ENERGY EDUCATION IN WAKE COUNTY PUBLIC SCHOOLS

A CASE STUDY OF LEESVILLE ELEMENTARY SCHOOL

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The environmental challenges we face today will continue to become more complex and each individual will be called upon to make critical decisions that will affect the future of our environment. These decisions must be made by an environmentally literate group of people who understand the core elements and complexities of their decisions. Given the need for increased environmental literacy, when should environmental education begin? What is the role of environmental education in preparing our younger generation for the future? Should environmental education be woven into the K-12 curriculum of public and private schools?

This case study attempts to answer these questions by focusing on one element of environmental education – energy education – at two 3rd grade classes in Leesville Elementary School in Raleigh, NC. Through eight learning modules and hands-on activities, the young students demonstrate that even at the 3rd grade level, they are willing and eager to learn more about their environment – specifically about energy resources and efficiency/conservation. They are prepared to become environmental stewards that can help solve the environmental issues of today and tomorrow if they are armed with the information and the opportunities to use it.

Environmental literacy is a life-long journey. In order to address the growing complexity of the environmental issues we face at the global, regional, and local levels, we need to implement environmental education into the school systems today. When expanded across all grade levels, environmental literacy can be fostered with minimal effort and training. Based on the success of this program, this report investigates methods to integrate environmental education into the K-12 curriculum to help foster the environmental literacy of tomorrow’s leaders starting today. These methods include an Energy Ambassador Program to provide knowledgeable guest speakers in the classrooms as well as recommendations to begin the integration of the energy education curriculum into the NC Standard Course of Study.
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INTRODUCTION

“In the coming decades, the public will more frequently be called upon to understand the complex environmental issues, assess risk, evaluate proposed environmental plans and understand how individual decisions affect the environment at local and global scales. Creating a scientifically informed citizenry requires a concerted, systematic approach to environmental education.”

- National Science Foundation, Advisory Committee for Environmental Research and Education Report, January 2003

We live in a world of uncertainty. Whether we realize it or not, uncertainty about our future – particularly our environmental future – is on every person’s mind. To some, the uncertainty is global in scope, focused on the impending tipping points and causes of global climate change. To some, the uncertainty is regional and revolves around food supply, water conservation or population growth. To some, the uncertainty is on local issues like animal habitat change, watershed challenges or whether to build a wind farm “in my backyard.” To some, the uncertainty is individual and focuses on rising energy costs and their effect on the household budget. To all, the uncertainty involves future generations.

The choices we, as a human race, make today will affect the future of not only our own children, but future generations of children as well. As the National Science Foundation pointed out in 2003, the environmental issues we face in the future will continue to become more complex and each individual will be called upon to make decisions that will affect the environment. In order to be successful, these decisions must be made at every level – at the individual level, the community level, the regional level and at the global level. More importantly, these decisions must be made by an environmentally literate and knowledgeable group of people who understand the core elements and the complexities of their decisions.

Given the need for increased environmental literacy, when should this education begin? What is the role of environmental education in preparing our younger generation for the future? Should environmental education be woven into the K-12 curriculum of public and private schools? Is there a place for it alongside the many other demands that are placed on teachers today? What is the best way to teach our young children to be environmental stewards that are prepared to tackle the environmental issues of tomorrow? What is the wisest course of action and how do we get there?
The answers to these questions are not easy. Environmental literacy is a lifelong objective. In order to foster the most environmentally knowledgeable citizens that are able to make the tough decisions that confront us today and into the future, environmental education can and should start as early as kindergarten and continue into adulthood. Through the development of an environmentally literate community, we will be better able to confront the environmental uncertainty of tomorrow and develop a more sustainable world for future generations.

OBJECTIVE

In his report “What Ten Years of NEETF/Roper Research and Related Studies Say About Environmental Literacy in the U.S.,” Kevin Coyle argues for “Organized delivery of Environmental Education content so that there is a logical progression of student knowledge from one year to the next.” This study takes a look at just one element of environmental education – education about energy resources – and offers a recommendation for how it should be woven into the existing curriculum for K-12 schools. It is a case study of two 3rd grade classes at Wake County Public School System’s Leesville Elementary School in Raleigh, NC, but the results can be extrapolated further to offer insight into how environmental education can be woven into all grade levels in all schools. Through the use of pre/post energy knowledge polls and eight 45-minute training modules, we can gauge the interest of teachers and students and explore how easily the students acquire the knowledge and investigate how environmental content can be integrated into the North Carolina standardized curriculum.

The energy education modules were broken into four primary groups:

1. Energy Basics – What is energy and why is it important?
2. Energy Sources – A discussion of renewable and non-renewable energy resources.
3. Electricity – How it is made, where it comes from and what it is used for.
4. Energy Efficiency/Conservation – How can we conserve energy and save resources and money?

Within each module, the students were presented with information to increase their awareness of the subject, given a hands-on activity to apply this knowledge, and then asked to reflect on how they could use this knowledge in the other areas of their lives. While the students were tested on

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Kevin Coyle, What Ten Years of NEETF/Roper Research and Related Studies Say About Environmental Literacy in the U.S., September 2005, p.xv
their knowledge of the subject through the use of an energy knowledge poll, the best way to
determine if they have learned the subject is to see how they can apply it to a real world situation.
When asked to find energy saving solutions within their own school, the students rose to the
challenge and used their newfound knowledge to make some pretty spectacular recommendations.
They demonstrated that a little environmental knowledge can go a long way.

From the information gained in this case study, long term recommendations can be made about
how to work within North Carolina’s Standard Course of Study curriculum to integrate energy
education lessons that will increase the students’ environmental literacy and provide a basis for
improving their critical thinking skills to help solve the environmental challenges of tomorrow.

BACKGROUND

Environmental Education (EE) has been taught in formal and informal settings for hundreds of
years. Dating as far back as the 1800’s, authors have written about the importance of nature and
human’s interaction within it. These include conservation-focused works like Ralph Waldo
Emerson’s Nature (1836), Henry Thoreau’s Walden (1854), and George Perkins Marsh’s Man and
Nature (1864). More recently, authors have started to focus on environmental awareness and
environmental literacy including notable works like Aldo Leopold’s A Sand County Almanac (1949)
and Rachel Carson’s Silent Spring (1962).

1972 was a major turning point in EE internationally. The participants in the first United Nations
Conference on the Human Environment in Stockholm, Sweden produced a declaration containing 26
principles. Principle 19 of the Stockholm Declaration specifically called for “education in
environmental matters, for the younger generation as well as adults.” While environmental
education was finally gaining some attention at the global level, the United States effort was already
well underway.

HISTORY OF ENVIRONMENTAL EDUCATION IN THE UNITED STATES

In the 1970’s, Congress passed the National Environmental Policy Act and the National
Environmental Education Act aimed at encouraging environmental education within the public,
specifically within K-12 classrooms. In 1973, North Carolina passed its own Environmental
Education Act to encourage programs in our home state. It seemed that everyone was in agreement

that EE was a key to the future sustainability of our country. In an August 1970 address to Congress, President Nixon stated:

“It is also vital that our entire society develop a new understanding and a new awareness of man’s relation to his environment—what might be called “environmental literacy.” This will require the development and teaching of environmental concepts at every point in the education process.”

For a few decades, EE took off in schools throughout the state and the county, but due to a variety of factors, including the No Child Left Behind Act of 2001 (NCLB) and budget constraints, EE was never completely integrated into the K-12 curriculum. Today, while there are still many teachers that weave environmental elements into their classrooms, there is no formalized mechanism or guidelines for what to teach or how to track the success of their environmental lessons.

BENEFITS OF ENVIRONMENTAL EDUCATION

According to the North American Association of Environmental Education (NAAEE), “Environmental education (EE) teaches children and adults how to learn about and investigate their environment, and to make intelligent, informed decisions about how they can take care of it.” It can be taught in classrooms, in nature settings, in museums or nature parks, however the NAAEE believes that EE works best when it is taught in an organized sequence. In schools, EE often attempts to reflect state and national learning standards. Done right, EE not only leads to environmentally literate people, but also helps increase student academic achievement. Benefits from including environmental education in K-12 schools include:

Environmental education increases student engagement in science. Research has shown enormous benefits from environmental education. When integrated into a science curriculum, environmental education demonstrably improves student achievement in science.

Environmental education improves student achievement in core subject areas. When integrated into the core curricula or used as an integrating theme across the curriculum,

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4 NAAEE website, http://www.naee.net/what-is-ee, accessed 2/25/12
5 NAAEE website, http://www.naee.net/what-is-ee, accessed 2/25/12
environmental education has a measurably positive impact not only on student achievement in science, but also in reading, math, and social studies.\textsuperscript{7}

**Environmental education improves critical thinking and basic life skills.** The National Science Board of the National Science Foundation confirmed the importance of environmental education to student learning in their 2000 report, *Environmental Science and Engineering for the 21st Century*:

"The twin goals of learning are to acquire knowledge and gain skills such as problem solving, consensus building, information management, communication, and critical and creative thinking. Environmental issues offer excellent vehicles for developing and exercising many of these skills using a systems approach...changes should be made in the formal educational system to help all students, educators, and educational administrators learn about the environment, the economy, and social equity as they relate to all academic disciplines and their daily lives."\textsuperscript{8}

This research paper neither supports nor rejects the arguments made about the academic benefits of EE. Rather, we make an assumption that there are inherent benefits to teaching EE at all stages of one’s life and focus instead on the increased environmental literacy and critical thinking skills obtained by the students when EE is integrated into the K-12 curriculum.

**MATERIALS AND RESOURCES**

There are many educational materials available to teachers and school administrators that can be used to teach children about environmental education (see Appendix A for a comprehensive list of EE resources and materials). In fact, it could be argued that one barrier to integration into the existing curriculum is that there is too much information for teachers to sort through – they just do not have the knowledge and the time to find the resources that will work for them within the constraints of the standardized curriculum they are required to teach.

Since my work focused specifically on energy education, this paper relied primarily on educational material available from The National Energy Education Development Project (NEED), and government organizations such as the Department of Energy (DOE), the Energy Information Administration (EIA), and Energy Star, a joint program between the U.S. Environmental Protection Agency (EPA) and the DOE. In addition, hands-on activities from non-profit EE organizations like Project WET and Project Learning Tree were interwoven into the training modules.


\textsuperscript{8} National Environmental Education Advisory Council, Report to Congress, September 2000.
The materials available from NEED (need.org) are of particular interest to this study, not only for the breadth and scope of energy education resources and lesson plans available, but also because they provided a pre/post energy knowledge poll – an assessment tool that teachers can use to measure individual student performance and knowledge gain. In addition, the NEED materials are divided into specific age groups to encourage learning at different levels: Primary (K-2), Elementary (3-5), Intermediate (6-8), and Secondary (9-12). This makes it easier to adjust the content to a particular audience’s age and attention span.

While this report relied on many of the educational materials available from these sources, particularly from the NEED Elementary materials, they were each adapted to meet the needs of the 3rd grade classrooms at Leesville Elementary. In an effort to design a unique curriculum that focused on building awareness of current energy issues, incorporating hands-on activities, and encouraging critical skills thinking into the lessons, each module utilized pieces from many different resources as outlined in the next section.

EDUCATION MODULES

In 1996, the EPA set out a definition of environmental education that focused on developing an environmental awareness without engaging in advocacy:

“Environmental education enhances critical thinking, problem solving and effective decision-making skills. It also teaches individuals to weigh various sides of an environmental issue to make informed and responsible decisions. Environmental education does not advocate a particular viewpoint or course of action.”

With this definition in mind, each module was designed to be educational and thought provoking – to build awareness without advocating a particular agenda. Each module had specific learning objectives, hands-on activities, and opportunities for students to reflect on the information they were learning. In addition, although each of the modules were taught by me, a non-affiliated instructor within the public schools, the teachers were able to utilize pieces of the information into their standardized lesson plans as is evidenced by the anecdotal remarks made in post-module surveys provided by the teachers. The following is a summary of each module.

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PRE-ENERGY KNOWLEDGE POLLS

To assess the general knowledge of the students prior to teaching the modules, an online energy knowledge poll was prepared based on the poll provided by NEED for the Primary Level (grades 3-5)\textsuperscript{10}. The poll questions were adjusted based on an assessment of the students’ knowledge of the subject and the concepts that were planned for each module. Since the modules were intended to teach less about topics of energy (convection/conduction, gravity & friction, and details of electricity) and more about renewable and non-renewable energy sources, energy efficiency and water conservation, some of the questions that were provided in the NEED poll were omitted and new questions related to the module content were added. In addition, an open ended question about what the students were already doing to save energy at home was added to gauge their current level of understanding of energy efficiency and conservation.

A summary of the questions can be found below (* denotes questions that were changed from original poll). For each question, four possible answers were listed as well as an “I don't know” response to eliminate guessing. The original NEED poll can be found in Appendix B and the adjusted survey that was given to the students can be found in Appendix C.

1. Energy is needed to do which of the following?

2. Which of the following is a renewable resource? *

3. Where does most of the garbage in the US end up? *

4. When you turn on a lamp, the electricity changes into what forms of energy? *

5. Which of the following items can be recycled? *

6. Each day, an average person uses how many gallons of water? *

7. In the United States, which energy source produces most of our electricity?

8. Which energy source is made by the uneven heating of the earth's surface?

9. Which energy source is used in nuclear power plants?

10. Which energy source means heat from inside the earth?

\textsuperscript{10} The NEED Project, Pre/Post Energy Poll, \url{http://edu.need.org/}, accessed 9/19/11
11. Which energy source provides most of our transportation needs?

12. Why are some energy sources called renewable?

13. Electricity is the movement of...

14. Electricity travels in closed loops called...

15. How much of the water found on earth can be used for drinking? *

16. How is the amount of electricity you use at home measured?

17. Which task in the average home uses the most energy?

18. Which type of light bulb is the most energy efficient?

19. Which one of the following is NOT a fossil fuel? *

20. What is coal made from? *

21. Which of these human activities contributes the most to global warming? *

22. What percentage of energy used around the world comes from fossil fuels? *

23. What types of things do you do at home to save energy? (Open ended response) *

FIGURE 1 - SAMPLE QUESTIONS FROM ENERGY POLL
MODULE 1: ENERGY BASICS

Goals:

Understand the concept of “energy” – how it is used and where it comes from. Be able to recognize the different types of energy sources

Key Questions:

• What is energy?
• Why is energy important?
• What are the different energy sources?
• What is the difference between and renewable and non-renewable energy source?

Activities:

• Draw a picture of a favorite superhero - describe how he/she gets their power.
• Discuss visuals of the different types of energy sources found on earth. Short “What am I” game to review energy sources.

Resources:

Project Learning Tree Activity#39
Energy Kids (EIA) Energy Sources Lesson

Teacher Comments:

“We talk about different types of resources in social studies. This lesson is a great introduction to that!”

“I think the lesson is great for third grade, however the content doesn’t fit in our standard course of study. If I had all the time in the world I would definitely use the lesson, but because we’re always so pressed for time and have other objectives to teach, I don’t think I would be able to use it for future classes.”

MODULE 2: TYPES OF ENERGY SOURCES - NON-RENEWABLE

Goals:

Understand the concept of “non-renewable.”
Identify the different types of non-renewable energy sources. Discuss the advantages and disadvantages of non-renewable energy.

Key Questions:

• What does the term ‘non-renewable’ mean in regards to energy?
• What are the different types of non-renewable energy source?
• Where do these energy sources come from and how do we use them?
• Why does this matter to us?

Activities:

• Discussion of types of non-renewable resources.
• Overview of how coal/oil/natural gas is formed.
• Brief discussion of nuclear energy
• Hands-on Chocolate Chip Cookie “Mining” exercise and reflection on results.

Resources:

Chocolate Chip Cookie Mining Exercise (NEED)¹³

Teacher Comments:

“What a GREAT idea; cooking mining!!!”

“I would love to use it if it were part of third grade curriculum. Unfortunately, we have so much on our plates, it’s hard to fit in ‘extra’.”

¹³ The NEED Project, www.need.org, accessed 10/24/11
MODULE 3: TYPES OF ENERGY SOURCES - RENEWABLE

Goals:

Understand the concept of “renewable.” Be able to recognize the different types of renewable energy sources. Predict the difficulty in using renewable energy.

Key Questions:

• What is a renewable energy source?
• What are the five renewable energy sources?
• Where does renewable energy come from?
• What are some of the benefits of using renewable energy?
• Why does this matter to us and what can we do?

Activities:

• Overview of renewable energy types
• Solar race car activity (outside)
• Wind Turbine activity
• Reflections ... what is your favorite energy source?

Resources:

Hydropower Video
Wind Video

Teacher Comments:

“I loved the hair dryer/turbine activity. I wish it had been sunny for the solar cars because I know the students would have been thrilled about that!”

“I would love to use these lessons if they tied in to third grade curriculum. I think they are wonderful lessons and I think these are topics third graders benefit from.”

MODULE 4: ELECTRICITY BASICS

Goals:

Understand the concept of electricity, electrons, and circuits. Discuss the different uses of electricity and how it is created.

Key Questions:

- What is electricity?
- How do we use it?
- Where does it come from?
- What is an electron?
- How is a generator used to create electricity?
- What is the difference between an “open” and a “closed” circuit.

Activities:

- Electric Circuit Exercise (with Tootsie Rolls for Electrons)
- Use a model circuit to power a light bulb

Resources:

School House Rock Electricity Video 16
Electric Generator Video 17

Teacher Comments:

“Even though I don’t really cover electricity and circuits in class, the lesson still covered the different types of resources needed to create electricity.”

“I love that multiple learning styles are being taught to! Research says kinesthetic learning is most directly related to memory”

16 Schoolhouse Rock – Electricity Video via Youtube, http://youtu.be/3RzN7T5xpVc
This module was taught by a guest speaker – Mr. Charles Lamm, the Energy Management Coordinator at Nash - Rocky Mount Public School System. A self-described “building whisperer,” Mr. Lamm has played an integral role in helping 26 of the school system’s 27 school earn the Energy Star certification.

In his animated discussion with the students, Mr. Lamm introduced five “Energy Stars” – a unique band of super heros - to help the students learn about energy efficiency and saving energy at home and at school:

- “Bulby” – a CFL light bulb
- “Bubbles” – a washing machine with the Energy Star label
- Celine Fannagan – a ceiling fan that can help reduce energy bills
- Laptop Larry – a laptop that puts himself to sleep when he’s not in use
- Teley – a TV that puts himself into standby mode

After discussing the roles of these five super heros, Mr. Lamm challenged the children to go home and look for ways to save energy at home. Although this lesson did not have a hands-on component, the teachers felt that in future lessons, an activity could easily be integrated into it.

**Teacher Comments:**

“I think energy conservation is important and should be taught/discussed!”

“This can just be part of our daily classroom routine. Making sure lights and computers are off.”

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MODULE 6: ENERGY SLEUTHS I – SAVING ENERGY AT HOME

Goals:
Understand the concepts of energy efficiency and conservation. Know where to look for energy saving opportunities everywhere.

Key Questions:
- What is energy efficiency?
- Why is it important?
- What makes something energy efficient?
- What is conservation?
- How do we measure energy savings?
- How can we save energy at home and at school?

Activities:
- Saver or Waster?
- A Tale of Two Light Bulbs – CFL v. Incandescent hands-on activity
- What energy efficiency things can you do at home?

Teacher Comments:

“All of the energy saving methods you discussed are ways that we can be responsible citizens which is one of the main themes in third grade social studies.”

“I feel like the students were really excited when they found out that some of their families were already using energy saving bulbs. Lights are something that all of the students can relate to.”
The second of the two Energy Sleuths modules concentrated on a hands-on activity that required the students’ use of all the information acquired in previous lessons and provided them an opportunity to apply it to a real world scenario – their school’s energy use. Armed with their environmental notebooks, the students completed a 20 minute tour of the building and grounds, noting areas of improvement and making recommendations along the way. During the tour, one student was overheard to tell a teacher that one of her light bulbs was incandescent and recommended she replace it with a CFL. Other students turned off lights in classrooms that were not in use.

Upon completion of the tour of the school, the students were asked to reflect on what they found and make one recommendation for a change that they would implement at Leesville Elementary. Responses varied, but all students recommended at least one of the following energy conservation strategies:

- Turn off lights in classrooms that are not in use.
- Turn off computers, smartboards, powerstrips, and TVs that are not in use.
- Replace incandescent light bulbs with more energy efficient CFLs.

Some students took their recommendations even further and suggested that solar panels be placed on the roof of the school to cut down on energy use and save the school money. When asked how they would pay for the solar panels, the students suggested Box Tops, Coupons and the sale of non-Energy Star appliances.

**Teacher Comments:**

“This was a great lesson because it allowed students to take ownership of their school! I heard several students in my group giving teachers advice after we walked through their rooms.”

“They LOVED going around the school and finding ways we could conserve and be more efficient in terms of energy.”

“It was so fun to hear the students using what they had learned as they were “sleuthing.” I heard things like: “It’s so sunny out, we could put solar panels on the roof!” “Mrs. ____ has incandescent bulbs, she needs to switch those!”
MODULE 8: WATER CONSERVATION

The final module was taught by one of the 3rd grade teachers. With a background in environmental education, she was eager to share a variation of Project WET’s “Drop in the Bucket” exercise with the classes. The objective of the lesson was to teach the students that although fresh water is a renewable resource, the amount available for human consumption is very small compared to the amount of water on earth. The students participated in a hands-on activity where the amount of water in a container was gradually taken away until only a small fraction (.00003%) was left for human consumption. The students learned that not all water can be consumed by humans and that they must think about their water use and encourage water conservation.

POST-ENERGY KNOWLEDGE POLL

In the final meeting, the students were asked to take the same computer-based Energy Knowledge Poll they were given at the onset of the lessons. No review or summary was given to the students prior to the poll and in some instances it had been over four months since the students had learned the information. With few exceptions, the students improved their overall scores as summarized in the following section.

19 Project WET Curriculum and Guide 2.0, 2011, p. 257
RESULTS AND OBSERVATIONS

The intention of this study is to report not only on the tangible knowledge obtained during the energy education modules, but also to analyze the behavior changes and critical thinking skills demonstrated by the students. Therefore the analysis of results and the accompanying observations will look at four elements of the teaching process:

1. A review of the pre/post NEED energy polls to determine if the students increased their knowledge of specific energy education concepts.
2. An analysis of how the students incorporated their new knowledge into other areas of study and applied it to real world situations.
3. Discussions with teachers and their observations of what the students have gained from the modules.
4. A look at behavioral changes of the students and an investigation into what they have done with the information they have learned.

All four sections of the analysis will investigate whether the students have an increased environmental literacy and whether they have become better prepared to tackle the environmental challenges of tomorrow.

STUDENT ENERGY POLL RESULTS

Standardized polls are useful in determining the knowledge gained by students during a course of study, but do not always tell the complete story of what a child is actually learning along the way. Because of this, the adjusted NEED Energy Knowledge Poll utilized in this study was not intended to grade a student on what they learned from the modules. It was utilized as a tool for understanding the students’ energy knowledge before and after the education modules. To this end, it was successful in demonstrating that the students were able to learn many of the key elements of energy education, particularly concepts about renewable energy sources and energy efficiency and conservation strategies. A summary of the pre/post responses can be found on the next page in Figure 2.
FIGURE 2 - COMPARISON OF PRE- AND POST-ENERGY KNOWLEDGE POLL RESULTS
As this graph indicates, the number of correct responses increased for almost every question. However it should be noted that individual student responses to many of the poll questions were difficult to measure as some of the students who had originally gotten an answer correct, switched their answer to an incorrect answer in the post-poll. This may have been because they had originally been guessing at the answer or the length of time between the module and the post-poll was too long for them to retain the specific answer. Overall, however, the number of correct responses increased by 52% and each module experienced similar improvement in scores as can be seen in Figure 3 below. This indicates an enhanced knowledge and understanding about energy, energy resources and energy efficiency.

FIGURE 3 - SUMMARY OF ENERGY POLL RESPONSES
STUDENT ANECDOTAL RESULTS

Perhaps more important than the poll results were the student responses to the open ended question *What types of things do you do at home to save energy?* While responses from the pre-poll revealed mostly recycling and water conservation activities, the responses from the post-poll revealed a much deeper level of understanding about energy efficiency and conservation:

"Turn off lights when not in use." (28 students)
"Get CFL bulbs." (4 students)
"Turn off TVs." (5 students)
"Take shorter showers / turn off water" (7 students)
"Turn the computer on sleep mode when not using it." (1 student)
"Keep doors closed." (1 student)

While there is no way of knowing if the students actually changed their behaviors at home, these results indicate that the students are taking their increased environmental knowledge and applying it to a real world situation – energy use in the home. They are making their own decisions about which elements of their increased environmental literacy they will use in their own lives to become better environmental stewards.

TEACHER DISCUSSION AND OBSERVATIONS

While the North Carolina Standard Course of Study does not currently include an environmental education component, it does promote "Science as Inquiry" with a goal that "Students experience science in a way that engages them in active building of ideas and explanations, and gives them more opportunities to develop the ability to do science." It is this inquiry perspective that the Leesville Elementary 3rd grade teachers most appreciated in the energy education modules. In the feedback they provided following each module, they rated the modules as "Excellent or Good" even if the content did not directly apply to the topics they were required to teach to the class. In fact, the most commonly cited benefit of each module was the hands-on activities that the students experienced within each module. They observed that the students were engaged with the material and were impressed by the students' ability to apply their knowledge to real world situations.

20 North Carolina Standard Course of Study, Grade Three Sciences, 2004
In order to assess whether the teachers would be able to teach the modules in future classes or use pieces of the content in other lessons, two questions were asked after each module. The following graphs indicate that while the teachers overwhelmingly felt comfortable weaving the material into existing lessons (such as social studies or science), they were less comfortable teaching the modules themselves in future years. One teacher summarized this sentiment well: “I think the lesson is great for third grade, however the content doesn't fit in our standard course of study. If I had all the time in the world I would definitely use the lesson, but because we’re always so pressed for time and have other objectives to teach, I don't think I would be able to use it for future classes.”

![Graphs showing teacher responses to post-module survey](image)

**FIGURE 4 - TEACHER RESPONSES TO POST-MODULE SURVEY**

In a wrap-up discussion following the final module, the teachers reflected on the elements they found most useful from the energy education curriculum and offered a few suggestions for enhancements to the training for future classes:

**Importance of introducing Environmental Education at all levels** – Both teachers agreed that although the current curriculum does not include specific requirements for environmental education, the concepts and vocabulary should be introduced starting in kindergarten and continuing through high school. This should be done gradually and reinforced each year to build knowledge and environmental awareness over time. One goal of teachers at all levels is to ensure that when students graduate high school, they are “college and career ready.” The teachers in this study agreed that awareness of environmental issues, particularly as they relate to energy, will help to prepare the students for when they enter the real world.
**Modules should be hands-on and inquiry based** – The teachers liked all the hands-on activities utilized in the modules and stressed the importance of incorporating the inquiry process into the students’ learning. Kids learn best when they can be involved with the lesson, predict what will happen and write down their results/conclusions. This enables them to become long term critical thinkers and problem solvers.

**Pre/Post tests were important, but shouldn’t be the only criteria to consider** – The teachers were surprised and impressed by how much the students learned, but advised that their scores on the post-test may not be entirely indicative of how much they actually learned. Most of the positive results observed by the teachers seemed to come from the hands-on and experimental activities. They also noted that the questions on the energy knowledge polls were on the difficult side – particularly for 3rd graders. They agreed that the pre/post tests should still be administered during the training, but the questions should be a bit easier and the language used on the tests should be used repeatedly during the modules to ensure student awareness of the important concepts.

**The students loved the Energy Sleuths modules** – It was within these modules that they were able to apply their new knowledge to real world situations. The students became the energy efficiency experts in the school and they enjoyed telling teachers to turn off their lights and pointing out incandescent light bulbs in the classrooms.

**The teachers would welcome the energy education training in the future, but would prefer it to be “guest speakers.”** Kids love to have new faces in the classroom and seem to have an increased appreciation of new material if it is taught by a guest speaker. In addition, the teachers in this study felt that if the energy education modules were to be taught by teachers, they guessed that 50% of the teachers would be able to teach the material if given in self-sustaining modules. However, the other 50% of the teachers would think it was “just one more thing” they have to try to accomplish during an already busy day or wouldn't feel they had sufficient knowledge of the subject to teach it. The teachers in the study advised that all teachers would love to have someone else come teach. In fact, they love the idea of having university students come into the classrooms to teach the modules every two weeks for 40-45 minutes.

In summary, the teachers were impressed by how much the children learned during the energy education classes and felt it was valuable information for all students to have at every level of their
education. However, due to time constraints and the requirements of the existing NC Standard Course of Study, they were not confident that teachers would be able to incorporate the additional modules into their course plans and instead recommended that the modules be standardized and taught by guest speakers trained in environmental sciences. This idea will be further discussed in the recommendations section.

ENERGY SLEUTHS – APPLYING KNOWLEDGE TO REAL WORLD SITUATIONS

The final measure of environmental literacy provided by the energy education modules was perhaps the most fun for the students, the teachers and for me, the instructor. After touring the school looking for energy efficiency and conservation opportunities, the students were asked to pick one recommendation that they would implement to save the school money. Their responses were inspiring and clearly indicated that they had indeed increased their awareness of environmental issues and recognized changes that needed to occur. Here is a sample of their recommendations. A video summary can be found at [http://youtu.be/JTT2p5gjjes](http://youtu.be/JTT2p5gjjes).

**What recommendation would you make to help Leesville Elementary save energy?**

- "We can save the school energy by turning off the computers." – Alex
- "I think the school can save money by turning off the lights." – Cedric
- "I think we save energy by turning off power strips when we aren't using them." – Loren
- "I think the school could save money and energy by turning off the smartboards." – Cate
- "I think the school could save money by using CFL lights." – Kennedy
- "Leesville should make a rule to turn off electronics when you are not using them." - Hailey

These students were able to identify the easy and inexpensive changes that could be made at their school to save energy and money. But some students took it one step further. A few students even thought through how to pay for their recommendations:
“The school could save money by turning off the lights when not in use and putting solar panels on the roof. We could pay for the solar panels by collecting Box Tops.” – Baylor

“*My biggest change is that I think Leesville should get solar panels. To get those panels, we could have a school sale, cut coupons, buy stuff and sell it. We could also maybe sell our non-Energy Star appliances and get even more money to buy Energy Star appliances. Well, what do you think?*” - Reagan

Clearly, the hands-on activities and inquiry-based modules have helped these students to increase their environmental literacy and make wise choices for the future. With sustained reinforcement, they will continue to be actively involved in energy decisions both at school, at home and well into their future careers.

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21 Box Tops for Education is a fundraising program sponsored by General Mills. Schools receive $0.10 for each Box Top collected. [http://www.boxtops4education.com/](http://www.boxtops4education.com/)
DISCUSSION

Based on the results and observations from the previous section, it is clear that the energy education program was successful in increasing the students’ environmental knowledge and awareness. The students gained an enriched knowledge of different types of energy sources and were able to identify changes that could be made to help their school and home save energy. Unfortunately, teacher feedback revealed a number of potential barriers to implementing an Energy Education on a larger scale. These barriers include a lack of environmental knowledge, a lack of time, and a lack of integration with the North Carolina Standard Course of Study.

In the following sections, I will identify areas of improvement for the program and offer recommendations for how to expand the program to all grade levels. With a consistent energy education program from kindergarten through high school, our young children will grow up with an environmental awareness that will help solve the global environmental issues of tomorrow.

IMPROVEMENTS TO THE ENERGY KNOWLEDGE POLL

As part of my attempt to measure the increased environmental literacy of the students, I used an Energy Knowledge poll provided by the National Energy Education Development program (NEED). While the poll was designed for grades 3-5, I found many of the questions to be difficult for this age group and not related to what the Energy Education modules were attempting to teach. However, in analyzing the results from the final poll, I realized that the students did improve their scores, indicating that they did increase their overall knowledge of the subject.

For future module development, I would recommend an Energy Poll that focuses specifically on the concepts being taught in each grade level. While I do not think that the poll by itself should be a comprehensive measure of the success of the program or the students’ improvements in environmental literacy, I think it is a valuable tool for assessing the knowledge gained by individual students.
TEACH THE TEACHERS OR TEACH THE KIDS?

Originally, the intent of this study was to develop a set of lessons that the teachers could use to teach future classes – a "teach the teacher" approach to education. However, it quickly became clear from teacher feedback that a "teach the kids" approach would be more appropriate in the short term. This is for two reasons:

1. **Many teachers do not have the knowledge to teach environmental subjects** – Of the two teachers involved in this study, one had previously taken environmental classes and the other had not. This provided each with a different comfort level for teaching the subject in future classes. Since an environmental education certificate is not currently a requirement for teachers, asking teachers to teach a subject with which they are unfamiliar would be a huge barrier to successfully implementing an energy education program like the one outlined in this study.

2. **Energy education does not currently fit into the existing curriculum** - With the exception of some high school environmental sciences classes, the North Carolina Standard Course of Study does not specifically include environmental topics in any of its grade levels or strands. Therefore the teachers today feel they do not have the time to include additional topics into their lesson plans. This issue is currently being addressed in North Carolina through the development of an Environmental Literacy Plan for K-12. This plan will be discussed in more detail in the next section.

INTEGRATION OF EE INTO THE EXISTING CURRICULUM

In 1995, the North Carolina Office of Environmental Education developed an Environmental Education Plan designed to integrate environmental education into North Carolina's state curriculum standards. In 1997, the State Board of Education approved a change in graduation requirements for North Carolina students to include one unit of earth/environmental science.\(^{22}\) While this is a step in the right direction towards fostering environmental literacy in the students and preparing them to tackle the environmental issues of today, North Carolina does not have a comprehensive environmental education curriculum guide for all grade levels.

\(^{22}\) The North Carolina Environmental Education Plan, 3rd edition, NC Office of Environmental Education, 2010
In December, 2010, a draft of a North Carolina Environmental Literacy Plan was jointly developed between the N.C. Departments of Public Instruction (DPI) and the N.C. Department of Environment and Natural Resources (DENR). This plan was initiated in 2009 after the No Child Left Inside Act\textsuperscript{23} was introduced in congress in April 2009. The act never became law, but North Carolina moved forward with a plan to support the Act's intended goal of introducing environmental education into elementary and primary schools. The plan has not yet been approved (a final draft was distributed for review in April 2012), however the draft plan outlines the components that would be necessary to create a comprehensive environmental literacy plan for North Carolina. The plan has three main objectives:\textsuperscript{24}

1. Show how the state's PreK-12 educational system will prepare students to understand, analyze, and address major environmental challenges facing the state and nation.

2. Provide field experiences as part of the regular school curriculum and create programs that contribute to healthy lifestyles through outdoor recreation and sound nutrition.

3. Create opportunities for enhanced and ongoing professional development for teachers that improve their environmental knowledge and skills in teaching students about environmental issues, including the use of interdisciplinary, field-based and research-based learning as well as innovative technology in the classroom.

The NC Environmental Literacy Plan outlines a number of strategies for achieving these objectives, including assisting teachers with earning an Environmental Education Certificate and encouraging the use of outside resources such as Project Wet, Project Wild and Project Learning Tree within the classroom. The plan stresses a point made earlier in this report that teachers are already pushing the boundaries of what they can teach:

"The intent of the literacy plan is not to add to the workload of our state's teachers and administrators but to provide a framework to support the integration of environmental literacy into the required curriculum and to support schools and teachers who are using the environment to engage students and increase student, teacher and institution STEM achievement."\textsuperscript{25}

\textsuperscript{23} S. 866, H.R. 2054: No Child Left Inside Act of 2009, 111\textsuperscript{th} Congress: 2009-2010.

\textsuperscript{24} North Carolina's Environmental Literacy Plan (Draft), April 2012, p.7.

\textsuperscript{25} Ibid, p.5.
The work done in this report reaffirms and validates the importance of environmental literacy for K-12 students and can provide one piece of the puzzle for North Carolina's revised Environmental Literacy Plan. The following section provides recommendations for how to integrate the energy education piece into the literacy plan and suggests a strategy for how to eventually weave it into the North Carolina Standard Course of Study.

RECOMMENDATIONS

The results of this study have shown two things: 1) even at a young age, students can become engaged in environmental issues and have the aptitude to increase their environmental literacy; and 2) teachers acknowledge the value of energy education, but feel they do not have the time or, in some cases, the knowledge to teach it to their students. Without a state mandated requirement to integrate it into their core curriculum, environmental education will continue to be taught on an “ad-hoc” basis by the teachers with a passion or knowledge of environmental issues. In the end, this is detrimental not only to the students, but to the global community as well. We might be missing out on helping to develop the skills of the next environmental entrepreneur - one who might discover a way to put solar panels on a school by saving Box Tops or cutting coupons.

Although this study only involved two third grade classes at one local elementary school, its success can be extended to a broader audience using two strategies. In the short term, lessons could be developed and taught by a group of environmental studies students or recent graduates that participate as guest speakers in classes similar to the method used in this report. In the long term, the lessons should be integrated into the North Carolina Standard Course of Study as proposed in the Environmental Literacy Plan. What follows are my recommendations for implementing both strategies.

ENERGY AMBASSADOR PROGRAM

Students studying Environmental Sciences at college and universities throughout North Carolina have a passion and knowledge of environmental issues. Often, they are looking for ways to share this knowledge and help others increase their own environmental literacy. This provides a perfect complement to the immediate need in the K-12 system for knowledgeable guest speakers to teach about energy and other environmental concepts. I propose an Energy Ambassador Program to match the two groups together. It is designed to work similar to Ameri-corps or Teach for America
where university students or recent graduates sign up to work with K-12 kids for a period of one to two years. The concept would work something like this:

- A set of standardized lesson plans and energy polls would be developed for each grade level for consistency in the education the students are receiving.
- University students would either receive class credit or a small stipend to provide lessons to local schools for 45 minutes every two weeks.
- University students would be matched with local schools based on geographic proximity.
- Funding for the program would come in the form of grants either from the universities themselves, the Environmental Education Trust Fund, utilities like Progress Energy, or other foundations.

The Energy Ambassador program is designed to be a short term solution to teaching energy and environmental education in K-12 schools. It is intended to give university students experience in discussing the concepts and offer K-12 schools the opportunity to enhance the environmental literacy of their students without placing a burden on the teachers. In the long term, however, environmental education can and should be integrated into the Standard Course of Study. The next section discusses one example of how this integration might take shape.

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**PROPOSED INTEGRATION INTO NC STANDARD COURSE OF STUDY**

In the 2012-2013 school year, North Carolina will adopt a new Standard Course of Study for its K-12 curriculum. This will include the incorporation of national Common Core State Standards and Essential Standards. Based on the new standards for the Science curriculum (a summary can be found in Appendix D), I propose that the following energy education concepts be woven into each grade level curriculum. This can be done initially through the Energy Ambassador program and then eventually, through teacher education and certification, become part of the Standard Course of Study for all grade levels.

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The approach outlined above will give each grade level the opportunity to focus on a specific energy topic and each year they will grow and enhance their environmental literacy with new concepts and hands-on inquiries. At this time, lessons will not be developed for high school students as there are currently several offerings available to them to expand their environmental knowledge. However, consideration could be made to including high school juniors or seniors with a passion for environmental literacy to be included in the Energy Ambassador Program and teach younger students as part of their classwork.

### CONCLUSION

Young students have an amazing capacity to learn new subjects and are eager to use their developing critical thinking skills to solve complex issues. This can be of great value to the growing need to improve environmental literacy in the United States to help overcome the uncertainty that surrounds the environmental issues that we globally face. There has been a consistent call within environmental scholarship across cultures to “promote young people’s competencies for critically
analyzing and reflecting on situations, living conditions and values, and for developing a multi-
perspective understanding of the complexity of these issues.”

This case study has demonstrated that even at the 3rd grade level, students are willing and eager to
learn more about their environment – specifically about energy resources and
efficiency/conservation. They are prepared to become environmental stewards and to help solve
the environmental issues of today and tomorrow if they are armed with the information and the
opportunities to use them. When expanded across all grade levels, imagine the growth in
environmental literacy that can be fostered with minimal effort and training.

Despite the fact that environmental education has not yet been woven into the existing North
Carolina Standard Course of Study, there are opportunities to increase environmental awareness
today through the use of guest speakers, after school programs and extracurricular activities like
trips to environmental education centers. An Energy Ambassador Program such as the one
outlined in this paper is a way to begin the integration with the NC curriculum – one that can be
woven into the Core Standards over time. This will give the teachers and the administration the
time they need to develop skills and standards for the curriculum as is being recommended in the
North Carolina Environmental Literacy Plan.

Environmental literacy is a life-long journey. In order to address the growing complexity of the
environmental issues we face at the global, regional, and local levels, we need to implement
environmental education into the school systems today. The children are ready. The teachers are
ready. The time is now.

Kyburz-Graber, R., Hofer, K., & Wolfensberger, B. Studies on a socio-ecological approach to environmental
education: a contribution to a critical position in the education for sustainable development discourse. In:
Environmental Education Research, 12 (1) 2006, p. 104
This is a non-exhaustive list of energy curricula and teaching materials available online for elementary, middle school, and high school students, in alphabetical order by the producing agency’s name.

- **4-H Group Environmental Science Curriculum**
- **California Energy Commission** – [Energy Quest](#)
- **Educators for the Environment** - [Energy for Keeps](#).
- **Energy Star Kids**
- **Energy Works Michigan**
- **GreenLearning Canada**
- **Idaho National Laboratory** - [Energy for Educators](#)
- **KidWind Project**
- **National Energy Education Development Project (NEED)**
- **National Environmental Education Week**
- **National Renewable Energy Laboratory (NREL)**
- **NEO K12**
- **Progress Energy** – [eSmart Kids](#)
- **Project Learning Tree**
- **Project WET**
- **Project WILD**
- **PSNC Energy** – [Conservation Education Programs](#)
- **Texas State Energy Conservation Office** - [Renewable Energy lesson plans](#)
- **U.S. Department of Energy (DOE)** - [EERE's Energy Education and Workforce Development](#)
- **U.S. Environmental Protection Agency (EPA)** – [Environmental Education](#)
APPENDIX B – ORIGINAL NEED ENERGY POLL (GRADES 3-5)

The following questions are from the Primary (Grades 3-5) Energy Knowledge Poll found on the NEED Project’s website ([http://edu.need.org/](http://edu.need.org/)). Unless it is noted, the question was used in the adjusted poll in Appendix C.

1. Energy is needed to do which of the following?
   A. make things move
   B. make things grow
   C. make heat and light
   D. all of the above

2. Newton’s Law of Motion states that an object in motion stays in motion unless a force changes its motion. If you kick a ball, what force makes the ball stop? (Not used in Adjusted Poll)
   A. gravity
   B. friction
   C. both gravity and friction
   D. neither gravity nor friction

3. When you place a metal spoon in a pot of boiling water, the handle of the spoon becomes very hot even though it isn’t touching the water. What kind of heat transfer is taking place? (Not used in Adjusted Poll)
   A. conduction
   B. convection
   C. radiation
   D. all of the above

4. When you turn on a lamp, the electricity changes into what forms of energy?
   A. heat and light
   B. sound and light
   C. electrical and light
   D. heat and electrical

5. Which of the following increases friction? (Not used in Adjusted Poll)
   A. freezing rain on a road
   B. wax on skis
   C. air blowing up on an air hockey table
   D. rubber soles on shoes
6. Why do most apples appear red to us? (Not used in Adjusted Poll)

   A. Red apples absorb the color red and reflect other colors.
   B. Red apples reflect the color red and absorb the other colors.
   C. Red apples reflect ultraviolet radiation.
   D. Red apples absorb infrared radiation.

7. In the United States, which energy source produces most of our electricity?

   A. solar
   B. natural gas
   C. petroleum
   D. coal

8. Which energy source is made by the uneven heating of the earth’s surface?

   A. wind
   B. hydropower
   C. geothermal
   D. solar

9. Which energy source is used in nuclear power plants?

   A. petroleum
   B. propane
   C. uranium
   D. biomass

10. Which energy source means heat from inside the earth?

    A. hydropower
    B. geothermal
    C. coal
    D. natural gas

11. Which energy source provides most of our transportation needs?

    A. solar
    B. petroleum
    C. biomass
    D. coal

12. Why are some energy sources called renewable?

    A. They are clean and free to use
    B. They take a long time to be remade by nature
    C. They do not produce pollution
    D. They can be remade by nature in a short time
13. Electricity is the movement of...
   A. neutrons
   B. protons
   C. electrons
   D. molecules

14. Electricity travels in closed loops called...
   A. transformers
   B. circuits
   C. shells
   D. generators

15. Generators have which of the following parts? (Not used in Adjusted Poll)
   A. magnets and transformers
   B. magnets and coils of copper wire
   C. transformers and coils of copper wire
   D. transformers and reactors

16. How is the amount of electricity you use at home measured?
   A. ampere
   B. volt
   C. kilowatt-hour
   D. watt

17. In which picture will the light bulb light? (Not used in Adjusted Poll)

   A. A
   B. B
   C. C
   D. D
18. What is the reading on the natural gas meter dials pictured below? (Not used in Adjusted Poll)

A. 7011 ccf
B. 6010 ccf
C. 6111 ccf
D. 6000 ccf

19. Which task in the average home uses the most energy?

A. lighting
B. keeping food cold
C. washing and drying clothes
D. heating and cooling rooms

20. Which type of light bulb is the most energy efficient?

A. incandescent
B. compact fluorescent
C. halogen
D. all light bulbs are the same
1. Energy is needed to do which of the following?

   A. make things move  
   B. make things grow  
   C. make heat and light  
   D. all of the above  
   E. I don't know  

2. Which of the following is a renewable resource? *(New Question)*

   A. oil  
   B. gas  
   C. trees  
   D. coal  
   E. I don't know  

3. Where does most of the garbage in the US end up? *(New Question)*

   A. oceans  
   B. burned for fuel  
   C. recycling center  
   D. landfill  
   E. I don't know  

4. When you turn on a lamp, the electricity changes into what forms of energy?

   A. heat and light  
   B. sound and light  
   C. electrical and light  
   D. heat and electrical  
   E. I don't know  

5. Which of the following items can be recycled? *(New Question)*

   A. batteries  
   B. clothes  
   C. soda cans  
   D. All of the above  
   E. I don't know  

6. Each day, an average person uses how many gallons of water? *(New Question)*

   A. 1 gallon  
   B. 7 gallons  
   C. 70 gallons  
   D. 700 gallons  
   E. I don't know
7. In the United States, which energy source produces most of our electricity?
   A. solar  
   B. natural gas  
   C. petroleum  
   D. coal  
   E. I don't know

8. Which energy source is made by the uneven heating of the earth's surface?
   A. wind  
   B. hydropower  
   C. geothermal  
   D. solar  
   E. I don't know

9. Which energy source is used in nuclear power plants?
   A. petroleum  
   B. propane  
   C. uranium  
   D. biomass  
   E. I don't know

10. Which energy source means heat from inside the earth?
    A. hydropower  
    B. geothermal  
    C. coal  
    D. natural gas  
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13. Electricity is the movement of...
   A. neutrons
   B. protons
   C. electrons
   D. molecules
   E. I don't know

14. Electricity travels in closed loops called...
   A. transformers
   B. circuits
   C. shells
   D. generators
   E. I don't know

15. How much of the water found on earth can be used for drinking? *(New Question)*
   A. Less than 1%
   B. 10%
   C. 50%
   D. 100% (all of it)
   E. I don't know

16. How is the amount of electricity you use at home measured?
   A. ampere
   B. volt
   C. kilowatt-hour
   D. watt
   E. I don't know

17. Which task in the average home uses the most energy?
   A. lighting
   B. keeping food cold
   C. washing and drying clothes
   D. heating and cooling rooms
   E. I don't know

18. Which type of light bulb is the most energy efficient?
   A. incandescent
   B. compact fluorescent
   C. halogen
   D. all light bulbs are the same
   E. I don't know
19. Which one of the following is NOT a fossil fuel? (New Question)
   A. Oil
   B. Trees
   C. Coal
   D. Gas
   E. I don't know

20. What is coal made from? (New Question)
   A. Dead plants
   B. Dinosaur fossils
   C. A whole bunch of chemicals mixed together by scientists
   D. Burnt wood
   E. I don't know

21. Which of these human activities contributes the most to global warming? (New Question)
   A. Riding scooters
   B. Cutting down trees
   C. Using fossil fuels for energy
   D. Fireworks
   E. I don't know

22. What percentage of energy used around the world comes from fossil fuels? (New Question)
   A. 10%
   B. 50%
   C. 90%
   D. 99%
   E. I don't know

23. What types of things do you do at home to save energy? (Open ended response) (New Question)
<table>
<thead>
<tr>
<th>Grade</th>
<th>Physical Sciences Strand</th>
<th>Earth Science Strand</th>
<th>Life Science Strand</th>
<th>Proposed Energy Education Supplement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kindergarten</td>
<td>Understand the positions and motions of objects.</td>
<td>Understand change and observable pattern of weather that occur from day to day and throughout the year.</td>
<td>Compare characteristics of animals that make them alike and different from other animals and non-living things.</td>
<td>Energy Basics – what is energy?</td>
</tr>
<tr>
<td>Grade 1</td>
<td>Understand how forces (pushes or pulls) affect the motion of an object.</td>
<td>Recognize the features and patterns of the earth/moon/sun system as observed from Earth.</td>
<td>Understand characteristics of various environments and behaviors of humans that enable plants and animals to survive.</td>
<td>Introduction to renewable energy (sun, wind, water)</td>
</tr>
<tr>
<td></td>
<td>Understand properties of solids and liquids and the changes they undergo.</td>
<td>Understand the physical properties of Earth materials that make them useful in different ways.</td>
<td>Summarize the needs of living organisms for energy and growth.</td>
<td>Recycling Programs</td>
</tr>
<tr>
<td>Grade 2</td>
<td>Understand the relationship between sound and vibrating objects.</td>
<td>Understand the patterns of weather and factors that affect weather.</td>
<td>Understand animal life cycles.</td>
<td>Introduction to non-renewable energy (coal, oil, natural gas, nuclear)</td>
</tr>
<tr>
<td></td>
<td>Understand properties of solids and liquids and the changes they undergo.</td>
<td></td>
<td>Remember that organisms differ from or are similar to their parents based on the characteristics of the organism.</td>
<td>Water Conservation</td>
</tr>
<tr>
<td>Grade 3</td>
<td>Understand motion and the factors that affect motion.</td>
<td>Recognize the major components and patterns observed in the earth/moon/sun system.</td>
<td>Understand human body systems and how they are essential for life: protection, movement, and support.</td>
<td>In-depth study of renewable and non-renewable energy sources.</td>
</tr>
<tr>
<td></td>
<td>Understand the structure and properties of matter before and after they undergo a change.</td>
<td>Compare the structures of the Earth's surface using models or three-dimensional diagrams.</td>
<td>Understand how plants survive in the classroom.</td>
<td></td>
</tr>
</tbody>
</table>
| Grade 4 | Explain how various forces affect the motion of an object.  
Understand the composition and properties of matter before and after they undergo a change or interaction.  
Recognize that energy takes various forms that may be grouped based on their interaction with matter. | Explain the causes of day and night and phases of the moon.  
Understand the use of fossils and changes in the earth as evidence of the history of Earth and its changing life forms. | Explain the effects of environmental changes, adaptations and behaviors that enable animals (including humans) to survive in changing habitats.  
Understand food and benefits of vitamins, minerals and exercise | Electricity Basics  
Energy Efficiency & Conservation |
| Grade 5 | Understand force, motion and the relationship between them.  
Understand the interaction of matter and energy and the changes that occur.  
Explain how the properties of some materials change as a result of heating and cooling. | Understand weather patterns and phenomena, making connections to the weather in a particular place and time. | Understand how structures and systems of organisms (to include the human body) perform functions necessary for life.  
Understand the interdependence of plants and animals with their ecosystems.  
Understand why organisms differ from or are similar to their parents based on the characteristics of the organism. | Agricultural topics – organic/local farming  
Water Quality & Conservation  
Establish a school garden |
| Grade 6 | Understand the properties of waves and wavelike property of energy in earthquakes, light and sound.  
Understand the structure, classifications and physical properties of matter.  
Understand the characteristics of energy transfer and interaction of matter and energy. | Understand the earth/moon/sun system, and the properties, structures and predictable motions of celestial bodies in the Universe.  
Understand the structure of the earth and how interactions of constructive and destructive forces have resulted in changes in the surface of the earth over time and the effects of the lithosphere on humans. | Understand the structures, processes and behaviors of plants that enable them to survive and reproduce.  
Understand the flow of energy through ecosystems and the responses of populations to the biotic and abiotic factors in their environment. | Introduction to Global Climate Change |
| Grade 7 | Understand motion, the effects of forces on motion and the graphical representation of motion. Understand the forms of energy, energy transfer, and transformation and conservation in mechanical systems. | Understand how the cycling of matter (water and gases) in and out of the atmosphere relates to Earth's atmosphere, weather and climate and the effects of the atmosphere on humans. | Understand the processes, structures and functions of living organisms that enable them to survive, reproduce and carry out the basic functions of life. Understand the relationship of the mechanisms of cellular reproduction, patterns of inheritance and external factors to potential variation among offspring. | In depth study of global climate change. |
| Grade 8 | Understand the properties of matter and changes that occur when matter interacts in a closed system. Explain the environmental implications associated with the various methods of obtaining, managing and using energy systems. | Understand the hydrosphere and the impact of humans on local systems and the effects of the hydrosphere on humans. | Understand the hazards caused by agents of diseases that affect living organisms. Understand how biotechnology is used to affect living organisms. Understand how organisms interact with and respond to the biotic and abiotic components of their environment. Understand the evolution of organisms and landforms based on evidence, theories and processes that impact the earth over time. Understand the composition of various substances as it relates to their ability to serve as a source of energy and building materials for growth and the repair of organisms. | Concepts of Sustainability Product Life Cycle Analysis |

Source: Science Essential Standards Worksheet, given to me by Jill Cannizzo, Leesville Elementary 3rd Grade teacher, Jan 24, 2012.