the global environment (Simpson & Meyers). Environmental literacy, primarily in youth, is developed through both formal and non-formal environmental education. Such experiences contribute to the gain of knowledge, skills, and a shift in attitude that applies this understanding to make sustainable decisions on an array of environmental topics (Simpson & Meyers).

The field of environmental education has grown over the past 30 years. Research and evaluation studies have been an integral part of developing this field and gathering

data on environmental literacy in youth (Hogwell et al). Environmental education teaches people of all ages how to engage with their environment and make intelligent, informed decisions about how they can help conserve it (NAAEE).

In the Syracuse City School District (SCSD), the students often experience disconnect from nature and don't realize that nature is in their own backyards. A recent study of poverty in America found that," Syracuse has the highest rate of poverty concentrated among African Americans and Hispanics of one of the hundred largest metropolitan areas in the nation," (Jargowsky). This study also found that Syracuse ranked 5th for highest poverty among non-Hispanic whites. The socio-economic make-up of the Syracuse City School District has a huge influence on childhood development in the area. Jargowsky's study points out that one of the primary concerns of high-poverty neighborhoods is the potential impact of development of children and adolescents in these areas. Children from poor areas are more likely to reside in high-poverty neighborhoods than poor adults (Jargowsky), which creates a negative feedback loop and puts urban children in an almost unbreakable cycle of under-development.

To combat the negative effects of the socio-economic make-up of the Syracuse City School District, Baltimore Woods Nature Center attempts to connect urban K-6th grade students directly with their environment through *Nature in the City (NITC)* school programs. Baltimore Woods Nature Center is a not-for-profit environmental education organization. It is committed to promoting environmental awareness, understanding of ecology and biology, and responsible natural resource stewardship among all people, especially children (Baltimore Woods Nature Center).

Nature in the City provides students with hands-on learning experiences that involve meaningful curricula relevant to tailored themes for each grade. The program involves three hour-long lessons that have common learning objectives and a theme. The lessons are connected to New York State Science Standards and reinforce the Elementary Science Core Curriculum (Baltimore Woods Nature Center).

All classes K-5 in the Syracuse City School District participate in the *NITC* program at various points throughout the year; for example 5th grade programs typically in the fall (sometimes spring), 4th grade programs occur in the winter, and Kindergarten programs occur once in the fall, winter, and spring. To improve the quality of the NITC program, as well as assess how 5th grade students' scientific knowledge changed, evaluations were conducted in all schools within the SCSD. Short-term outcome measurement, through pre- and post-assessments is appropriate for quantifying knowledge gained, and assessing behavior/opinion changes that occur following the experience of *Nature in the City*. The advantages to short-term assessments are accessibility to participants immediately following a program allows for topics to be easily accessible in recent memories, continual program improvements from feedback and evaluation results, and expenses are manageable as evaluation are conducted in a timely manner, over several weeks rather than over years (McReynolds et al).

Due to disruption reports, scheduling conflicts, and incomplete data, only 12 schools are included in this study. These schools include: Bellevue, Dr. King, Dr. Weeks, Delaware, Ed Smith, Frazer, H.W. Smith, Mckinley-Brighton (2 out of 3 classes included because the third class did not complete the *NITC* program due to extreme disruptive

behavior), Porter, Roberts, Salem-Hyde, and Van Duyn. A total of 560 students in 3-4 classes per school participated in evaluations; this large sample size is preferential for assessing impacts throughout the district, to show a wide variety of impacts of the program. I hypothesize that *NITC* has a positive impact on students and increase their environmental literacy.

Methods

1. Lesson Plan Overview

All *Nature in the City* programs are designed by BWNC staff. The theme of the 5th grade series is that energy is all around us. The first lesson is "Falcon Food". Students learn about peregrine falcons and their role as predators in urban environments. Students create food chains and food webs, demonstrating how energy flows through an ecosystem. Students look at food energy pyramids, producers and different levels of consumers.

The second lesson is "Bright ideas." Students learn about different forms of energy in the world around them. Students perform experiments at several "energy stations". One station involves a hand-cranked generator to experience how much muscle it takes to light an incandescent light bulb versus a compact-fluorescent bulb. Another station shows how sound energy is transformed into motion. Students experiment with photovoltaic toys with different light sources. Finally, they discover how mechanical energy moves through a Newton's Cradle. This knowledge is applied to understand the law of energy conservation and get the students to think about their own habits of energy consumption

The third lesson is "It's Gettin' Hot in Here." This lesson looks at how CO_2 generated from the burning of fossil fuels impacts the planet. Students partake in a hands-on activity that demonstrates different planets' (Venus, Earth, and Mars) atmospheric heat retention qualities. A discussion then occurs about the planet's CO_2 concentrations and how they have been rising since the industrial revolution. Students work together to brainstorm ways that they can help combat rising CO_2 concentrations

2. Data Collection

The assessment (see copy in the appendix- page 19-22), was designed by the BWNC staff. Questions correspond with the three *NITC* lessons that take place in 5th grade classrooms. There were a total of 11 questions; 9 correspond with the program's content (3 questions for each lesson), and the final 2 questions are opinion questions ("Will you change your habits to save energy in your daily life? " & "Do you feel your actions impact the environment?"). Pre-assessments were typically scheduled within 1 week prior to the start of the first *NITC* program. The educators traveled to each school and proctored the assessment in each 5th grade classrooms. The test usually took 20 minutes to conduct and disruptions within classrooms were noted. The educator would read through the entire assessment with the students so reading would not inhibit anyone from participating. Students were instructed to try their best and to make educated guesses if they were unsure of the answers. The post-assessment was identical to the pre-assessment to eliminate inconsistencies in evaluation results. The exact same protocol was followed for the post-assessment process, and would take place (usually) within 1 week following the completion of the last *NITC* program.

3. Grading and Evaluation

A grading system was established by BWNC staff and involved inputting data into an excel spread sheet. For pre-assessments teacher, student name, gender, school and primary language (ESL or non-ESL) were recorded. Students were awarded 1 point for each correct answer (1-9). Open-ended questions were graded if answer was appropriate (i.e., saving energy saves money or saving energy reduces pollution). The response to opinion questions (10-11) were documented using a code of 1,2,3, or 4. The pre- (and post-) scores were calculated by adding the points for questions #1-9 and dividing them by the total to obtain a percentage. For post-assessment grading, students' names were matched to existing pre-assessments and the same process was followed. A class from Mckinley-Brighton did not complete the third *NITC* program, so they did not complete post evaluation. However, there is still data included from the other two 5th grade classes from that school. Pre-Assessments with no corresponding Post-Assessment were discarded.

Once all pre and post scores were input, a percent change was calculated for each student. The average and standard deviation for pre and post scores was calculated for each school and for the overall SCSD school district.

4. Statistical Analysis

Using Minitab statistical software, paired t-test were run using the pre and post scores of students from all schools. Paired t-tests were also performed on each school's data individually. Data was then analyzed by question (1-9), paired t-tests were ran on each individual pre- and post-question to determine significance in performance. A level of 95% confidence, with a significance (α) of 0.05, was used for hypothesis testing.

Results

As shown in figure 1, the assessment question with the highest percent change (116.3%) from pre- to post-score was question 6, the open-ended response question of "Why is it important to save energy." Figure 2 shows that the average pre-score for this question was 13.89% (± 0.339) and this increased to an average post-score of 30.03% (± 0.467). Question 7 saw the next highest change with the average pre-score of 37.2% (±0.441) increased by 62.7% to an average post score of 60.50% (± 0.469) (Figure 1 and 2). The lowest percent change was seen in questions 4, with a negative change of -1.2% (Figure 1). The average pre-score for this questions was 71.53% (±0.453) and the average post-score was 70.66% (±0.478). Following statistical analysis, it was found that questions 1, 2, 4, 5, 6, 7, & 8 yielded significant results (increases in all questions except for 4, which was a significant decrease) from pre- to post-assessments ($p<0.05$; individual p-values shown in figure 2). It was also found that questions 3 & 9 did not yield a significant change, with p-values >0.05 (shown in figure 2).

Analysis of pre- and post-evaluations, which was used to assess whether there was an increase in students' environmental literacy following *NITC*, found that there was a significant increase from pre- to post-assessment scores in the Syracuse City School District ($p= 0.0000$). The average pre-score of 48.61% (±0.185) increased to an average post-score of 61.94% (±0.205) (Table 1; Figure 3). The percent change was 43.32%. Further analysis showed that 10 out of the 12 schools demonstrated significant increases of pre- and post-assessment scores (Table 1; Figure 4).

Salem-Hyde showed the greatest average percent change of 73.29%. The average pre-score was 46.32% (± 0.141) which increased to an average post-score of 73.01%(±0.159) ($p= 0.000$). Dr. King and Dr. Weeks-class1 showed the next greatest

percent changes in scores. The average pre-score at Dr. Weeks (Class 1) was 35.67% (±0.132), this increased to an average post-score of 54.53% (±0.219) which resulted in a 71.89% change ($p=0.001$). Dr. King's average pre-score was 40.48% (±0.157) and the average post-score was 57.85% (±0.202), this resulted in a 71.51% change (Table 1; Figures 4 and 5).

The school with the lowest average percent change was Porter at 2.1%. The average pre-score of 58.57% (±0.181) decreased to an average post-score of 56.83% (±0.201) ($p=0.588$). While Delaware saw a change of 36.41%, the paired-t test showed this change as not significant ($p=0.086$) (Table 1; Figures 4 and 5).

Figure 6 shows how students' responses changed to the question, "Will you change your habits to save energy in your daily life?" following *NITC* in their classroom. The answers, "I already do," and "yes I will," both yielded a 1% increase. The choice, "I don't know if I can," saw a 2% decrease and the response of, "no I won't," remained the same. Figure 7 displays student's change in response to the question, "Do your actions impact the environment?" The answer, "yes they do," yielded a 3% increase while the answer, "I don't know if they do," saw a 3% decrease following *NITC.* The number of student who answered, "No, they don't," did not change from pre- to post-assessments.

Discussion

With results showing that most had a significant increase between pre-scores to post-scores, as well as a significant increase of the overall average assessment score, I conclude that Baltimore Woods' *Nature in the City* program is effective at increasing students' environmental literacy. The fifth grade programs give students a greater

understanding of trophic food webs, different kinds of energy in the environment, and how CO2 affects global temperatures.

To gain a better understanding of the influence of *NITC's* influence on students' environmental literacy, it is important to look at the analysis of individual questions, it is important to consider the context in which each question was asked, as well as look at the lesson plan that the question correlates with. Question 6, which has the highest percent change (Figure 1), was an open ended response question, "why is it important to save energy?" This question correlates with the *NITC* lesson, "Hot in Here." This lesson emphasizes that carbon dioxide is released into the atmosphere as a result of energy consumption (pollution). The students learn about CO_2 as a greenhouse gas and its ability to increase atmospheric heat retention. Students also learn that using a lot of energy costs more money, which is another incentive for conservation. The question with the next highest percent change (figure 1), question 7 was about the Peregrine Falcon Energy Pyramid. Students were to label four levels of the pyramid with labels: producer, 1st level consumer, 2nd level consumer, and 3rd level consumer. This questions correlates with the *NITC* lesson, "Falcon Food." Students partake in a hands-on activity, outside of their classroom, that involves labeling an energy pyramid in different ecosystems (one of the ecosystems is urban and is the peregrine falcon energy pyramid). Students are responsible for matching organisms (covered in question 8) and labels to each energy level. Due to the nature of this activity, it is likely that the hands-on experience greatly reinforced this topic (Councill & Weigel), which resulted in a high increase in scores from pre- to post-assessments.

In regards to questions that resulted in poor performance, it is essential to take a closer look at which topics need to be better emphasized in *NITC* lessons. Question 4 saw a decrease in average pre- to post-scores (Figure 1 and 2). This was a multiple choice question that asked, "A fossil fuel is: A. an energy source made out of corn, B. an energy source composed of dead plants and other organisms that were buried over millions of years ago, C. an energy source made in a factory." This question correlates with the lesson, "Hot in Here." The primary focus of this lesson is an in-class, a hands-on activity that demonstrates atmosphere heat retention qualities on three different planets. Although it is discussed that carbon dioxide is released into the air as a result of burning of fossil fuels, it is possible that the exact origin of fossil fuels gets lost in the lesson. Perhaps students had a pre-existing knowledge of this fact, which explains high pre-assessment response (71.53%). Although there was a small negative percent change from pre- to post-scores (Figure 1 and 2), when the paired t-test was run on the data for this question, at 95% confidence, a p value of 0.0044 (<0.05) was found. This value indicates that the change was statistically significant, and suggests that there is room for improvement in this lesson plan to better emphasize this topic. BWNC Educators need to ensure that this topic is being taught properly in future *NITC* lessons.

Because of the lack of significant content gain in two schools, there is room for improvement in the program but also to look at other reasons for these changes. While showing an increase from pre- to post-scores, Delaware had a small sample size, and a high standard deviation from the means of both pre-and post- assessment scores. This could be reflected by the high p value (0.086) of these assessment scores and why this data showed an insignificant gain in content. Moreover, the decrease from pre- to post-

score at Porter calls for a further investigation. Porter Elementary was identified as a priority school in 2013 and inducted into the SCSD Innovation Zone. The Priority School program is an attempt to change the academic outcomes of core schools involved (SCSD). Schools included in this program showed low test scores and more behavioral disruptions. The increase in classroom disruptions could be behind the overall decreased assessment scores for these students.

Disruptions in the classroom during *NITC* could also result in student distraction and decreased learning, and it is suggested that BWNC keep a detailed report of each *NITC* program (educator who taught, what lesson, brief note on it went in each classroom). As for ensuring lessons are taught for maximum learning potential, it is suggested that teachers give students follow-up questions (either later in the day, or the next morning), to reinforce topics. BWNC staff usually asks one question about the previous lesson, but perhaps they could incorporate a couple more to ensure students understood the theme.

When looking at opinion questions the response was positive. Figure 4 illustrates that there was a 1% increase in answers, "yes I will," and "I already do." Figure 5 shows that there was a 3% increase in the response, "Yes they do." These increases, while positive, are insignificant, as a percent change of 10% or higher are required to show a significant change between pre-and post-responses. Along with no change in response, "no," on either question, it is suggested that lessons could be strengthened to further support positive environmental attitudes. The initially high percentage for these responses could be related to the existence of *NITC* programs in classrooms K-5. With a majority of the students having already experience 5 years of

NITC lessons, their environmental attitudes could have be influenced by these previous interactions. There are many draw backs with short-term evaluation methods that could have implications about the findings of this report. Results could be temporary and not accurately measuring changes in knowledge or behaviors/opinions. Behaviors and opinions take time to develop and influence and might not be measurable immediately after the experience of *NITC.* There is also a negative stigma associated with pre- and post-testing, with it being seen as taking away from a fun, entertaining program (McReynolds et al.)

It is suggested that a long-term assessment be implemented. Long-term outcome measurement can show impact of a program over time, which can be positive for reaching long-term goals and gaining funding. Long-term evaluations can show attitude or opinion changes, interest in science and the environment, career choices, as well as many other outcomes. Whether it involves tracking students' changes in attitudes from K to 5th grade or interviewing students in 7th/8th grade about last impacts of *NITC* (what they remember the most). Unfortunately, there are drawbacks to long-term evaluation methods such as difficulty keeping track of participants, maintaining staff (and consistency of programs), as well as keeping funders interested while waiting for assessment results (McReynolds et al). This method is considerably time consuming, however the benefits of implementing this type of evaluation may pay off in the long run.

Conclusions

The overall findings of this report indicate that the *Nature in the City* program is effective at increasing participants' environmental literacy, specifically in knowledge of

energy in the world around us. Emphasis of themes in lessons could be implemented to improve overall quality of the program. Specific topics also need to be better incorporated into lessons, or better-emphasized (i.e., the origin of fossil fuels). This improvement could lead to greater retention of scientific knowledge and thus increase environmental literacy. There is also room for improvement for including the encouragement positive environmental behaviors (why they should save energy, why they should recycle). By translating *NITC* lessons not only into increased knowledge, but into also into positive environmental behaviors that will result in students acting favorably towards the environment. Through *Nature in the City* school programs, Baltimore Woods Nature Center is influencing students' knowledge, skills, attitudes, and behaviors, and increasing 5th grade students' environmental literacy which will help improve the environment in Syracuse and the World.

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APPENDIX

Table 1. Average Pre- and Post-Assessments Scores of 5th grade *Nature in the City* Programs in the Syracuse City School District.

School	Pre-Score	Pre-Standard Deviation	Post-Score	Post-Standard Deviation	Percent Change
Bellevue	44.01%	0.157	56.94%	0.183	44.19%
Deleware	42.28%	0.157	49.18%	0.186	36.41%
Dr.King	40.48%	0.157	57.85%	0.202	71.51%
Dr.Weeks-1	35.67%	0.132	54.53%	0.219	71.89%
Dr.Weeks-2	41.67%	0.175	54.33%	0.187	52.51%
Ed Smith	49.01%	0.190	64.07%	0.208	46.67%
Frazer	52.24%	0.188	66.47%	0.152	49.38%
HW Smith	54.56%	0.189	67.95%	0.208	32.53%
Mckinley-Brighton	48.87%	0.190	56.34%	0.158	33.36%
Porter	58.57%	0.181	56.83%	0.201	2.10%
Roberts	54.21%	0.195	66.48%	0.254	46.65%
Salem-Hyde	46.32%	0.141	73.01%	0.159	73.29%
Van Duyn	49.49%	0.182	61.33%	0.191	41.69%
Overall	48.63%	0.184	61.94%	0.205	46.32%

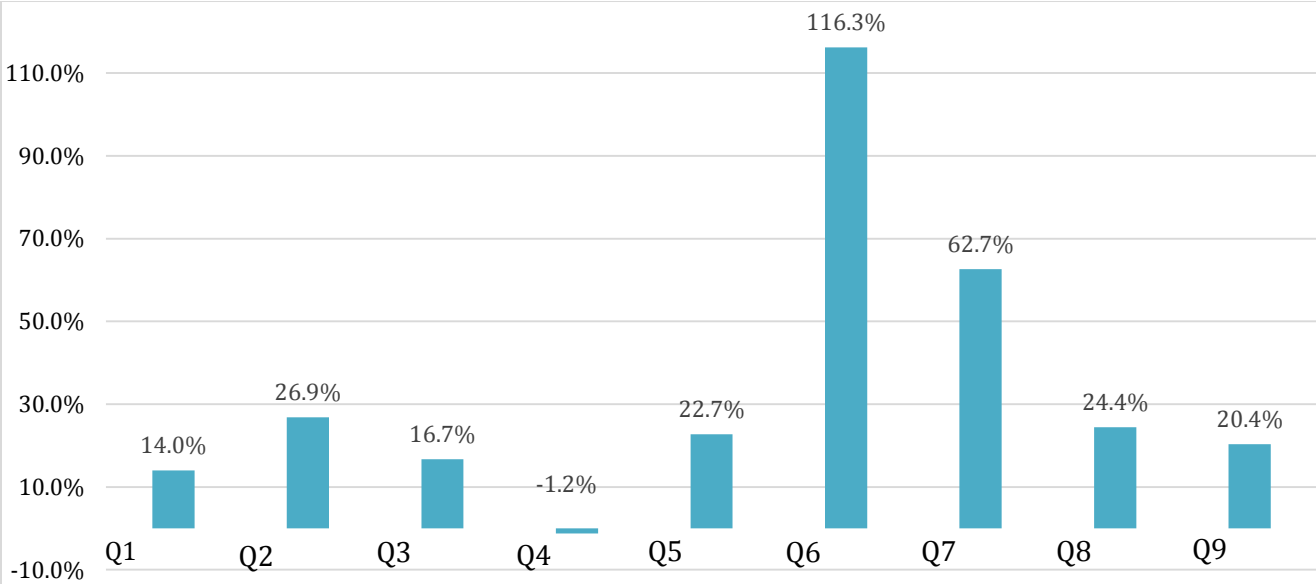
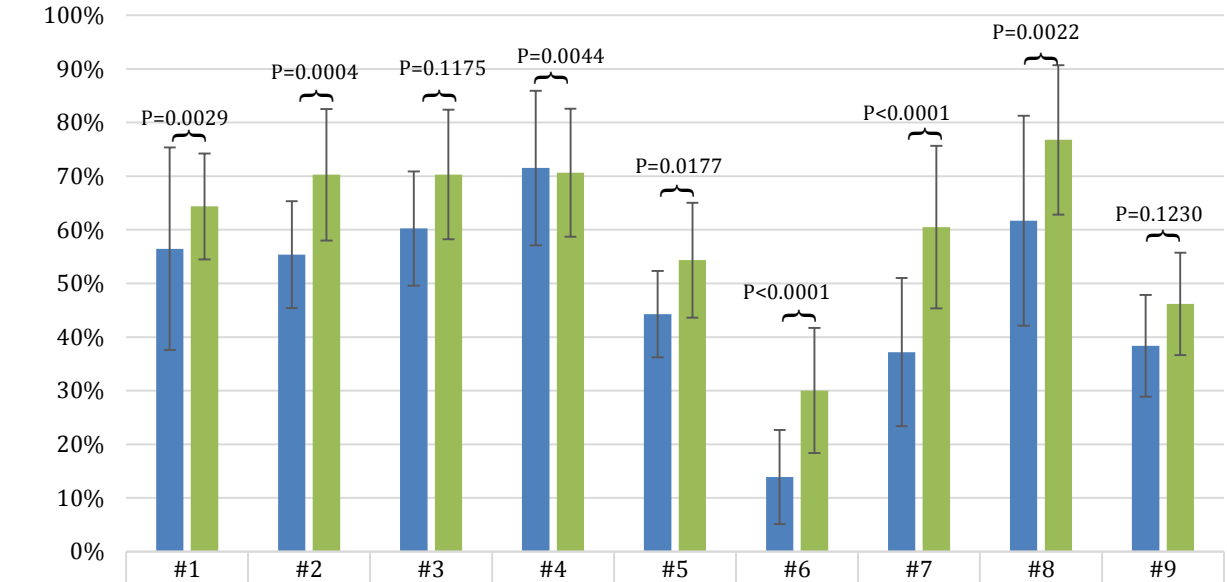


Figure 1. Average Percent Change of Individual Questions (#1-9) from Pre- to Post-Assessment Scores



	#1	#2	#3	#4	#5	#6	#7	#8	#9
Pre-Score	56.47%	55.38%	60.24%	71.53%	44.27%	13.89%	37.20%	61.72%	38.37%
Post-Score	64.37%	70.26%	70.31%	70.66%	54.34%	30.03%	60.50%	76.78%	46.18%

Figure 2. Average Pre- and Post-Scores of Assessment Questions #1-9

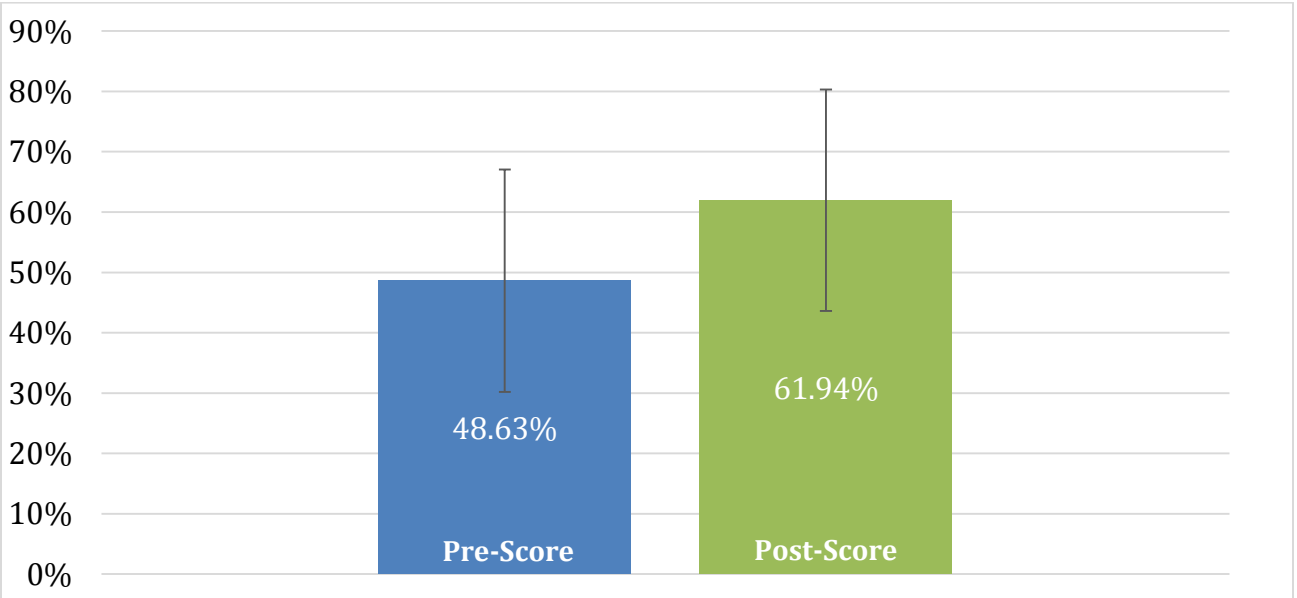


Figure 3. Overall Averages of Pre- and Post-Assessment Scores of 5th Grade Students in the Syracuse City School District showing a significant increase (p=0.000)

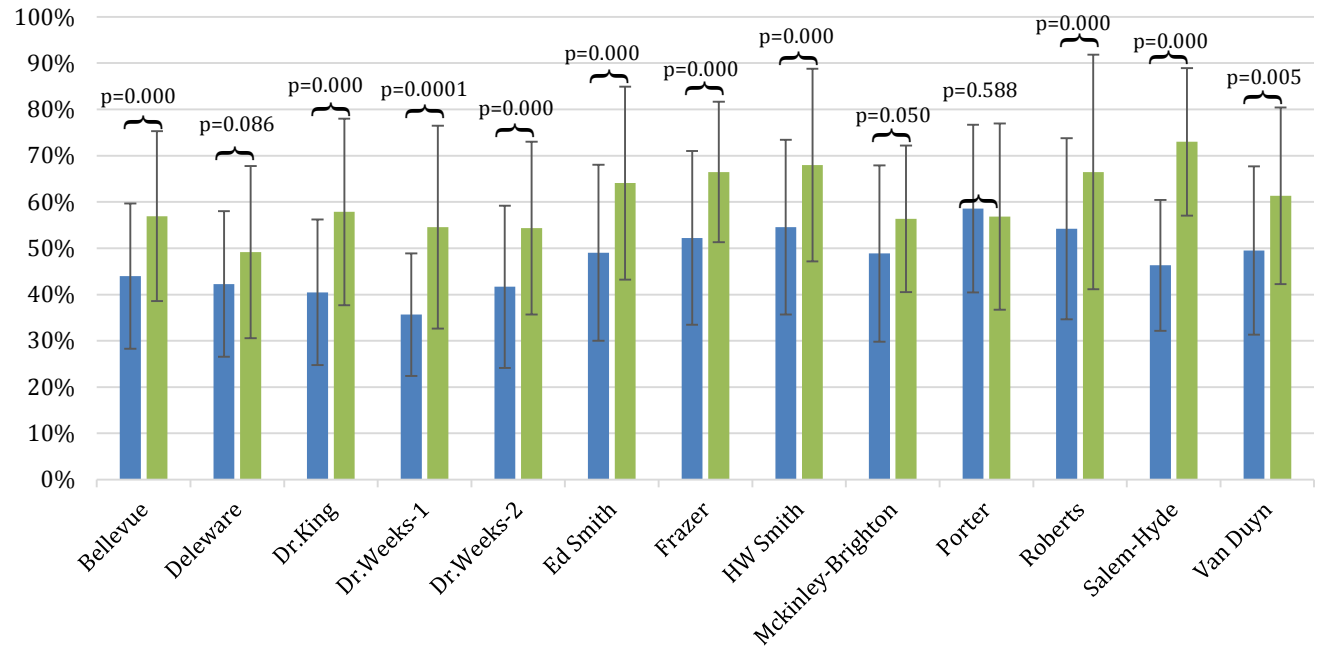


Figure 4. Pre-and Post-Assessment Scores of 5th Grade Classes in the Syracuse City School District showing significance testing (p<0.05)

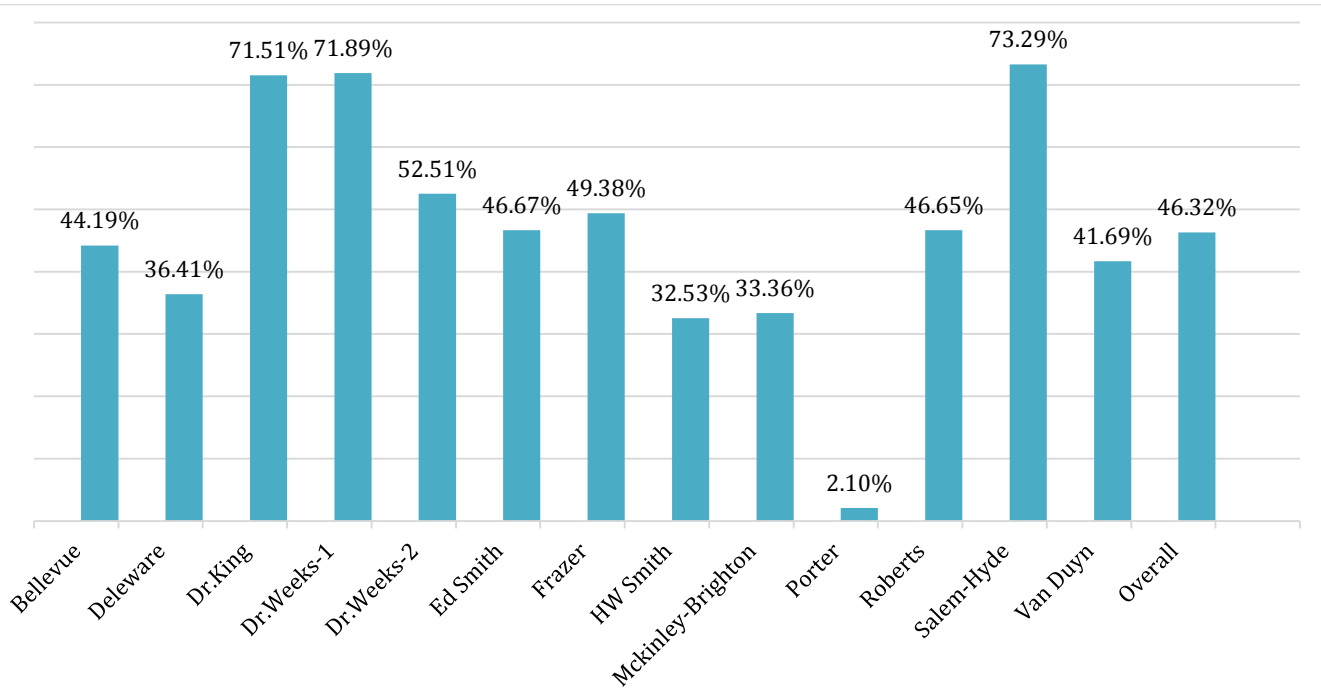


Figure 5. Average Percent Change of Pre- and Post-Assessment Scores of 5th grade Students in the Syracuse City School District

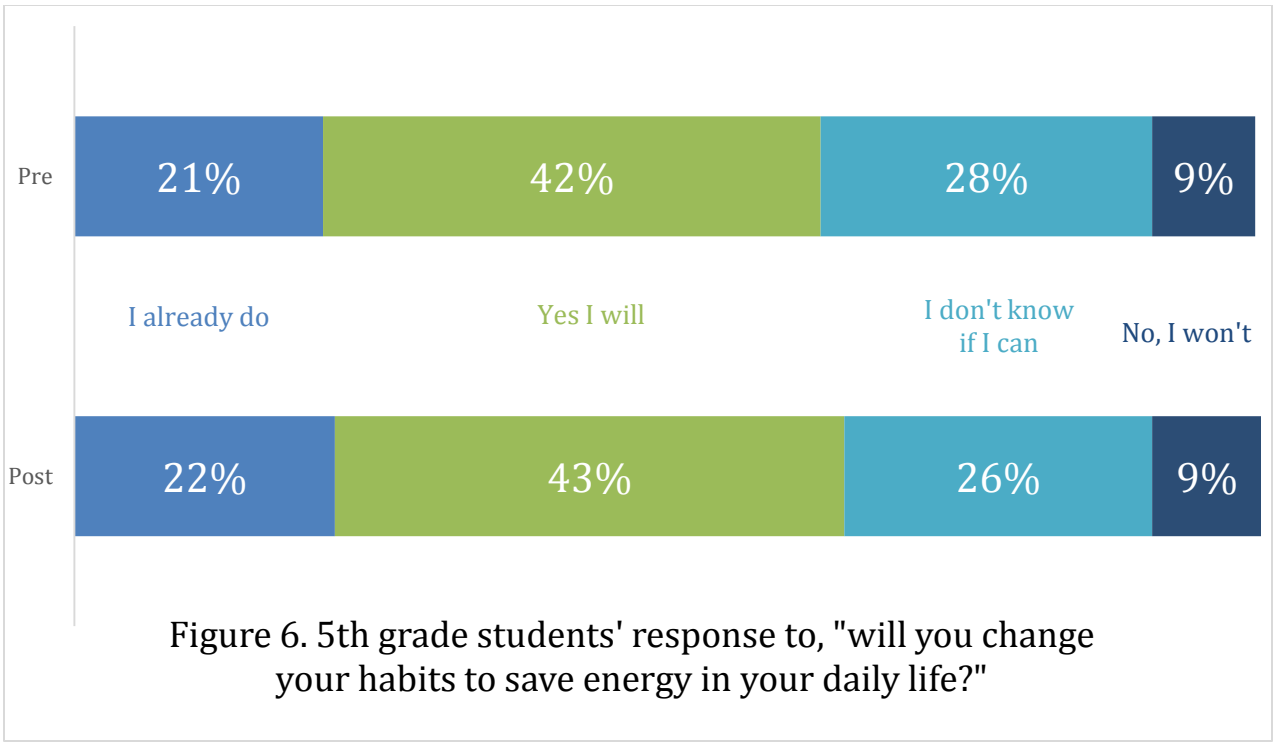


Figure 6. 5th grade students' response to, "will you change your habits to save energy in your daily life?"

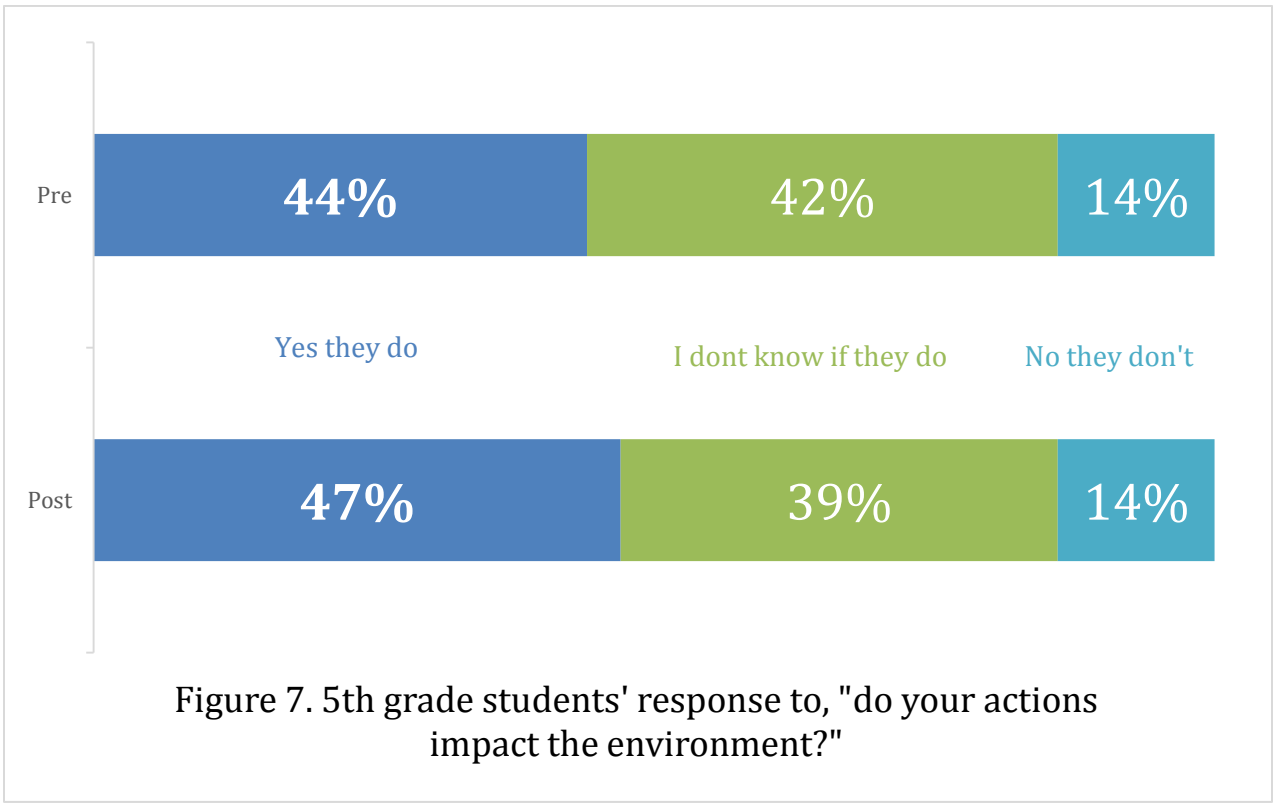


Figure 7. 5th grade students' response to, "do your actions impact the environment?"

Baltimore Woods Nature Center
Nature in your hands

NATURE in the CITY

5th Grade Pre/Post Evaluation

Student's Name_____

Teacher's Name_____ Date_____

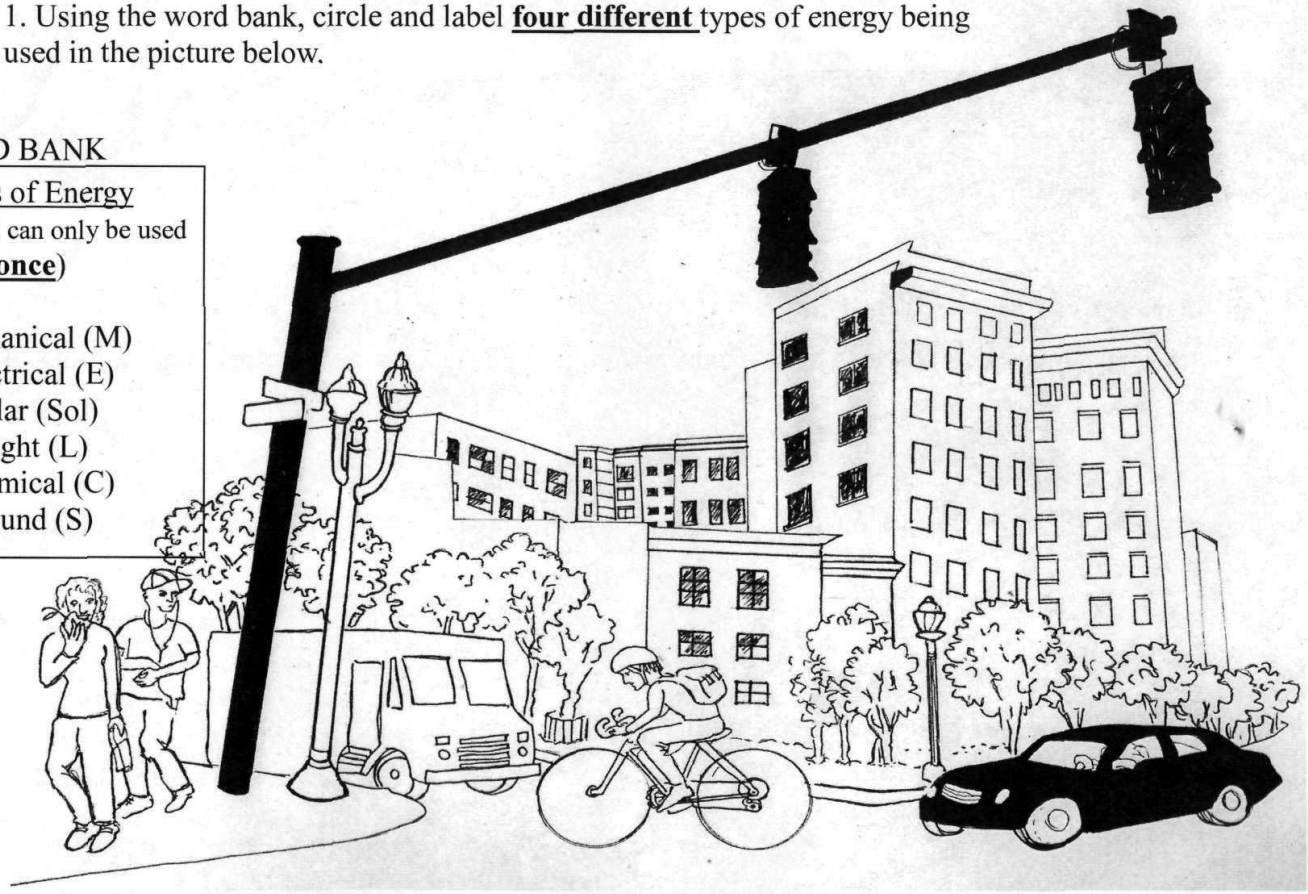
Please answer the following questions the best you can. If you don't know an answer it's okay to leave it blank.

1. Using the word bank, circle and label **four different** types of energy being used in the picture below.

WORD BANK

Types of Energy
(Each word can only be used **once**)

Mechanical (M)
Electrical (E)
Solar (Sol)
Light (L)
Chemical (C)
Sound (S)



2. Which type of light bulb uses less energy?

A. Compact fluorescent

B. Incandescent

3. Light bulbs that require more energy, waste energy in the form of _____.

A. Radiation B. Sound C. Heat D. None of these, that energy simply disappears

4. A fossil fuel is

A. An energy source made out of corn.

B. An energy source composed of dead plants and other organisms that were buried over millions of years ago.

C. An energy source made in a factory.

5. Increasing the amount of greenhouse gases, such as CO_2, in a planet's atmosphere will cause the temperature on that planet to _____.

A. Increase B. Decrease C. It will have no effect on the planet's temperature

6. Why is it important to save energy?

_____

_____

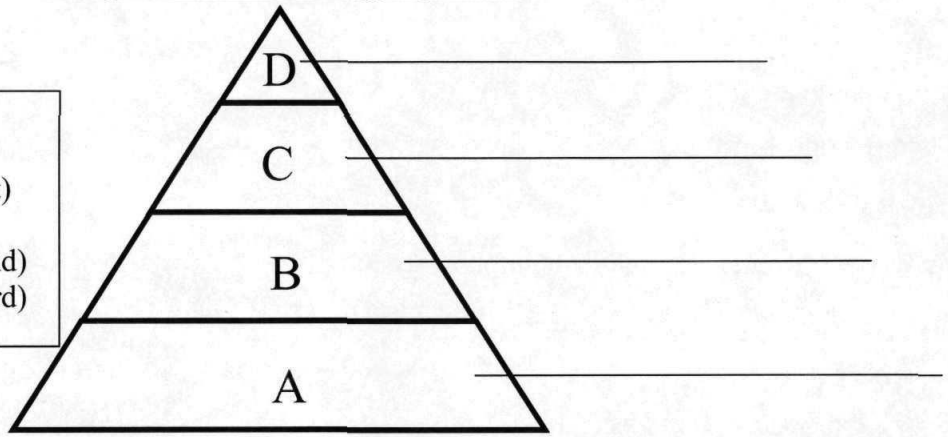
7. Use the word bank below to help you label the different levels of the Peregrine Falcon Energy Pyramid

Peregrine Falcon Energy Pyramid

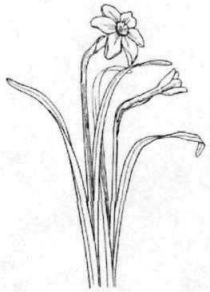
WORD BANK

Energy Pyramid Levels

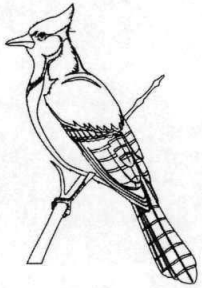
1st Level Consumers (1st)
Producers (P)
3rd Level Consumers (2nd)
2nd Level Consumers (3rd)



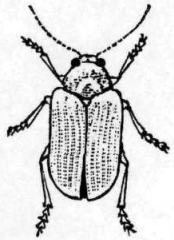
8. Next, label each of the living things below with the letter associated with their location on the energy pyramid above.



Plant _____



Blue Jay _____



Beetle _____

Peregrine Falcon _____

9. As you move up the energy pyramid the levels decrease in size. What does this represent?

A. Number of living things decreasing

B. Amount of energy available at each level decreasing

C. The size of living things are decreasing

D. The decreasing size isn't significant

The following are opinion questions, so there is no right or wrong answer. These answers should be based on how you feel.

10. Will you change your habits to save energy in your daily life?

    A. Yes, I will
    B. I do not know if I can
    C. No, I won't
    D. I already do

11. Do you feel your actions impact the environment?

    A. Yes, they do
    B. I do not know if they do
    C. No, they don't

Please circle the school you attend.

Bellevue	Franklin	LeMoyne	Salem Hyde
Delaware	Frazer	McKinley-Brighton	Seymour
Dr. King	Hughes	Meachem	Van Duyn
Dr. Weeks	Huntington	Porter	Webster
Ed Smith	HW Smith	Roberts	

Gender ☐ Female (girl) ☐ Male (boy)

Language ☐ ESL student