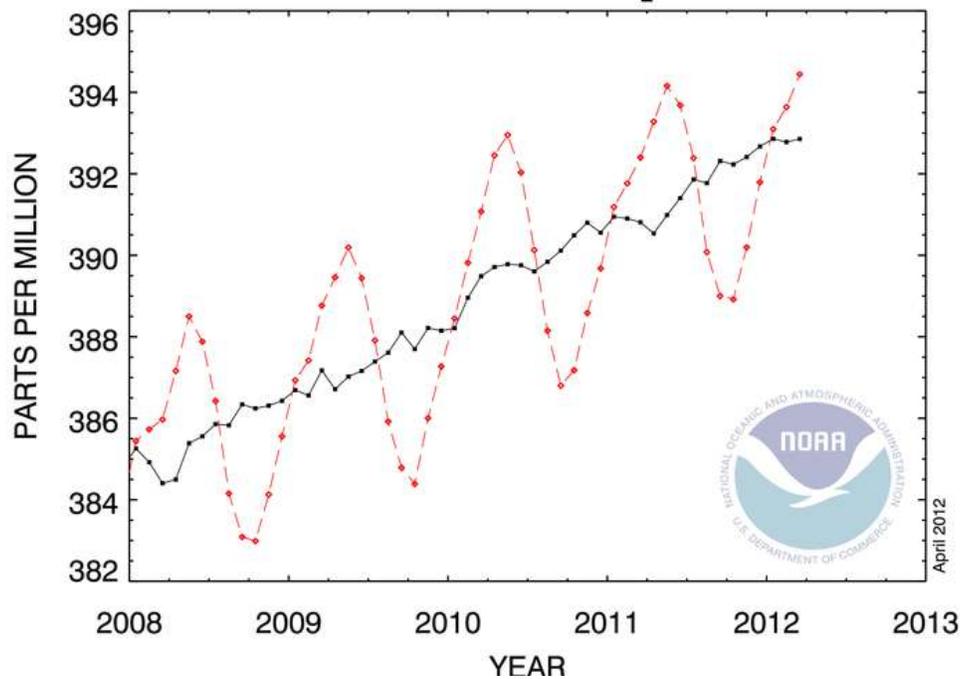


# Energy and Climate Change



## Links to our Past, Present and Future



Understanding energy and its connection to climate change



How much energy does the United States consume? Are our natural resources able to keep up the pace? What are the environmental impacts associated with renewable and nonrenewable energy technologies? What are my choices? Are their solutions? Can I take action and make a difference? Find out in Energy and Climate Change: Links to our Past, Present and Future.



Energy and Climate Change  
Links to our Past, Present, and Future

***Special thanks to those who worked to make this opportunity possible.***

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## I. Eco-Schools USA Energy and Climate Change Overview

### Eco-Schools USA

A part of an international family, Eco-Schools is found in over 50 countries and serves over 11 million students. The seven step framework is universal and guides schools as they develop, plan, implement, monitor, and evaluate their sustainable initiatives. National Wildlife Federation is privileged to have been selected as the sole US host for the Eco-Schools program which we rolled out in the fall of 2009. To date there are almost 2000 registered Eco-Schools in the US (found in 48 states plus DC and Puerto Rico) all at various award levels, from registered (just beginning – have made the commitment to work toward a more sustainable campus) to the ultimate recognition, the prestigious Green Flag.

National Wildlife Federation and its Eco-Schools USA program believe educators play a key role in developing an energy and climate literate citizenry. Energy and climate changes are two of the most significant environmental issues of our time and therefore are two of our environmental focus areas or pathways with our Eco-Schools USA program. Starting at a young age, students begin to develop their understanding of the Earth system and the role natural and human activity play in that system. Now more than ever it is critical that students are taught about the past, present, and future of energy and climate change as they will be the future decision makers in an economy and market starving for scientists, engineers, and mathematicians. We hope the Eco-Schools program will provide opportunities for students to be exposed to “real science” that is not only experiential and engaging, but understood and applied. Providing them with the ability to communicate about energy and climate change will afford future generations to make informed decisions and neighborhood and community changing actions. It is our desire that educators utilize this curriculum to attract and retain students in STEM disciplines as they relate to energy and climate change, and inspire the next generation of Earth system scientists.

### National Wildlife Federation and Education

The National Wildlife Federation has a 40-year history of developing and delivering high quality educational programming focused on the use of nature, the earth and wildlife study and observation to advance science learning and non-fiction, informational reading. Our programs currently serve four to five million children/students each year.

Since 2006, NWF has developed a number of educational programs on the subject of global climate change. These include its award-winning<sup>1</sup> website, **ClimateClassroom.org**, which

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<sup>1</sup> In June 2009, the International Academy of Visual Arts (IAVA) awarded Siteworx, the developer of NWF's Climate Classroom website, its highest honor, the Award of Excellence, in the Green/Eco-Friendly category. The IAVA is an invitation-only professional organization consisting of top-tier professionals from leading media, communications, advertising, creative and marketing firms. The 2009 Communicator Awards drew from a pool of over 7,000 entries from around the world, making it one of the largest and most prestigious awards of its kind. See Siteworx announcement at <http://www.pr.com/pressrelease/156252>.

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features guides for teachers, parents and young children and has a classroom-tested high school curriculum and activities that can be used by teachers and volunteers in the classroom.

NWF is particularly well-suited to develop and deliver an age-adapted curriculum on climate and energy, having recently developed and published the accepted U.S. national standards for effective climate change education for 4th, 8th and 12th graders. These national education guidelines have been officially endorsed and adopted by the North American Association for Environmental Education as effective climate- and energy-related education tools. They are specifically designed in keeping with the Association's broader national guidelines for excellence in environmental education, the National Environmental Education Excellence Project, which is a five-year effort to strengthen the scientific accuracy, pedagogy, depth and age-appropriateness of environmental education in throughout the U.S. The NWF/NAAEE guidelines for age-appropriate, 4th grade through high school, climate change education are available to educators for free at:

[http://online.nwf.org/site/DocServer/NWF\\_NAAEE\\_Educational\\_Guidelines1.pdf?docID=9581](http://online.nwf.org/site/DocServer/NWF_NAAEE_Educational_Guidelines1.pdf?docID=9581)

NWF is also a recognized leader in the emerging movement to “green up” K-12 schools around the country. We were recently were designated as the U.S. host of the prestigious **International Eco-Schools Program**, a network of 30,000 schools in 43 nations and is set to launch the Eco-Schools USA Program in Fall 2009. (Our Eco-Schools USA website may be found at [www.nwf.org/ecoschools](http://www.nwf.org/ecoschools).)

In addition to K-12 programs, NWF runs a **highly effective and nationally-recognized campus program** that assists colleges and universities in reducing their carbon footprints. We are launching a **program with American community colleges to bolster their green job training capacity**, and have designed **numerous climate training courses** for adult leaders in communities of interest such as hunters and anglers, land trust representatives, watershed conservation groups, business leaders, church and civic organizations and others.

### NWF and Entergy Collaboration

National Wildlife Federation and Entergy are both committed to finding solutions to the climate crisis. We believe climate change is happening now and is significantly affected by human activities. With a deep commitment to the environment and the communities we serve NWF and Entergy have joined forces to create an effective educational program that positively frames energy conservation in the context of climate change. Climate science and the importance of reducing our collective carbon footprint are not routinely taught in schools today, nor do students consistently learn about the role that new energy-efficient technology and alternative energy sources can and will play in the lower-carbon future that awaits them. Our goals are to:

- develop and distribute an effective energy and climate change curriculum model;
- offer high quality educator orientation and training on energy and climate change education;
- support state incorporation of climate change education into statewide science and social studies standards;

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- provide school-based action teams of educators, parents, students, and community volunteers with opportunities to participate in school greening activities via NWF's Eco-Schools USA program;
- offer an “energy and climate solutions” online center and instruction for students to learn practical skills in conservation and energy footprint assessment.

### The State of Climate Change Today

No longer is global warming something only facing future generations. Changes to our climate are being documented all across the planet today. People, animals, and plants are already feeling the heat.

National Wildlife Federation's climatologist Dr. Amanda Staudt has compiled state data that highlights how global warming is and will continue to affect your state along with information on clean energy solutions. <http://www.nwf.org/Global-Warming/In-Your-State.aspx>

Regional information from Global Climate Change Impacts on the United States, <http://globalchange.gov/> Houston is right on the cusp of the Great Plains and Southeast maps therefore looking at information contained in each will be insightful.

Great Plains-<http://globalchange.gov/images/cir/region-pdf/GreatPlainsFactSheet.pdf>

Southeast-<http://globalchange.gov/images/cir/region-pdf/SoutheastFactSheet.pdf>

### Earth as a System

Earth systems science is gaining popularity nationwide from elementary to college campuses. It is imperative for our students to become systems thinkers; looking at the parts of larger systems, which are systems themselves, and how those parts or smaller systems affect the larger system. Dr. Art Sussman, author of Dr. Art's Guide to Planet Earth is a fabulous resource for basic understanding of systems thinking as it relates to the Earth system.

“[A]ll the planet's physical features and living organisms are interconnected. They work together in important and meaningful ways. The clouds, oceans, mountains, volcanoes, plants, bacteria and animals all play important roles in determining how our planet works. Earth systems scientists combine the tools and ideas from many scientific disciplines including geology, biology, chemistry, physics, and computer science. In addition, they use modern technologies to measure key features of our planet, such as the concentration of gases in the atmosphere and the temperature of the ocean in many locations. Satellites orbiting our planet provide enormous amounts of data that Earth system scientists use to try to understand how our planet works and what

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kinds of changes are happening. To understand how the Earth works you must become a systems thinker.”

To help adults and students understand systems of any kind Dr. Art suggests always start by asking these three questions –

- What are the parts of the system?
- How does the system function as a whole?
- How is the system itself part of larger systems?<sup>2</sup>

Doing so allows one to begin thinking about what they already know regarding a particular Earth system; what pieces might be missing or misconceptions held, as well as guiding one to new learning and understanding.

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<sup>2</sup> Dr. Art Sussman, *Dr. Art's Guide to Planet Earth* (Chelsea Green Publishing, 2000 ), 2-8.

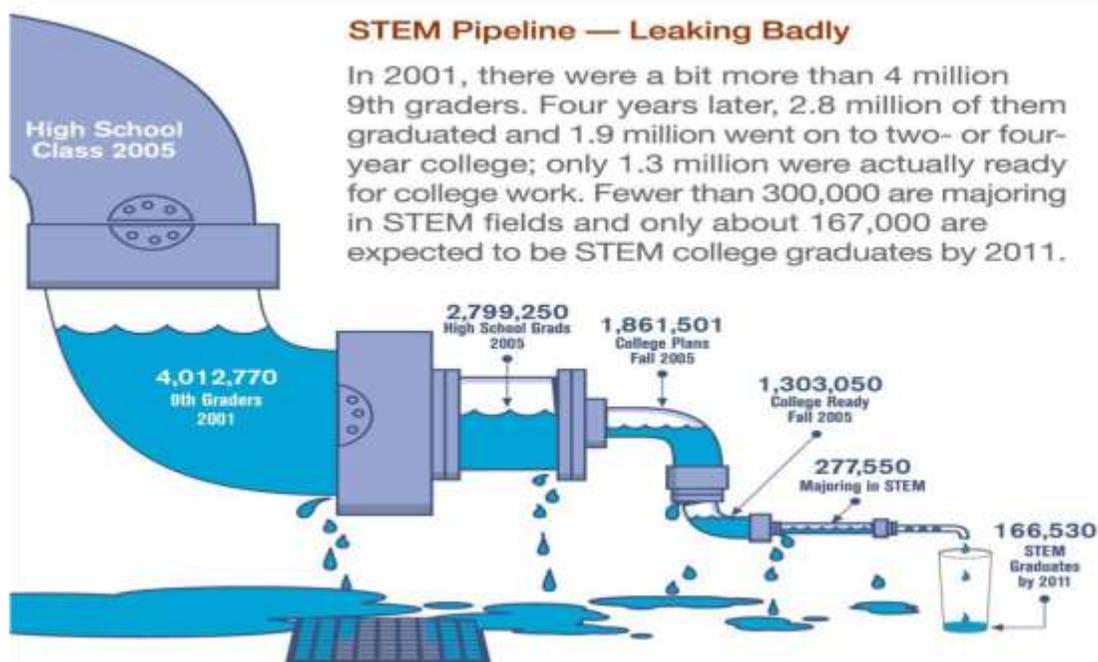
## II. Teaching Using Best Practice

### INQUIRY IN THE CLASSROOM

Inquiry is a wondrous tool teachers have available to them as they work to keep students engaged and motivated in the classroom. Typically schools teach inquiry as the “scientific method”, a linear pathway which begins with “Asking a Question” and ends with “Communicating Conclusions”, however inquiry is not linear but more cyclical of which there is not a definite beginning or end. One hopes that at the conclusion of an experiment you will be led to ask more questions thus participating in the cycle once more. Although it is imperative students go through the entire process to learn how scientists of all kinds draw conclusions there is a misconception regarding the scientific method; one must go through all “steps” at one time; this is certainly untrue. Inquiry allows one to start and stop at any point in the cycle dependent upon the scientist’s thoughts on progress.

Please take the time to read, “[The Inquiry Primer](#)”, by Alan Cogburn. This document will not only reaffirm your knowledge and understanding of inquiry, but will give you insights into inquiry that will make inquiry in *your* classroom stronger. For more information regarding inquiry, including, advice for implementation, video clips of inquiry taking place in the classroom, and assessment’s place in the inquiry driven classroom please visit, <http://www.justsciencenow.com/index.htm>

### WHY STEM EDUCATION?

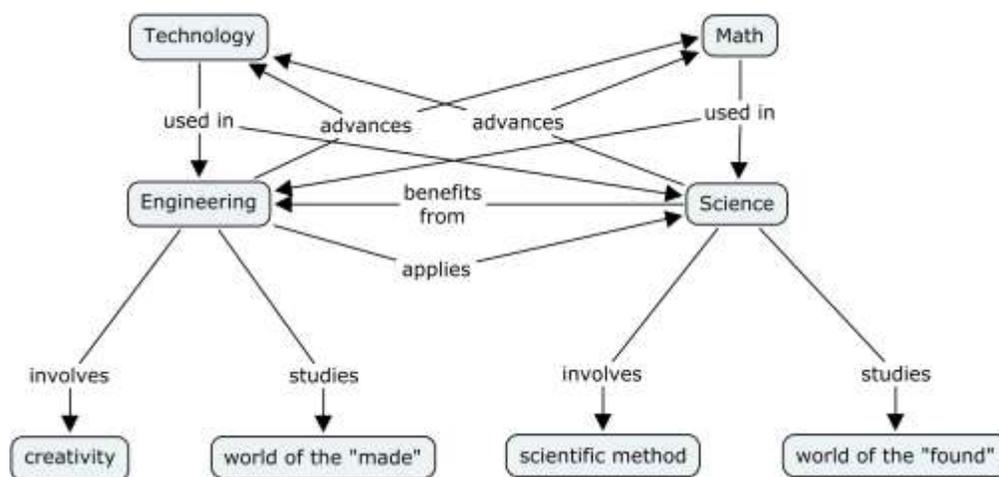


Source: NCES Digest of Education Statistics; Science & Engineering Indicators 2008

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The graphic above from NCES Digest on Education Statistics demonstrates our nation's desperate need for scientists, engineers, mathematicians, and technologists.

“STEM literacy is an interdisciplinary area of study that *bridges* the four areas of science, technology, engineering, and mathematics. STEM literacy does not simply mean achieving literacy in these four strands or silos. Consequently, a STEM classroom shifts students away from learning discrete bits and pieces of phenomenon and rote procedures and toward investigating and questioning the interrelated facets of the world. One hallmark of a STEM classroom is an emphasis on design and problem-solving in “intellectually messy” learning situations that weave together the disciplines.” (Washington STEM Initiative, 2009)



Thornburg, 2009

STEM is a key component to our future's success in a competitive global economy. According to the National Environmental Education Foundation, 80% of all students decide to opt out of science and math careers before entering high school. Environmental education, which opens its doors to a myriad of opportunities in STEM careers, is a heuristic tool for making science more relevant and engaging, and provides an appealing entry point for students thinking about future careers.

Did you know the most recent ten year employment projections by the U.S. Labor Department show that of the twenty fastest growing occupations projected for 2014, fifteen of them require significant mathematics or science preparation to successfully compete for a job<sup>3</sup>? Even the requirements for occupations that historically

**“We must prepare students so they have a strong foundation in STEM subjects and are able to use this knowledge in their personal and professional lives. And we must inspire students so that all are motivated to study STEM subjects in school and many are excited about the prospect of having careers in STEM fields.”**

<sup>3</sup> Bureau of Labor and Statistics, Fastest growing occupations, 2004-14, <http://www.bls.gov/emp/emptab21.htm>

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did not require a high school education have dramatically shifted. In the last thirty years, the share of factory workers without a high school degree fell from more than half to just one in five (21%). At the same time, those with a post-secondary education had reached 31 percent. If current trends continue, over 40 percent of factory jobs will require post-secondary education by 2012<sup>4</sup>.

Knowing these facts lends itself to anxiety over the fact that our students are falling behind their peers around the world, especially in math and science. According to the National Center for Education Statistics, about one-third of the fourth-graders and one-fifth of eighth-graders cannot perform basic mathematical computations, and U.S. high school seniors recently tested below the international average for 21 countries in mathematics and science.<sup>5</sup> As a result, fewer American students than ever are graduating from college with math and science degrees. When compared with our international competitors, we are not performing well. In 1995, U.S. fourth graders ranked 12<sup>th</sup> against other nations when it came to mathematics competency<sup>6</sup>. By the 8<sup>th</sup> grade their ranking dropped to 19<sup>th</sup>, below not only Asian students in countries such as Korea, Japan and Taiwan, but also below students in many Eastern European nations such as Bulgaria, the Czech Republic and Slovenia. A similar deterioration has occurred in science. In 1995, U.S. fourth graders ranked 6<sup>th</sup> in science competency. By the 8<sup>th</sup> grade their ranking dropped to 18<sup>th</sup>, below many of the same countries cited above. More recent rankings of U.S. students relative to their counterparts around the globe have been no more encouraging with respect to America's future ability to compete.<sup>5</sup>

A call to action by the President's Council of Advisors on Science and Technology report, "The success of the United States in the 21st century – its wealth and welfare – will depend on the ideas and skills of its population. These have always been the Nation's most important assets. As the world becomes increasingly technological, the value of these national assets will be determined in no small measure by the effectiveness of science, technology, engineering, and mathematics (STEM) education in the United States. STEM education will determine whether the United States will remain a leader among nations and whether we will be able to solve immense challenges in such areas as energy, health, environmental protection, and national security. It will help produce the capable and flexible workforce needed to compete in a global marketplace. It will ensure our society continues to make fundamental discoveries and to advance our understanding of ourselves, our planet, and the universe. It will generate the scientists, technologists, engineers, and mathematicians who will create the new ideas, new products, and entirely new industries of the 21st century. It will provide the technical skills and quantitative literacy needed for individuals to earn livable wages and make better decisions for themselves, their families, and their communities. And it will strengthen our democracy by preparing all citizens to make informed choices in an increasing technological world. The council is asking the president to transform K-12 Education using a two-pronged approach. We

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<sup>4</sup> Standards for What? Educational Testing Service, 2003

<sup>5</sup> National Center for Education Statistics

<sup>6</sup> International Association for the Evaluation of Educational Achievement

<sup>5</sup> STEM Education Caucus

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must prepare students so they have a strong foundation in STEM subjects and are able to use this knowledge in their personal and professional lives. And we must inspire students so that all are motivated to study STEM subjects in school and many are excited about the prospect of having careers in STEM fields.” (Holdren, John P., et. al.)

### IMPORTANCE OF PROCESS SKILLS

#### Excerpt from *Science and Children* “Editor’s Note Inquiry-Process Skills”

We take for granted that students have some abilities in questioning, observing, predicting, planning an investigation, collecting data, interpreting information, and communicating their ideas. But, this is more than likely not the case. We must be deliberate in how we instruct students and encourage their development of these skills. For example, we can’t simply say “observe this leaf” and expect them to be able to clearly see the intricacies of the vein and margin patterns. We must be specific in how we direct them and teach them how to critically look at a phenomenon and question it. Learning in isolation of content does not maximize the ability to learn these skills in such a way that they can be easily transferred to other situations. The National Science Education Standards integrate process skills into the broader abilities of scientific inquiry. “Students at all grade levels and in every domain of science should have the opportunity to use scientific inquiry and develop the ability to think and act in ways associated with inquiry, including asking questions, planning and conducting investigations, using appropriate tools and techniques to gather data, thinking critically and logically about relationships between evidence and explanations, constructing and analyzing alternative explanations, and communicating scientific arguments” (NRC 1996, p. 105). If you search, you will find a variety of lists identifying process skills. Basically, they are the tools and skills students need to investigate phenomenon. But don’t assume students develop these skills without your careful guidance. They must be prompted to investigate in such a way that they can develop increasingly more sophisticated skills and attitudes. We should not underestimate the capabilities of young students and they should be urged to reach a high bar. They are capable of engaging in all of the process skills when provided with guidance and encouragement. Don’t simply hand them a ruler and ask them to measure. (Froshchauer, 2010)

The learning of process skills have been hindered by present generations who rely more on electronic devices for quick access, information, and stimulation as well as spending less and less time out of doors in nature. For these reasons it is important to include a variety of process skills in all science lessons. Below shows the process skills found within the Energy and Climate Change curriculum.

- Observing
- Predicting
- Inferring
- Identifying and manipulating variables
- Investigating
- Measuring
- Making and making sense of models
- Drawing conclusions
- Communicating Outcomes

### SCIENCE NOTEBOOKING

Science Notebooking is called by many names- such as science journals, logs, and notebooks. Notebooking builds science content and process skills. All scientist notebook; it their hypotheses, their questions, their data collection, and reflections. A notebook holds many tools and shows knowledge and learning before, during, and after observation, investigation, and communication. Notebooking also promotes literacy development in a variety of contexts, for instance through both oral and written communication, reading informational text, and promoting academic vocabulary. As well as developing science and literacy skills notebooks can be used

to formatively assess students by checking for understanding allowing you to better differentiate your instruction and demonstrate small gains over time in understanding. Science notebooks are an integral piece of this curriculum and a powerful tool for you the educator. For more information on science notebooking please see the following resources-

1. **Science Notebooks-Writing About Inquiry**, Brian Campbell and Lori Fulton
2. ***Twas the Start of Science Notebooking***,  
<http://www.nsta.org/store/search.aspx?action=browse&text=science%20notebooking&price=0&product=0&subject=0&topic=0&gradelevel=0&qolid=&state=&subid=&gl=&docyear=>
3. **Science Notebooks**, <http://www.sciencenotebooks.org/>
4. **Creating Science-Centered Science Notebooks**,  
<http://www.esiponline.org/csl/presentations/lorifulton.pdf>

## The 5E Instructional Model

*Adapted from NASA's 5E Overview: "The 5E instructional model"*

<http://www.nasa.gov/audience/foreducators/nasaclips/5eteachingmodels/index.html>

The 5E instructional model is a constructivist set of teaching stages that allow teachers to **Engage, Explore, Explain, Extend, and Evaluate** students. This model reflects best practices in student learning and can be utilized in any subject area.

### Engage

During this first stage you want to capture student's interest – similar to the hook of a book or the first line in a short story and get them personally involved in the lesson. Here students will make connections to prior knowledge as you lay the foundation for further learning.

### Explore

Now that you have their attention it is time to allow them to explore the content or concept, thus building new learning based on their understanding. Acting as the facilitator, the teacher provides guidance as students work in groups sharing and communicating their common experiences. Emphasis is placed on questioning, data collection and analysis, as well as critical thinking.

### Explain

The purpose for the explain stage is to provide students with an opportunity to communicate what they have learned so far and figure out what it means. Explain is the stage at which learners begin to communicate what they have learned. Language provides motivation for sequencing events into a logical format. Communication occurs between peers, with the facilitator, and through the reflective process.

### Extend

This stage allows students to use their new knowledge and explore its implications. Students are now ready to elaborate upon this new learning and apply it new situations and other related concepts.

### Evaluate

Evaluation serves both the teacher and the students as a tool to see how much learning and understanding has taken place. Evaluations can be both formative in nature, small snapshots along the way and summative, a culminating look at overall knowledge and understanding. Types of assessments include utilizing, rubrics, Thinking Maps®, Foldables®, teacher observations, student interviews, portfolios, and problem and project based learning products.

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**For more information regarding the 5E Model look to these resources.**

### **The 5E Learning Cycle Model-MSU**

<http://faculty.mwsu.edu/west/maryann.coe/coe/inquire/inquiry.htm>

### **The BSCS 5E Instructional Model: Origins, Effectiveness, and Applications**

<http://www.bsccs.org/pdf/bsccs5eexecsummary.pdf>

## **INTERDISCIPLINARY CONNECTIONS**

“By their very nature, reading and writing activities can play a vital role in achieving a minds-on emphasis in the learning of science. Reading and writing activities can serve as conceptual tools for helping students to analyze, interpret, and communicate scientific ideas.” (Holliday, Yore, and Alvermann 1994, p.877)

“These activities can help engage in students’ minds the complex reasoning and problem solving processes that scientist use in the course of their work. Meaningful learning is the process of actively constructing conceptual relations between new knowledge and existing knowledge...” (Glynn 1999, p.222)

### **Reading**

“In investigating the natural convergences between science and literacy, we found a great deal of evidence for mutual support, and none was more central than our understanding of the way in which text can support rather than supplant inquiry-based science learning.” (Cervetti et. al., 2006) Students are assigned articles to read specific to topics covered. They must be able to read, comprehend, and discuss their understanding to a partner, small group, and whole group. Students will have the opportunity to participate in an environmental book club as a part of an extension and action project; opening their eyes to the foundations of environmental awareness, stewardship, activism, and education.

### **Writing**

“There is probably no better way to assess students understanding than to look at what students write in their conclusions.” (DeFronzo, 2006) Students are actively engaged in writing throughout the unit as they are asked to write all observations, predictions, questions, vocabulary, and all other parts of the scientific method in their science notebook. Also students will be asked to write a summary of articles read including questions they would like to have answered or topics for further research. Writing in response to video segments and lessons completed will be an additional opportunity to write in the science notebook.

### **Social Studies**

The National Council for the Social Studies defines social studies as the “integrated study of the social science and humanities to promote civic competence”. Within the discipline students learn about history, geography, economics, government, citizenship, and culture. Some lessons within the curriculum have direct ties to various areas of social studies. In other lessons you can work with your social studies teacher(s) to look for direct connection between the science and historical and or current events. Throughout time, scientific innovation has been the result of historical moments.

## **III. Curriculum Overview**

### **Student Goals and Objectives**

#### **Goals**

1. Improve student competency for energy and global climate change knowledge, problems, and solutions.
2. Utilize engaging 21<sup>st</sup> century skills and resources to strengthen learning about the affects of our energy needs and uses on the Earth system and the relationship climate change plays and will play as future generations move forward.
3. Increase interest in STEM disciplines.

#### **Objectives**

1. Students will learn about the Eco-Schools USA framework, the 8 pathways to sustainability, and have access to a variety of tools and resources to apply to helpful solutions that will positively impact not only their local area, but the global Earth system.
2. Students will learn the history, the present uses and trends, and the future related to our nation’s energy needs and uses.
3. Students will understand the relationship between energy and climate change and utilize energy conservation techniques and tools to make a positive impact at their school and home as well as their community.
4. Students will understand that climate change is due to natural cycles and anthropogenic impacts on Earth’s systems.
5. Students will understand the potential results of human impact on climate change and understand that local concerns become global concerns.

## Energy Awareness and Climate Literacy Principles

The Energy Awareness and Climate Literacy Principles were created by the collaboration of many agencies including NASA, NOAA, US Forest Service, USGS, AAAS, NAAEE, US Department of Energy, and NRCL. These two documents serve several purposes but one of the most important is its development to serve educators who teach energy and climate science as a part of their curricula. Each guide is written to help you better understand the role that each play in our nation today.

These documents served to guide our writers in the development of the curriculum which is designed to increase the numbers of citizens who are energy aware and climate literate. As students become adults it is important that their decisions are based on learning that was accurate, free of bias, and responsible.

### Energy Awareness Principles<sup>7</sup>

Energy awareness is a complex topic. There are many ways to approach energy depending on the grade level, course topics, and instructional methods. Yet no matter the pedagogic setting, using a literacy based approach can provide a sound foundation to build learners' understanding surrounding the topic. The energy awareness principles set out a broad framework from which to teach about energy topics. Energy is an inherent driving force throughout the universe and the Earth system. Humans use energy from various sources, and there are environmental, political, and social consequences related to our use of energy. Sustainable energy use can only occur when there is balance between the amount of energy available and the rate at which it is consumed.

- Energy drives the Earth system.
- The primary sources of energy used by society are non-renewable stores sources, such as fossil fuels and nuclear and renewable sources, such as solar, wind, hydro, and biomass.
- Humans' use of energy has consequences on the environment that sustains them.
- The distribution of stored non-renewable and renewable energy sources varies around the planet, resulting in distribution and transmission costs.
- There are significant social, political, and equity issues associated with the human use of and access to energy.
- Developing a sustainable energy supply that minimizes impacts on the environment will require informed decision-making, technological and societal innovation, and improved efficiency.

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<sup>7</sup> CLEAN – Climate Literacy & Energy Awareness Network, June 2011.  
<http://cleanet.org/clean/literacy/energy.html>

### Climate Literate Citizens<sup>8</sup>

Climate literacy is an ongoing process and is an understanding of your influence on climate and climate's influence on you and society. A climate-literate person –

- understands the essential principles of Earth's climate system,
- knows how to assess scientifically credible information about climate,
- communicates about climate and climate change in a meaningful way, and
- is able to make informed and responsible decisions with regard to actions that may affect climate.

### The Seven Climate Literacy Principles

- The sun is the primary source of energy for Earth's climate system.
- Climate is regulated by complex interactions among components of the Earth system.
- Life on Earth depends on, is shaped by, and affects climate.
- Climate varies over space and time through both natural and man-made processes.
- Our understanding of the climate system is improved through observations, theoretical studies, and modeling.
- Human activities are impacting the climate system.
- Climate change will have consequences for the Earth system and human lives.

### LESSON COMPONENTS

The curriculum is composed of two grade bands, grades five through eight and grades nine through twelve. Each lesson, regardless of grade band, is developed using the 5E Model, engage, explore, explain, elaborate, and evaluate and will all include the following elements.

 Blue Box Information	Grade level, completion time, Texas and Arkansas standards, prerequisite knowledge, learning outcomes and student objectives, materials, academic vocabulary and lesson links
 Introduction	Teacher background which includes, an overview and preparation
 5E Lesson	Student groupings and completion time, essential questions, and directions

<sup>8</sup> "Climate Literacy Principles, Mar. 2009, 20 Oct. 2010 < <http://www.climatescience.gov/Library/Literacy/> >.

### PLANNING FOR INSTRUCTION

To allow students to gain an in depth understanding of energy and climate change via ***Energy and Climate Change: Links to our Past, Present, and Future*** curriculum we understand the demands placed on you. If you are unable to take on the entire curriculum it is suggested that you incorporate into your teaching the following lessons.

**At a minimum** complete: Lessons 1, 2, 12 and 3 lessons of your choice for grades 5-8 and for grades 9-12 complete Lessons 1, 2, 10 and 3 lessons of your choice.

**NOTES: What makes the most sense with my curriculum timeline and my students?**

## LESSON SUMMARIES

### Grades 5-8

#### **Lesson 1: It's A Green Revolution!**

##### **An Introduction to Eco-Schools USA**

Greening the school building, grounds, curriculum, and student experience; students are introduced to the Eco-Schools framework and pathways to sustainability. Utilizing our environmental audit students will begin the process necessary to guide their campus community towards efficiency and sustainability.

#### **Lesson 2: Lights, Camera, Action!**

##### **Conducting an Energy Audit**

The nation's school districts spend more than \$7.5 billion a year on energy. Schools are the largest energy consumer in many municipalities. But up to 30 percent of that energy is used inefficiently or unnecessarily. Students dive into the audit process by assessing their school's energy efficiency. Actively engaged, students will collect and analyze data, and develop action plans in an effort to raise energy awareness and reduce carbon emissions.

#### **Lesson 3: An Energy Mix**

##### **Renewable and Nonrenewable Resources**

Our natural resources contribute significantly to society's needs and wants. Students will learn the division of our natural resources into renewable and nonrenewable categories, determine the reasoning behind their placement within each group, and understand what these natural resources are used for in our everyday life.

#### **Lesson 4: By Air, Land, or Sea**

##### **The Formation and Location of Our Natural Resources**

As students learn about the formation process regarding Earth's natural resources students will also make observations as to their locations within the Earth system; is there an observable pattern?

#### **Lesson 5: Yesterday**

##### **Our Energy Needs Over Time**

Students will explore how our energy needs have changed over time by integrating social studies and science content. Many times historical events have led to scientific innovations. Students will use timelines to chart events in both science and history and discuss possible relationships between the two.

#### **Lesson 6: Meet the Extractors, Harvesters, and Harnessers**

##### **Methods, Technology, Benefits and Consequences in Acquiring Natural Resources**

The acquisition of our natural resources is an ongoing process. Students will be introduced to how our natural resources are taken from the Earth system and along with technological advancements that have allowed our society to grow. Students will also investigate the environmental benefits and consequences to sequestering energy.

#### **Lesson 7: Power Pellets**

##### **Nuclear Energy in the United States**

As a nonrenewable natural resource, uranium supplies more power in one pellet than in one ton of coal. The only fossil fuel that does not burn a product to make energy and does not release carbon dioxide into the atmosphere, students learn the benefits and challenges to nuclear power reactors in the U.S.

## LESSON SUMMARIES

### Grades 5-8 continued

#### **Lesson 8: It's All in the Name**

##### **Weather vs. Climate**

Students commonly use weather and climate interchangeably. In fact there is a difference. Students will investigate the meaning of each word via online portals and distinguish between their meanings. This lesson will provide a basis for understanding in later lessons.

#### **Lesson 9: Hot, Hotter, Hottest**

##### **Extreme Weather's Impact on Our Resources**

Scientists project global warming will bring more uncertainty, potentially causing both more extremely dry periods and more heavy rainfall events. These extreme events will exacerbate the problems we face with water management and protection in the U.S. Students will analyze national and state drought maps and investigate how these conditions impact the national, state, and local community.

#### **Lesson 10: The Amazing Adventures of Carbon**

##### **How Carbon Cycles through the Earth System**

Students will learn about the processes and interactions that occur in the carbon cycle and be introduced to systems thinking. As a part of their work they will understand the role pools and fluxes play within the cycle.

#### **Lesson 11: Why All the Wiggling on the Way Up?**

##### **CO<sub>2</sub> in the Atmosphere**

Starting in 1958, Charles D. Keeling from the Scripps Institute of Oceanography began measuring the amount of carbon dioxide (CO<sub>2</sub>) in the atmosphere in Mauna Loa, Hawaii. Students will have the opportunity to examine the CO<sub>2</sub> data from Mauna Loa, Alaska, and their home location. They will use this data to explore how the seasonal growth and die-off of vegetation in temperate and colder regions influences CO<sub>2</sub> levels.

#### **Lesson 12: Master P in the House**

##### **An All School Energy and Climate Change Action Plan**

The United States is home to just five percent of the world's population but consumes more than twenty percent of its energy. Student will take data collected from Lesson 2 along with new knowledge gained regarding energy and climate change and develop a class, grade level, or hopefully a school-wide improvement plan. This plan will be monitored and evaluated for effectiveness and will reduce the environmental footprint of the school.

## LESSON SUMMARIES

### Grades 9-12

#### **Lesson 1: A Green Revolution!**

##### **An Introduction to Eco-Schools USA**

Knowing that solutions and mitigation to our energy needs are crucial to battling our long term environmental and societal challenges, it is our hope that the Eco-Schools program will strengthen school's commitment to sustainability in which eventually sustainability becomes a part of the internal and external culture of the school.

#### **Lesson 2: Lights, Camera, Action!**

##### **Conducting an Energy Audit**

The nation's school districts spend more than \$7.5 billion a year on energy. Schools are the largest energy consumer in many municipalities. But up to 30 percent of that energy is used inefficiently or unnecessarily. Students dive into the audit process by assessing their school's energy efficiency. Actively engaged, students will collect and analyze data, and develop action plans in an effort to raise energy awareness and reduce carbon emissions.

#### **Lesson 3: This Blanket is Making Me Hot**

##### **Greenhouse Gas Investigations**

Some greenhouse gases occur naturally and are released into the atmosphere through natural processes and human activities and others are strictly created and released through human activity. Students will learn exactly what are greenhouse gases, their significance in the atmosphere, and the role they play in energy and climate change.

#### **Lesson 4: Why All the Wiggling On the Way Up?**

##### **Investigating CO<sub>2</sub> Trends**

Starting in 1958, Charles D. Keeling from the Scripps Institute of Oceanography began measuring the amount of carbon dioxide (CO<sub>2</sub>) in the atmosphere in Mauna Loa, Hawaii. Students will examine CO<sub>2</sub> data from various locations, explore seasonal growth and die-off, and investigate the long term trend in CO<sub>2</sub> while discussing how these emissions relate to human activity.

#### **Lesson 5: Wherefore Art Thou, Albedo?**

##### **Investigating Ice-Albedo Feedback**

The Earth has an average albedo, which describes how much sunlight is reflected on average for the whole planet and the whole year. How fast the planet warms in response to adding greenhouse gases to the atmosphere depends in part on climate feedbacks. Students will collect ice-snow data and make connections to trends in albedo. What could be the causes for current trends and what role both seasonal and human induced activity play.

#### **Lesson 6: Naturally Speaking**

##### **Investigating Natural Resource Production in My State**

Our energy needs have been met in many ways throughout history, from fire rings and wood burning hearth's, to oil burning lamps and steam powered engines. Students will learn how different parts of our society use energy and how that energy use has changed over time. Next students will investigate natural resources found in their state and the fuel mix used to satisfy the state's energy needs.

**Lesson 7: Stifling, Oppressive, Sweltering, Oh My!**

**The Science Behind Heat Waves and their Effect on Human Health**

In August 2007, a severe heat wave affected much of the central, southeast, and eastern parts of the United States. This lesson will give students an opportunity to explore how the heat wave progressed and learn about the impacts on human health. Students will collect air temperature and longwave radiation data and look for connections to ground level ozone allowing them to analyze and draw conclusions about the effects of heat waves on various populations.

**Lesson 8: Power Pellets**

**Nuclear Energy in the United States**

As a nonrenewable natural resource, uranium supplies more power in one pellet than in one ton of coal. The only fossil fuel that does not burn a product to make energy and does not release carbon dioxide into the atmosphere, students learn about careers in nuclear energy, uranium isotopes, and simulate the milling process as a part of the nuclear fuel cycle.

**Lesson 9: I've Got the POWER!**

**Investigating Solar and Wind Energy Potential at School**

Renewable energy sources, such as solar and wind, help reduce carbon dioxide emissions that cause climate change. Student will collect solar and wind data to estimate their school energy potential. After analyzing the data students will determine if these renewable energies 1) have the potential to be used on campus and 2) are cost effective in terms of supporting the energy needs of their school.

**Lesson 10: Master P in the House**

**An All School Energy and Climate Change Action Plan**

The United States is home to just five percent of the world's population but consumes more than twenty percent of its energy. Student will take data collected from Lesson 2 along with new knowledge gained regarding energy and climate change and develop a class, grade level, or hopefully a school-wide improvement plan. This plan will be monitored and evaluated for effectiveness and will reduce the environmental footprint of the school.

## National Standards

### National Science Education Standards

In 2011 the National Research Council established a diverse committee to “develop a conceptual framework that would specify core ideas in the life, physical, earth and space sciences, and engineering and technology, as well as crosscutting concepts and practices, around which standards should be developed”. In the likeness of the Common Core State Standards for math and reading standards are in development for science via the non-partisan, non-profit educational reform organization Achieve, Inc.

<p><b>1. Scientific and Engineering Practices</b></p> <ol style="list-style-type: none"><li>1. Asking questions (for science) and defining problems (for engineering)</li><li>2. Developing and using models</li><li>3. Planning and carrying out investigations</li><li>4. Analyzing and interpreting data</li><li>5. Using mathematics and computational thinking</li><li>6. Constructing explanations (for science) and designing solutions (for engineering)</li><li>7. Engaging in argument from evidence</li><li>8. Obtaining, evaluating, and communicating information</li></ol> <p><b>2. Crosscutting Concepts</b></p> <ol style="list-style-type: none"><li>1. Patterns</li><li>2. Cause and effect: mechanism and explanation</li><li>3. Scale, proportion, and quantity</li><li>4. Systems and system models</li><li>5. Energy and matter: flows, cycles, conservation</li><li>6. Stability and change</li></ol>	<p><b>3. Disciplinary Core Ideas</b></p> <p><b><u>Physical Sciences</u></b></p> <ul style="list-style-type: none"><li>❖ PS 1: Matter and its interactions</li><li>❖ PS 2: Motion and stability: forces and interactions</li><li>❖ PS 3: Energy</li><li>❖ PS 4: Waves and their applications in technologies for information transfer</li></ul> <p><b><u>Life Sciences</u></b></p> <ul style="list-style-type: none"><li>❖ LS 1: From molecules to organisms: structures and processes</li><li>❖ LS 2: Ecosystems: interactions, energy, and dynamics</li><li>❖ LS 3: Heredity: inheritance and variation or traits</li><li>❖ LS 4: Biological evolution: unity and diversity</li></ul> <p><b><u>Earth and Space Sciences</u></b></p> <ul style="list-style-type: none"><li>❖ ESS 1: Earth’s place in the universe</li><li>❖ ESS 2: Earth’s systems</li><li>❖ ESS 3: Earth and human activity</li></ul> <p><b><u>Engineering, Technology, and Applications of Science</u></b></p> <ul style="list-style-type: none"><li>❖ ETS 1: Engineering design</li><li>❖ ETS 2: Links among engineering, technology, science, and society</li></ul>
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Energy and Climate Change  
 Links to our Past, Present, and Future

Below are the National Science Education Standards covered as a part of the curriculum. The unifying concepts and processes are strategically interwoven throughout each content standard at all grade levels. The concepts and processes included in the curriculum are **Systems, Order, and Organization, Evidence, Models, and Explanation, and Change, Constancy, and Measurement.**

Science Content	Grades 5-8	Grades 9-12
<b>SCIENCE AS INQUIRY</b>		
Abilities necessary to do scientific inquiry.	X	X
Understanding about scientific inquiry.	X	X
<b>PHYSICAL SCIENCE</b>		
Transfer of energy	X	
Interactions of energy and matter		X
Behavior of organisms		
<b>EARTH AND SPACE SCIENCE</b>		
Structure of the Earth system	X	
Energy in the Earth system		X
Geochemical cycles		X
<b>SCIENCE AND TECHNOLOGY</b>		
Understanding about science and technology	X	X
<b>SCIENCE IN PERSONAL AND SOCIAL PERSPECTIVES</b>		
Personal health	X	
Personal and community health		X
Populations, resources, and environments	X	
Natural hazards	X	
Natural resources		X
Risks and benefits	X	
Environmental Quality		X
Science and technology in society	X	
Natural and human induced hazards		X
Science and technology in local, national, and global challenges		X
<b>HISTORY AND NATURE OF SCIENCE</b>		
Science as a human endeavor	X	X
Nature of science	X	
History of science	X	
Nature of scientific knowledge		X
Historical perspectives		X

[NSES](#)

**National Education Technology Standards**

Content Standards	All Grade Levels
<b>CREATIVITY AND INNOVATION-STUDENTS WILL:</b>	
Use models and simulations to explore complex systems and issues.	X
Identify trends and forecast possibilities.	X
<b>COMMUNICATION AND COLLABORATION-STUDENTS WILL:</b>	
Interact, collaborate, and publish with peers, experts, or others employing a variety of digital environments and media.	X
<b>RESEARCH AND INFORMATION FLUENCY-STUDENTS WILL:</b>	
Locate, organize, analyze, evaluate, synthesize, and ethically use information from a variety of sources and media.	X
Evaluate and select information sources and digital tools based on the appropriateness to specific tasks.	X
Process data and report results.	X
<b>CRITICAL THINKING, PROBLEM SOLVING, AND DECISION MAKING-STUDENTS WILL:</b>	
Collect and analyze data to identify solutions and or make informed decisions.	X
<b>DIGITAL CITIZENSHIP-STUDENT WILL:</b>	
Advocate and practice safe, legal, and responsible use of information and technology.	X
Exhibit a positive attitude toward using technology that supports collaboration, learning, and productivity	X
<b>TECHNOLOGY OPERATIONS AND CONCEPTS-STUDENTS WILL:</b>	
Understand and use technology systems.	X
Select and use applications effectively and productively.	X
Troubleshoot systems and applications	X
Transfer current knowledge to learning of new technologies	X

[NETS](#)

### The National Council for the Social Studies

Each academic content area, the language arts, science, mathematics, and the social studies significantly contribute to the overall education of our students. A well rounded student will have educators that are able to make connections between content areas; best accomplished when teachers work together. Although this curriculum is focused on science there are linkages to the social studies. Some connections are directly made with a lesson while others are not. In cases where direct links are not outlined work with your social studies teacher to broaden the depth of understanding your students attain regarding energy and climate change. Throughout history there are instances where events have brought about scientific innovation and invention, for instance Polio, one of the most feared diseases of the post-war era affecting nearly 58,000 people, mostly children at its height in 1952; its most recognizable victim, the 44<sup>th</sup> president of the United States, Franklin D. Roosevelt. Jonas Salk, a medical researcher and virologist is “best known for his discovery and development of the first safe and effective polio vaccine.”<sup>9</sup> This curriculum lends itself to elaboration through the social studies in many of its ten themes, ***Culture, People, Places, and Environment, Individual Development and Identity, Production, Distribution, and Consumption, Science, Technology, and Society, and Civil Ideals and Practices.*** The new standards for the social studies can be found at, <http://www.socialstudies.org/standards/curriculum> .

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<sup>9</sup> Wikipedia, Jonas Salk, [www.en.wikipedia.org/wiki/jonas\\_salk](http://www.en.wikipedia.org/wiki/jonas_salk), 2/5/2012.

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<<http://www.experientiallearning.ucdavis.edu/module2/el2-60-primer.pdf>>.

## Curriculum Overview – Web Resources

### Arkansas Department of Education

Science and Social Studies Framework

<http://arkansased.org/educators/curriculum/frameworks.html#science>

### California EEI

<http://www.calepa.ca.gov/Education/EEI/Curriculum/Default.htm>

### Climate Literacy Principles

<http://www.globalchange.gov/resources/educators/climate-literacy>

### Department of Energy

<http://energy.gov/>

### Dr. Art's Guide to Planet Earth

<http://www.planetguide.net/>

### Dinah Zike's Foldables

<http://www.dinah.com/videolibrary.php>

Energy and Climate Change  
Links to our Past, Present, and Future

**Energy Awareness Principles**

<http://www.globalchange.gov/resources/educators/climate-literacy>

**Energy Kids**

<http://www.eia.gov/kids/index.cfm>

**Get Energy Active**

<http://www.getenergyactive.org/fuel/state.htm>

**Just Science Now: Exploring Science through Inquiry**

<http://www.justsciencenow.com/index.htm>

**Make An Impact**

<http://makeanimpact.c2es.org/>

**My NASA Data**

<https://mynasadata.larc.nasa.gov/>

**NASA Earth Observatory**

<http://www.earthobservatory.nasa.gov/>

**NEED's Energy Flows**

<http://www.need.org/needpdf/Energy%20Flows.pdf>

**NOAA Satellite and Information Service**

<http://www.ncdc.noaa.gov/sotc/drought/2011/9>

**Texas Education Agency**

**Science**

<http://ritter.tea.state.tx.us/rules/tac/chapter112/index.html>

**Social Studies**

<http://www.tea.state.tx.us/index2.aspx?id=3643>

**The Franklin Institute**

<http://www.fi.edu/learn/case-files/index.php>

**Thinking Maps**

<http://www.thinkingmaps.com/products.php>