Science Connection
KENTUCKY DEPARTMENT OF EDUCATION
A Collaborative Resource for Teachers
March 2014 Volume 1 Issue 4

EVERY CHILD PROFICIENT & PREPARED FOR SUCCESS

In This Issue

How infographics transformed my classroom

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ALL

Infographics are everywhere these days, from newspapers to heads-up displays for astronauts. These graphic representations can, in little space, parse through large data sets or provide deeper insights into complex ideas.

For the past three years, my students have learned to decipher infographics and then create their own graphic representations. While infographics come in many forms, I favor ones that work with data rather than simply telling a narrative. My goal is for students to learn to use and think critically about multiple, complex and sometimes large datasets. The great thing about this project is all activities listed below conform to the CCR anchor standard 7 to integrate and evaluate content presented in diverse media and formats.

Strategies I use:

Read aloud/Think aloud: (NGSS Practice 4: Analyzing and Interpreting Data; Practice 8: Obtaining, Evaluating, and Communicating Information)

I am lucky enough to have a Promethean board and a projector in my classroom. Using the duel monitors option on my laptop, I pull a different infographic out of a folder every day that I set as my background. This gives a constantly changing image for my students and me to discuss, rather than just a pretty picture. My students look forward to seeing the infographic and will ask questions during class, thinking they are getting the teacher off topic. All the while I am teach-

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March Science Connection

"March, in like a lion and out like a lamb!" If this old weather lore holds true, we can only hope to be basking in the warm sunshine soon! As do the seasons change so does our view of science education. More and more teachers are embracing the standards, emphasizing science concepts, processes and the application of student knowledge through investigations, explorations and engineering design. This is an exciting time to be involved in the roll out of the new science standards. We have been given an opportunity to change the trajectory of many students through learning experiences related to the natural phenomena that occur in our daily lives. Many thanks to those of you who have made contributions to this month's Science Connection. Your willingness to collaborate speaks to the collaborative nature of the NGSS implementation in our state. Again, I encourage those of you who have expertise, experience and energy to take part in the development of this science resource. The Science Connection, by teachers, for teach-

— *Christina*

NEXT GENERATION SCIENCE STANDARDS

Practice	DCI	Crosscutting Concept
Asking questions and defining problems	LS1 from molecules to organisms: structure and function	Patterns

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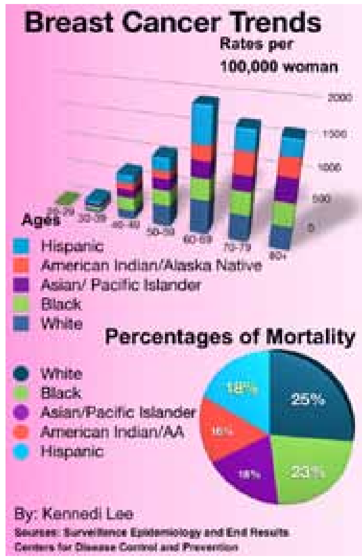
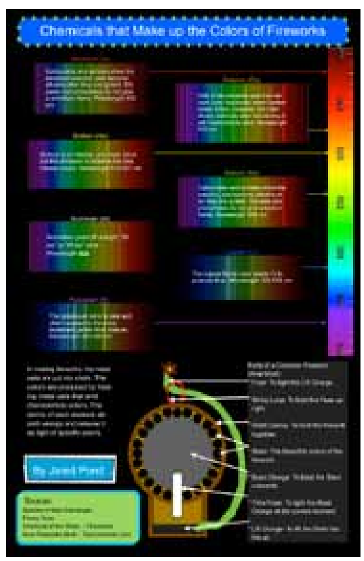
ing them about data literacy, various types of infographics and lots of new information. Eventually, I perform a more formal read aloud/think aloud of the infographic. I give my reactions to it and walk through my thinking and where my mind wanders when reading the infographic. This allows students to see my thought process. And I am teaching them how to think critically and look critically at data. This in itself is very powerful and personal as I am letting them into my mind. As a side note, this process creates a closer connection with my class, because they begin to share how I look at this information.



Back searching. (Practice 4 Analyzing and Interpreting Data; Practice 6 Constructing Explanations and Designing Solutions; Practice 8 Obtaining, Evaluating, and Communicating Information) An infographic, or for that matter anything on the Internet, is taken as scripture by students. I teach them to search for the infographic's sources or, if none are given, find the sources. My goal is to make them more scientifically literate. They have to look at the sources and dig through the original data in its non-infographic form. This also better explains the process of creating visual data to the student.

And do they take it personally when someone puts out something in an infographic that is either not truthful or highly misleading!



Comparison: (Practice 2 Developing and Using Models; Practice 4 Analyzing and Interpreting Data; Practice 6 Constructing Explanations and Designing Solutions) I put two infographics on the same subject side by side and ask my students to rip them apart, saying everything they don't like about them. Students find this cathartic and it puts them in a better frame of mind to really look at the infographics. I then have them discuss what they liked about the infographics. Sometimes, they realize that the very piece they didn't like before is valuable. I then have them cut out the pieces they like, paste the pieces on a new paper to create a hybrid of the two infographics, and add the infographic with markers and data they find online. This creates a "Frankenstein" infographic, but it again promotes a better understanding of priorities and what is important

Data Parsing: (Practice 4: Analyzing and Interpreting; Data Practice 8: Obtaining, Evaluating, and Communicating Information) The students are given a graphically-rich infographic and asked to present the same data in simple *xy* graphs. They learn how to the dig through data and how much data are available in some infographics, even when the information is simply presented.

Production: (Practice 2: Developing and Using Models; Practice 4: Analyzing and Interpreting Data; Practice 6: Constructing Explanations and Designing Solutions; Practice 8: Obtaining, Evaluating, and Communicating Information) My students next pick a topic within chemistry or biochemistry, and find the data needed to create an infographic. Using the *iWork* suite on the mac, especially *Pages*, they create infographics on the subject they have chosen. Other software, such as Illustrator, Adobe Photoshop, and even PowerPoint can work.

They create several versions that all receive journalistic style edits, either from peers, professional editors or myself. To create an infographic, the student must understand the data on a far deeper and personal level than they ever would for a research paper.

To quickly set up the infographic creation, I teach my students Pages and Numbers in a single day using a lesson titled the "Cell Phone Activity." In this activity the students use data from their own cellphone usage to produce an infographic in less than one hour. They list data on number of songs, apps, videos, texts, and calls. They create a function to find out the percentage of the total items on the cellphone. This data is used later to scale icons from Iconspedia.com to reflect the relative amount on their cellphone. The icons that apply to their phone are dragged to a poster size Pages file. They then add text boxes with descriptors and the percentages from Numbers. The icon receives a shadow and reflection to add interest, is scaled, linked to the corresponding text box and arranged in order by size. A background is added with a gradient, then a title and student name. This is all finished in 50 minutes and the student has produced their first infographic.

For me, the best part of the infographics project is you can get your students to sit down and comb over data for an hour, and at the end of the time they will thank you for doing something fun. Humans love visual information and love to explore data in this format. They look for comparisons, connections, trends, and find insights that the author may or may not have even intended. An infographic can also allow a person to see trends that would never visualize in other more traditional formats for conveying information. To learn more, go to www.science-infographics.org and see work created by my students, lessons, and the cellphone activity. Also check out my article in the March issue *of The Science Teacher*.

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Connections to Next-Generation Science Standards

Activity	NGSS Standards met by Activity
Read Aloud/ Think Aloud	Practice 4 - Analyzing and Interpreting Data Practice 8 - Obtaining, Evaluating and Communicating Information
Back Searching	Practice 4 - Analyzing and Interpreting Data Practice 6 - Constructing Explanations and Designing Solutions Practice 8 - Obtaining, Evaluating and Communicating Information
Comparison	Practice 2 - Developing and Using Models Practice 4 - Analyzing and Interpreting Data Practice 6 - Constructing Explanations and Designing Solutions
Data Parsing	Practice 4 - Analyzing and Interpreting Data Practice 8 - Obtaining, Evaluating and Communicating Information
Infographic Production	Practice 2 - Developing and Using Models Practice 4 - Analyzing and Interpreting Data Practice 6 - Constructing Explanations and Designing Solutions Practice 8 - Obtaining, Evaluating and Communicating Information

Matter and energy in organisms and ecosystem

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MS

The Core Idea LS2: Ecosystems: Interactions, Energy, and Dynamics is all about what happens in ecosystems. This disciplinary core idea addresses the relationships between living things in ecosystems; relationships between living things and the physical environment; how matter and energy move through ecosystems; and how ecosystems change over time. This big idea is divided into the subcategories below.

LS2.A: Interdependent Relationships in Ecosystems

LS2.B: Cycles of Matter and Energy Transfer in Ecosystems

LS2.C: Ecosystem Dynamics, Functioning, and Resilience

LS2.D: Social Interactions and Group Behavior

In middle school, students build on understandings that they learned in elementary school in each of these subcategories.

In LS2.A, middle school students have had prior learning experience that focused on recognizing food chains and webs as well as describing the relationships between producers, consumers, and decomposers. They can distinguish between healthy and unhealthy ecosystems.

Interdependent Relationships in Ecosystems is addressed in the sixth grade in the Kentucky Core Academic Standards (KCAS). To build on their previous understanding, students are expected to explore relationships within and among ecosystems more deeply by looking at how variables such as carrying capacity, limiting factors, and different types of interactions affect ecosystems.

One performance expectation in this subcategory (6-LS2-1) calls for students to analyze and interpret data as evidence of how resource availability affects organisms and populations within ecosystems.

One way to address this content is to have students read and interpret a graph that relates the availability of rain to the population of mice in a desert ecosystem and then look at graphs relating mouse population to snake population. They might be asked to explain how the two data sets relate to one another, to describe the relationships that they show, or make inferences about other organisms not shown in the graphs.

The other middle school PE for this subcategory (8-LS2-4) asks students to construct explanations that predict patterns of interactions that would apply across various ecosystems. One might ask students to research a single ecosystem to learn about the interactions within it and then to use that information to develop a claim about interactions that would occur within any ecosystem. They could do further research on other ecosystems to develop evidence that supports their claim in order to develop their explanation.

Cycles of Matter and Energy Transfer in Ecosystems is also addressed in 6th grade. Students should already know that matter from air, soil, and water moves between organisms and that matter in all states is released back

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into the environment. At the middle school level, they are asked to develop a model to describe this cycling of matter along with the flow of energy among living and non-living parts of an ecosystem (6-LS2-3). Students should be able to define where one ecosystem ends and another begins. They should understand that matter is conserved in these exchanges and be able to trace the energy as it flows into and throughout an ecosystem. It is important to note that the purpose of the model they develop is to describe. This means that they should be able to use their model(s) to help someone else to picture the cycling of matter, including how that matter is conserved, and the flow of energy, including how it enters the ecosystem.

The content for LS2-C: Ecosystem Dynamics, Functioning, and Resilience is addressed in 8th grade. Students already understand that changes in an environment can cause organisms to survive and reproduce, to move to new locations, move into the changed environment, or die (8-LS2-4). At the middle school level, they will build on this understanding by going into more detail about the changes that occur and using empirical evidence to examine the variables that affect the reaction of the organism to those changes.

One performance expectation at this level (8-Ls 2.4)asks students to construct arguments about living or non-living components of an ecosystem and how they affect the populations within that ecosystem. Students are expected to use empirical evidence to support their argument, recognize patterns in the data they are using to make inferences, and evaluate the evidence that supports their own and the arguments of others. The second performance expectation at this grade level (8.Ls2.5) is an engineering connection that requires students to evaluate competing design solutions for maintaining biodiversity and ecosystem services. They should be able to look at competing designs for services, such as a water purification system, and use constraints based on scientific, economic, and social principles to determine the "best" design. Negotiating these constraints would be a valuable use of instructional time as they include examination of principles in each of the disciplines and could even be part of a cross curricular unit involving social studies, mathematics, English/language arts, and science.

LS2-D Social Interactions and Group Behavior is not addressed by a performance expectation in middle school. However, the understandings related to it can easily be folded into the activities that are designed for instruction. This content concentrates on groups that form within ecosystems and how they benefit the organisms or populations. This could easily be addressed as part of LS2-A as one relationship between organisms.

KCAS Connections

Purposeful connections between science and mathematics

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ALL

Science class should be the opportunity students have to apply math concepts and skills to real world situations. Many of the same skills learned in math class can be applied successfully during science class. Mathematical thinking and making connections to math students already know will enhance students' science understanding at all levels. Great science lessons intentionally help students make connections between math and science in applicable ways. The Next Generation Science Standards (NGSS) include resources to assist teachers in making those intentional connections with Kentucky Core Academic Standards for Math (KCASM).

This article will focus on ways teachers can make intentional connections between the science Disciplinary Core Idea (DCI) of Interdependent Relationships in Ecosystem (LS2) and math standards at elementary, middle school and high school levels.

Elementary

Grade 2 students can apply math skills to create picture and bar graphs to represent a data set with up to four categories to show results (such as height, time to sprout, etc.) from planning and conducting an investigation to determine if plants need sunlight and water to grow. Collecting and organizing data in this way provides the foundation for comparing facts and visually showing relationships. Bar graphs help students to see relationships quickly. (NGSS 2-LS2-1, Math 2.MD.D.10, MP 1, 2, 3)

Grade 3 students work with social interactions and group behavior of animals. When thinking quantitatively about larger numbers, students should apply the skills learned from working with number and operations in base ten to describe how animal group behavior affects survival. Students master rounding whole numbers to the nearest 10 or 100 using place value and learn to fluently add and subtract within 1000 using various strategies. Applying these skills to science by having students count animals in groups and consider group size of animals in different situations will benefit more exact explanations students offer for animal behavior based on environmental conditions. (NGSS 3-LS2-1, 3-LS2-D, Math 3.NBT, MP 1, 2, 3, 4)

Middle School

In middle school, teachers should provide students opportunities to apply mathematical skills learned from math

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ratio and proportional relationships to analyzing and interpret data from investigations, distinguish between correlation and causations, and basic statistical techniques of data and error analysis.

When analyzing interdependent relationships in ecosystems, students can apply math skills to explore ratios and relationships in amount of space and populations of organisms in a particular ecosystem. This can include the number of producers in an area of space and the subsequent effects if the space is proportionally larger or smaller. Students can analyze the volume of liquid needed in an aquatic habitat to produce the appropriate ecosystem for organisms to thrive, to make connections to volume and to apply math work with volume to the science investigations.

Middle school students can summarize and describe distributions using graphs and statistical tables to support viable arguments and analyze results of investigations. (NGSS LS2-1, 3, 4, 5/ LS2-A,B,C,D Math 6.RP, 7.RP, 6-8.EE, 6-8.SP, MP 1, 2, 3, 4)

High School

High school students should constantly ask, "How can I use real data to show results, relationships, and representations?" High school science investigations provide authentic application of mathematical thinking and use of mathematical reasoning skills. For example, when students study cycles of matter and energy transfer in ecosystems, they can count the respirations of gold fish in different aquatic environments and graph the data, and then use the graphs to analyze the impact of various organisms within that system.

Students can study photosynthesis and plant respiration using elodea plants in different conditions. Elodea is a water plant and is strongly photosynthetic (dense chloroplast structures), which means students can observe oxygen bubbles being given off by the plant underwater when exposed to a strong light source. Students collect data based on differing conditions and then ask themselves, "How can I use data to show flow of energy in different conditions?" (NGSS HS-LS2, Math HSN-Q.A.1,2,3, HSS- ID.A.1, B.6, MP 1,2,3,4)

In conclusion, science teachers should look for every opportunity to purposefully and intentionally integrate science with mathematics in authentic ways. Science investigations provide those opportunities to collect data and use number sense in real world applications at all grade levels. Teachers must make explicit and purposeful connections to mathematics and encourage students to apply math skills in science classes. Teachers should plan collaboratively and look at both sets of content standards to see where connections can naturally be made between science and mathematics and ask, "How can I provide opportunities for students to apply concepts and skills learned in math within the science class?"

The NGSS provides Appendix L with more specific examples of how to integrate math and science standards. http://www.nextgenscience.org/sites/ngss/files/Appendix-L_CCSS%20Math%20Connections%2006_03_13.pdf

Tier two vocabulary: A hidden piece of the vocabulary puzzle

Teresa Rogers, *KDE Consultant*

ALL

In Thinking as a Science, Henry Hazlitt stated, "A man with a scant vocabulary will almost certainly be a weak thinker. The richer and more copious one's vocabulary and the greater one's awareness of fine distinctions and subtle nuances of meaning, the more fertile and precise is likely to be one's thinking. Knowledge of things and knowledge of the words for them grow together. If you do not know the words, you can hardly know the thing." The NGSS presents a new approach to building student knowledge, which requires a deeper understanding of vocabulary as they delve into richer, more complex texts.

So, will simply assigning more vocabulary words impact student learning? According to Appendix A of the Common Core Academic Standards, students need incremental, repeated exposure to a variety of contexts to the words they are trying to learn. However, how do you make the instructional decision of what words to teach? Appendix A addresses provides guidance by identifying three tiers of words. Rather than a hierarchy of importance, the tier represent how these words are acquired and the amount of effort required in their acquisition. Understanding these tiers can help educators plan effective instruction.

- Tier One words are the words of everyday speech and are normally learned in the early grades.
- Tier Two words, often referred to as general academic words, are more likely to appear in texts than in speech. Found in all content areas, they often represent subtle, precise ways to say relatively simple things. Words commonly found in scientific texts might include relative, multiple, specificity, reacts, average anddefinite.. According to David Liben, tier two words can carry a disproportionate weight in conveying the meaning of a text, and a reader who doesn't understand even a single such weighty word might have his or her comprehension thrown off track.
- Tier Three words are specific to a content area, e.g., molecule, oxygen, atom, and molarity. They are commonly defined explicitly in the text or glossary.

Teachers typically define tier three words prior to encountering them in a text and reinforce them frequently throughout a lesson. Tier two words are not unique to a specific discipline, so teachers often overlook this support for students. In addition, tier two words are typically difficult to understand by using context clues and texts rarely provide explicit explanations.

So where do you begin instruction of tier two words? The

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first step is to recognize and develop an awareness of the key role these words play in texts. Asking questions such as:

- What are the tier two words in this text? What variations may students find?
- What are the shades of meaning of this word?
- Does this word have multiple meanings?
- How critical is this word to understanding the text?
- What words will cause the most difficulty for my students?

Once you have identified these hidden pieces of the vocabulary puzzle, purposely incorporate them into instruction. Provide students with multiple opportunities to use and respond to the words through informal talk, discussion, reading, and responding to what is read. Creating intentional encounters over time leads to significantly greater gains in student acquisition, and ultimately, a deeper comprehension of the content.

To learn more about Tier Two words and assist you in planning, check out:

Appendix A of the Common Core Academic Standards for English Language Arts & Literacy in History/Social Studies, Science, and Technical Subjects http://education.ky.gov/curriculum/docs/Documents/CCA%20Appendix%20A.pdf

Which Words Do I Teach and How? http://www.achievethecore.org/content/upload/Liben_Vocabulary_Article.pdf

Instructional Guide for General Academic Vocabulary http://www.ride.ri.gov/Portals/0/Uploads/Documents/Common-Core/Instructional-Guide-for-Academic-Vocabulary-blank.pdf

Literacy strategies to tackle texts

Latisha Sparks, *KDE Regional Instructional Specialist*

ALL

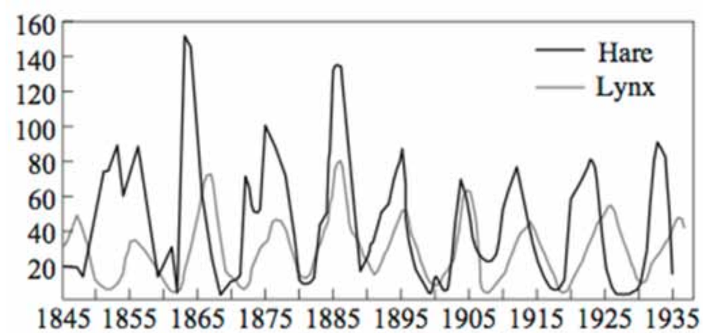
Life Science 2-Ecosystems: Interactions, Energy and Dynamics, like most of the NGSS standards, asks students to make meaning of textual information. hat information may be presented in many different forms including: graphs, tables, student- generated or published lab reports, charts, infographics and other texts. Students are expected to understand and synthesize the information presented in an array of multiple texts in order to understand and communicate an understanding of the scientific phenomena. While this may seem like a lot (and it is) there are a few things to keep in mind that can make the process simpler for students and the teacher.

Modeled reading

It cannot be overstated how much students benefit from having teachers explicitly walk them through the process of making meaning of a text. This modeled reading experience is even more important in comprehending content specific texts due to the complexity of vocabulary, and content and the limited exposures most students have had to these forms of writing.

In early education and in life, most students have had many experiences with narrative, linear text including fiction and non-fiction. But in order to understand science students must also learn how to read charts, tables, lab reports and graphs. Teachers can assist students by explicitly guiding them through the parts of and information in these types of scientific text.

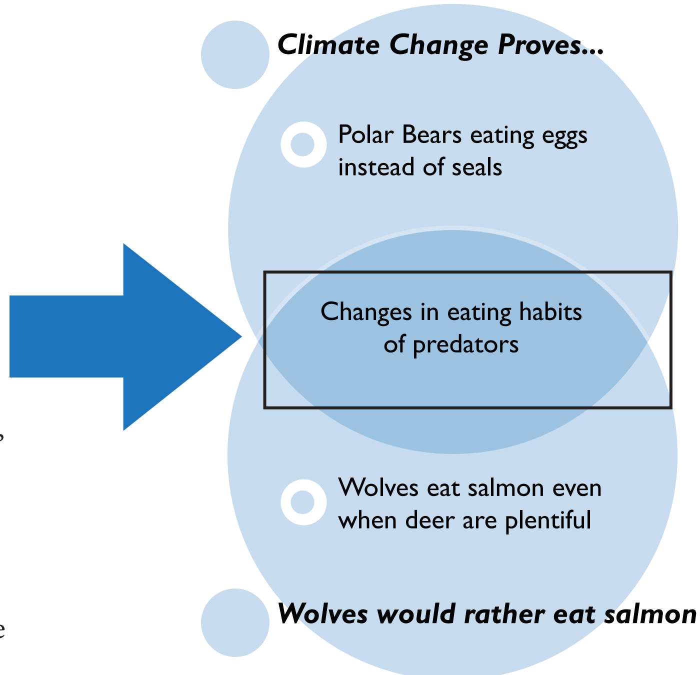
Consider the graph below. The teacher would want to make it clear to the students that in order to understand a graph it is crucial to first look at all of the information being presented. In this case, it would be important to point out that the information on the left side is defining the number of a species and the information across the bottom is showing time. Moving through the graph the teacher would point out that using the number and time information it is possible to see that that hare population is at times increasing and at other times decreasing. Here is an opportunity for the teacher to model her thinking by explaining to students that she is wondering about the relationship between populations at various points on the graph. By sharing aloud her thinking, the teacher brings awareness to a causational relationship and models for students the kind of thinking they should be doing when reading a graph.



This lesson would follow a similar pattern as the teacher moved the students through all of the information on the graph. For students with limited background experiences related to interpreting or reading graphs, this type of modeling of the process needs to happen multiple times. Each new form (tables, scientific articles, lab reports) will require multiple modeled readings as well. Explicit instruction in how to read scientific text provides students with the tools and confidence for future independent reading.

Tools

Once students understand the components of scientific texts through teacher modeled reading experiences, they still need tools to gain entry into the complexity of these texts. Literacy tools, or activities, can act as a sort of scaffolding for students on their way to independent reading. Typically literacy activities are labeled for use before, during or after reading with some being suitable for more than one stage. The key for learning is to make sure the literacy activity is appropriate for the text being read and the learning target. Consider that students are being asked to read an article about ecosystems and predator/prey relationships. The teacher might ask students to respond to an anticipation guide that includes several statements about ecosystems and habitat adaptations. The students would then read the article while looking for evidence to support their anticipation guide answers. Later in the course of the unit, the teacher could provide the students with a Venn diagram to compare two texts. The graphic below gives an example of what that might look like in a classroom where students are looking at two articles about predator/prey relationships. Tools like anticipation guides, and Venn diagrams may seem like old news but they can still be effective in bridging the space between students and texts.



Talk Time

Before, during and after reading students need time to talk. Verbal communication is an important and often overlooked part of making meaning of text. Talking about text can be as simple as having students form pairs and discuss the texts or teachers can create specific questions for the groups to answer. Separating the text into sections or jigsaw reading, allows students to become experts on their section and then verbally share their understanding. Socratic Seminar is a way to involve a larger group of students in a conversation about a text. As students engage in these conversations it is important to create the expectation that they connect their talk to the text. Using textual information and citing evidence in conversation will move students toward a deeper understanding of the text.

Conclusion

Scaffolding literacy instruction takes time and planning but the results are worth the effort. Taking time to show students how to read science texts, giving them tools to delve into the text and encouraging conversations about the text all move students closer to being able to read and comprehend science text independently and proficiently (KCAS RSL. 10)

Incorporating project-based learning into classrooms

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ALL

As Next Generation Science Standards are rolling out across the commonwealth teachers are looking for ways to incorporate project- based learning into their classroom. The article below introduces teachers to Project Lead The Way's Biomedical Science (BMS) pathway for high school students. In BMS students play the role of biomedical professionals as they investigate and study the concepts of human medicine, physiology, genetics, microbiology, and public health. In the PLTW Biomedical Science program, students engage in activities like investigating the death of a fictional person or dissecting a sheep's heart, learning content in the context of real-world cases. They examine the structures and interactions of human body systems and explore the prevention, diagnosis, and treatment of disease. Students work collaboratively to understand and design solutions to the most pressing health challenges. The future of the biomedical sciences comes alive in this rigorous and relevant four-course sequence that prepares students to continue their studies through post-secondary education and careers.

For STEM Jobs eMagazine: http://www.flipsnack.com/95C6DEB8B7A/ftcjwmf3 Courtesy of: STEM JOBS®

How did Anna Garcia die?

It was a hot, 92°F summer morning. The emergency call came in at 9:45 a.m. A man contacted the police to report that he was worried about his next door neighbor, a woman named Anna Garcia. He informed the police that he had spoken to Anna the previous morning when he saw her walking her dog around 6:30 a.m. He decided to call the police this morning because Anna's dog had been barking excitedly for the past two hours. He tried to call Anna on the telephone, but no one answered. Both the police and the EMT arrived at the scene at 9:56 a.m. Upon entering the house, they found Anna lying face down in the entry hallway. The EMT determined that Anna was dead. The police immediately notified your team of crime scene investigators as well as the medical examiner, both of whom were dispatched to the house.

Your team arrives at the scene. Yellow police tape marks the perimeter. You notice a toppled lamp and table, a handful of pills strewn across the floor, an overturned cup of juice, and a muddy shoe print. The outline of woman's figure lies in the middle of the crime scene. It is your job to figure out what led to Anna Garcia's death. Where do you begin? Has a crime been committed?

Each year this type of incident takes place in the U.S. But

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it's not nearly as morbid as it appears. Anna Garcia is a fictional character and part of Project Lead The Way (PLTW)'s Principles of the Biomedical Sciences (PBS) course. Her mysterious death greets students the first day they enter the PBS classroom. Through her case, students have a chance to experience what it is really like to investigate a crime scene as they explore different careers in biomedical sciences – 30 different careers, in fact.

Setting aside pop culture images of crime scene investigations and forensic science, the reality is that every career in biomedical sciences requires a deep understanding of how to apply science, technology, engineering, and math (STEM) to solve complex problems. The case of Anna Garcia begins on day one and spans the entire course, bringing human physiology, medicine, research processes, and bioinformatics to life in the classroom in the context of one woman's life and death. Students piece together evidence from the crime scene and document their ongoing investigation and analyses. The PBS course comprises a series of activities, projects, and problems that build on one another to pave the way for increasingly complex – and fun – work in the classroom. The solution is open-ended, surprising, and surprisingly real. The muddy boot print and chaotic scene, not to mention (fake) bloodstain on the floor, require careful investigation. Students design and conduct an experiment to analyze the blood splatter on the scene, drawing conclusions to explain Anna's untimely death.

Using autopsy reports and medical history documents, students also explore possible natural causes, such as diabetes, heart disease, sickle-cell disease, and infectious diseases. Students ask themselves tough questions that biomedical sciences professionals think about on a regular basis: What could Anna have done differently? What would you have recommended she do differently to prolong her life? And they ask questions that explore the impact medical breakthroughs could have on improving our lives and making a difference in the world: What innovations could improve the life of a person with Type 1 diabetes?

Knowledge in Biomedical Sciences paves the way for a wide range of careers. A small sample of recent graduates who completed at least one PLTW Biomedical Sciences includes students who went on to study microbiology, chemistry, nursing, nutrition and dietetics, pharmacy, and neurobiology; other students were enrolled in medical or dental school, pursuing careers in forensic science, or conducting research in immunology and cancer. The opportunities are many. What is more, the jobs are highgrowth and personally and professionally rewarding. CNNMoney's November 2013 ranking of the 100 "Best Jobs in America" listed Biomedical Engineer and Clinical Nurse Specialist in first and second place based on pay, growth prospects, and satisfying work; two other jobs – General Surgeon and Clinical Research Associate also ranked in the top ten. If you are intrigued by the mystery of Anna Garcia – and the many mysteries that Anna represents – careers in biomedical sciences are worth investigating.

About PLTW

Project Lead The Way (PLTW) is a 501(c) (3) nonprofit organization and the nation's leading provider of STEM programs. PLTW's world-class, activity-, project-, and problem-based curriculum and high-quality teacher professional development model, combined with an engaged network of educators and corporate partners, help students develop the skills needed to succeed in our global economy. More than 5,000 elementary, middle, and high schools in all 50 states and the District of Columbia are currently offering PLTW courses to their students. For more information on PLTW's Biomedical Sciences, Engineering, or Computer Sciences programs for high schools, visit www.pltw.org.

For more Information, please contact Director of School Engagement KY/TN Mark Harrell mharrell@pltw.org c:502-803-0836

Why environmental education?

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Teachers use environmental education as an avenue to teach NGSS. In December 2011, the Kentucky Board of Education voted to support the Kentucky Environmental Literacy Plan (KELP) in conjunction with the implementation of the Next Generation Science Standards. The plan was developed in a collaborative effort between the Kentucky Environmental Education Council and the Kentucky Department for Education. The Kentucky Association for Environmental Education also partnered in developing the plan. Over 200 individuals and organizations helped write the plan by participating in the plan's development (http://keec.ky.gov/Publications/Pages/KELP.aspx).

The goal of KELP is to provide students and educators with tools and resources vital to building environmental literacy in the Commonwealth. Students need a solid understanding of the interconnections between human and environmental systems, current environmental challenges and how these connect to civic engagement and responsibility. To achieve this, it is essential to give students a solid understanding of current environmental challenges while providing them with basic tools to find solutions and make informed choices.

Environmental science and 21st Century Learning Skills are key components of the NGSS. The skills and abilities required for environmental literacy are also needed to demonstrate proficiency on many NGSS Performance Expectations. In Appendix H of the NGSS, teachers will see that environmental topics are not limited to one specific Disciplinary Core Idea (DCI) strand, but throughout many

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DCIs. For example, HS-PS1-5 requires students to: "Apply scientific principles and evidence to provide an explanation about the effects of changing the temperature or concentration of the reacting particles on the rate at which a reaction occurs." By investigating the effects for thermal pollution on river ecosystems, students relate their knowledge and skills to a real world setting. Another DCI example is ESS3: Earth and Human Activity. Teachers can look through the strand as it progresses through grade levels to see how student learning is expected to build on previous grade-level specific concepts.

A growing body of research demonstrates that using an environmental connection to teach other concepts has positive student results.

- Incorporating environmental connections increases student achievement on standardized tests and other measures of academic progress in all content areas, not just science (Athman & Monroe, 2004; Falco, 2004; Lieberman & Hoody 1998; NEETF, 2000; Norman, et. al, 2006; SEER, 2005). In fact, *Closing the Achievement Gap (*Lieberman & Hoody 1998) included research from four schools in Kentucky— Clay County High School; Jackson County Middle School; and Valley High School and Wheatley Elementary in Jefferson County.
- Environment-based education also has been shown to improve student motivation, measured by increased attendance, decreased tardiness and fewer discipline referrals. (Lieberman & Hoody, 1998; NEETF, 2000; SEER, 2005). Attendance and timeliness are particularly important due to the fiscal implications of absenteeism on school district funding.
- Using the environment and the outdoors for educational purposes has a positive influence on student health. National studies show a correlation between taking students outdoors for learning and decreased obesity, depression and anxiety (NEEFT, 2011).
- Kentucky teachers have done similar research in their own classrooms to decide if using the environment and the outdoors impacts their students' learning. Teaching biology at Southwestern High School in Pulaski County, James Cox (james.cox@pulaski.kyschools.us) experimented with using outdoor instruction in four classes, throughout an entire school year. He alternated which classes had outdoor, environmentally-oriented instruction and which had traditional instruction. In all cases, unit test scores from the outdoor, environmentally-oriented instruction were higher than those from traditional instruction. In another study, Cassy Elmore (cassy.elmore@lincoln.kyschools.us) from Lincoln County Middle School simply administered her tests indoors and outdoors to determine if the outdoor setting made a difference in student achievement. Her 7th-grade students all received the same instruction and the same pre- and post-unit tests but some were seated outdoors and others in the classroom. For both the pre- and post-tests, those students seated outdoors scored higher. These research results provide a compelling reason to use environmental connections and the outdoors in your instruction. A great source for more research information is the Children and Nature Network (http://www.childrenandnature.org/).

Another reason to use environmental education as a way to teach the NGSS is that it is fun! Most students today enjoy the outdoors but do not have the opportunity to spend much time there. In a school setting, an outdoor, environmental connection provides a real world context for learning; stimulates the senses (helping attention deficits); and allows students to apply their knowledge to problem solving and decision making while offering a change from traditional classroom approaches. There are many excellent resources here in Kentucky to help teachers use the environment to improve the effectiveness of their instruction. One good place to start is the environmental education column that is featured in this newsletter every month. Other good contacts include the Kentucky Environmental Education Council (www.keec.ky.gov), the Kentucky Association for Environmental Education (www.kaee.org), the Kentucky University Partnership for Environmental Education (http://www.kupee.eku.edu) and the EE in Kentucky website (www.eeinkentucky.org)

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Using environmental education to teach Interdependent Relationships in Ecosystems: A natural fit

Elizabeth Schmitz, *Executive Director, Kentucky Environmental Education Council*

MS

There are so many connections between environmental education (EE), interdependent relationships, and analyzing and interpreting data that it is difficult to limit the scope of this article to the required word length. Nonetheless, here are just a couple of ideas for teachers at the middle and high school level that can help you use experiential activities to teach these crucial concepts.

Oh, Deer!

One beloved EE activity that fits perfectly with MS-LS2-2 is found in the EE Curriculum, *Project WILD. The activity is known as "Oh, Deer!" As a result of this activity, students will identify and describe food, water, and shelter as essential components of habitat; describe factors that influence carrying capacity; define "limiting factors" and provide examples; and recognize that natural fluctuation in wildlife populations are part of the constant change found in ecological systems (page 36, Project WILD K-12 Curriculum and Activity Guide, Council for Environmental Education, 2003). During multiple rounds of the activity, students act as deer populations and components of habitat, and experience how the deer herd shrinks and grows in response to habitat conditions and associated limiting factors. Predators, droughts, and other conditions that impact population size can be introduced during various rounds. At the conclusion of each round, a tally of the deer population is summarized and graphed. At the end of the activity, students review the resulting graph, and basic statistical analysis can be performed.*

Photo by Bryan Thompson, Blackacre Nature Preserve, Jefferson County

- While this activity is designed for grades 5-8, it would also be an excellent tool for assessing or ensuring students' base knowledge for HS-LS2-1 and HS-LS2-2.
- At the middle school level, "Oh, Deer!" addresses the crosscutting concepts of:
  - Patterns (identify cause and effect relationships), and
  - Stability and Change (small changes in one part of a system might cause large changes in another part).
- "Oh, Deer!" supports the Science and Engineering Practices of:
  - Constructing Explanations and Designing Solutions (Construct an explanation that includes qualitative or quantitative relationships between variables that predict phenomena), and
  - Analyzing and Interpreting Data (Construct, analyze, and/or interpret graphical displays of data to identify linear and nonlinear relationships; distinguish between causal and correlational relationships in data; apply concepts of statistics and probability to analyze and characterize data).
- It also supports Core Content for Mathematics:
  - MP.4 (model with mathematics), and
  - 6.SP.B.5 (summarize numerical data sets in relation to their context).
- While this activity best fits Kentucky Academic Core Standards for middle and high school, it can easily be applied to younger grades, as demonstrated in the photos accompanying this article.

To learn more about Project WILD, visit www.projectwild.org.

Educators must attend training and become certified in Project WILD before they are able to access the curriculum. To learn about upcoming trainings or find a training facilitator, contact Amy Eichorn with Kentucky Fish and Wildlife: Amy.Eichorn@ky.gov, or by phone at 270-625-9492.

Schoolyard Lichen Survey

Exploring lichens and their presence and/or absence is another opportunity to get your students outdoors, this time exploring MS-LS-2-2; HS-LS2-2; and HS-LS2-6. Science and Engineering practices used in this activity include: Analyzing and Interpreting Data, Using Mathematics and Computational Thinking, and Engaging in Argument from Evidence.

Students explore the growth of lichens on trees on your school campus (this is also a great opportunity for students and/or teachers to identify the kind of trees and lichens growing on campus); gather baseline data by determining the percent of lichen coverage on tree species found on site; and attempt to correlate any changes in lichen coverage to environmental factors such as air quality/atmospheric pollution (sulfur dioxide, ground level ozone, or acid rain).

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This activity is available free of charge via Hands on the Land, at http://www.handsontheland.org/data/monitoring/documents/Lichen-Lesson.pdf. In certain cases, data collected from this activity may be submitted to Hands on the Land for their citizen science initiative.

Environmental education specialist Roberta Burnes (Kentucky Division for Air Quality) is available as a resource to assist with researching and/or implementing this activity with your students, and/or can provide professional development workshops to help teachers in your school district implement this activity and other activities relating to air quality, for grades K-12. Ms. Burnes can be reached via email: Roberta.Burnes@ky.gov, or by phone at (502)564-3999.

Literacy Design Collaborative: New Look and New Tools

Kelly Philbeck, *ELA Network Specialist*

ALL

The Literacy Design Collaborative launched its newly designed site last month www.ldc.org . On the site, teachers will find many new and updated resources and a revised set of template tasks. Template Task Collection 2 offers some revisions in the phrasing of the original 29 template tasks. L2 and L3 options have been enhanced by a list of eight demands to help students meet the rigor of the CCSS literacy standards. These demands can be added to teaching tasks to increase the cognitive challenge of the task. They may also be used to differentiate for specific students or specific classes. In Collection 2, teachers will also see a more clearly defined list of texts that can be used in an LDC module and a list of diverse student product options. These options provide teachers with the opportunity to create their LDC teaching tasks and modules so they are a natural fit into each content area. LDC is a strategy science teachers can use to engage their students in scientific reading and writing as it naturally would occur in science content instruction.

The most exciting feature of the new LDC site is the CoreTools section. Teachers create log-in credentials to access a bank of teacher-created modules. Human Impacts on Marine Ecosystems, Nuclear Sustainability, Pesticides: A Blessing or a Curse are just a few of the modules available for science teachers. The CoreTools log-in also allows teachers to access the new module creation tool. Here, teachers can decide whether they would like to create their modules using an LDC prototype or if they would like to use a blank template.

Once teachers open and begin a module, there is also a mini-task library which can be accessed through the process of module creation. Teachers will find mini-tasks for each of the four components of the LDC Instructional Ladder: preparing for the task, reading process, transition to writing, and writing process. These mini-tasks are customizable to accurately capture classroom instruction.

Along with www.ldc.org, Kentucky teachers trained in LDC also have access to using Module Creator (www.modulecreator.com). Module Creator provides teachers with a bank of teacher-created modules searchable by grade and content, a module design tool, and a lexile-leveled bank of texts through EBSCO.

Additional support materials for LDC and for literacy in science and other content areas may be accessed through www.kellyphilbeck.com . Once on the site, be sure to look at the LDC tab, the Literacy tab, and the Favorites tab for a variety of literacy strategies that can be used in science classrooms. Also under the Favorites tab, teachers can find a section of Text Resource sites to provide texts that could be used in the science classroom.

Teachers who would like to learn more about LDC or who would like to schedule LDC training/support may contact Kelly Philbeck at kelly.philbeck@education.ky.gov to discuss your LDC needs.

Science for All

Co-teaching in the science classroom

Tristan Parsons, *KDE Consultant, Division of Learning Services*

ALL

In the science classroom there are a variety of co-teaching models that can be used to increase levels of learning and student engagement. This article addresses the following models: stations, team teaching, and parallel teaching.

Station co-teaching model is used to divide the instructional content into two or three segments. When using two stations there is a teacher at each station presenting different content at separate locations within the classroom. A third station can be used for independent work, to decrease the number of students in each work group, allowing for more individualized instruction. Station co-teaching can be used at any grade level. Some benefits to the station co-teaching model are as follows:

- Students can work in small groups; more individual attention is given to students, while many levels of readiness can be addressed.
- Station co- teaching is well suited to science cooperative learning activities, science reading groups and learning centers. Stations can be used for review (remediation or tutorials), enrichment activities and introduction of new vocabulary.

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Team teaching model consists of both teachers fully sharing the teaching responsibilities for all students. Both teachers actively share the planning and instruction of content and skills for all students. Both teachers exchange ideas and concepts in front of learners. Teachers share facilitation responsibilities of small group work and student led discussions. Both teachers model appropriate questioning techniques and think aloud strategies. Teaching roles are interchangeable and there is a constant level of active involvement during the entire lesson. Some benefits to team teaching are as follows:

- Team teaching provides a supportive environment for both teachers. Allowing opportunities to discuss issues related to students such as behavior, motivation and teaching styles.
- Teachers are exposed to different styles of planning, organization and presentation. It encourages the development of new teaching approaches.
- Both teachers have an opportunity to actively teach all students.
- Teachers are viewed as co-equals.
- Team teaching can be used for practically any type of activity, but is best suited for whole group instruction. Purposeful planning between the two teachers is necessary if this model is going to be successful.

Parallel teaching classes are divided into two large groups, each teacher taking a group. It is best practice that each group faces a different direction of the classroom as the groups are taught the same content simultaneously. Groups can be formed heterogeneously, based on readiness, or even learning style. Allowing instruction to be designed to meet the needs of the students. Parallel teaching works well when there is a need to use leveled reading materials.

Some benefits for parallel teaching are as follows:

- Student teacher ratio is low
- Increased opportunities for students to participate and receive help
- Student responses and knowledge can be more closely monitored
- Students with behavior problems can be separated
- Teaching can be tailored to meet the needs of much smaller groups

To learn more about co- teaching check out the following resources:

http://nichcy.org/schoolage/effective-practices/coteaching

Co- Teach! By Marilyn Friend can be found at www.coteach.org

The Power of Two 2nd edition DVD can be found at www.forumoneducation.org

Be In The Know

CIITS Update

Joe McCowan, *KDE Consultant*

The components of CIITS are used to provide additional support for managing teaching and learning at the classroom level for all educators. However, did you know CIITS also supports students use? Students can login to their CIITS home page to take assessments that have been assigned to them by the teacher. They also can also login to access instructional materials, too. Teachers can create a student resource, search for a student resource already in the system, add instructions or attachments and assign these to students. Once the teacher has made these assignments, the students will see everything they need once they login. The login metrics have been showing at least 50,000 students have been logging in per week and this number continues to increase as more teachers become aware that CIITS can do this. This is a very powerful feature that can be used to connect and deliver instructional materials aligned to standards prior to taking assessments online. If you are wondering about the steps it takes to make this happen in CIITS, you can check out the support materials at the following link: CIITS Resources and Materials. We would also like to hear your feedback related to students using CIITS and this can be sent back by using the suggestion box located on your CIITS home page.

From "Wow" to "I Wonder"

Greg Geihart, *Professor, Murray State University*

EARLY CHILDHOOD

Science at the early childhood level is shifting from the "WOW" to the "I Wonder" stage. Being involved with the Early Learning Leadership Network (ELLN) at the state and regional level has allowed me to recall how I first investigated many of the science standards. For example, the ELLN decided to focus on pushes and pulls. My mind went racing back to HotWheels tracks and designing elaborate paths for the car to travel.

There area lot to the kindergarten standards dealing with pushes and pulls that a teacher must consider. The performance expectations clearly state that students must conduct and design an investigation (http://www.nextgenscience.

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org/kfi-forces-interactions-pushes-pulls) which involves comparing the effects of the direction and speed of an object.

Planning with the state ELLN team is exciting and invigorating. As a resource, the committee began with an article about building ramps and pathways from the Young Children Journal (http://www.naeyc.org/files/naeyc/Ramps_Pathways.pdf). This article was the impetus behind our planning for a learning experience for teachers in the regional ELLN to investigate pushes and pulls. The pictures in the article told us the story of the students engaged in the learning experience.

A video was chosen to show teachers of the elaborate designs students can create with their ramps and pathways (http://www.youtube.com/watch?v=ReaIZFxiy4I). Of course there are vendors who have created materials to assist teachers in developing the concepts related to pushes and pulls (http://www.youtube.com/watch?v=9Qwgu58SQAo). One vendor has taken the pushes and pulls outside in the form of a product called Magna Walls

From the onset of the planning, it was important for our teachers to not be overwhelmed with the NGSS but to understand that there are wonderful learning experiences for our students to make connections to the NGSS. Resources were gathered to assist us. Nancy Lovett used ideas from Peep and the Big Wide World (http://www.peepandthebigwideworld.com/guide/pdf/peep-guide-ramps.pdf) to construct the ramps and pathways.

The collaboration and the excitement of the teachers when it came to the construction of the ramps and pathways showed the trainers great promise that they may return to the classroom to investigate with their students about ramps and pathways. By the way, many of these teachers went back to the classroom and documented their experiences and shared them with the trainers.

Ramps and pathways are an excellent way to make connections to the NGSS. Teachers realized this at the Kentucky Early Learning Network. Well done ELLN, well

Science as Problem Solving

(Ramp & Pathways Activity Instructions)

Play Experience Posed as a Problem

1. **Problem #1**: Use a ramp to roll an object to a targeted spot.
   - As a team, develop your plan.
     * Design a ramp, sketching it on your whiteboard (before building). You will be provided 4 pieces of ramp in varying lengths (36 inches, 20 inches, 16 inches, 12 inches).
     * Predict where the object will stop. Mark that spot with an X. Consider this the target spot.
   - Conduct (implement) your plan.
     * Build the ramp and roll the ball down the ramp.
     * Mark the actual spot the ball stopped with a different color X.
     * Make any necessary changes to the ramp to make the ball stop at the target spot.
2. **Problem #2**: Create a new ramp that transports the ball to the same targeted spot.
   - As a team, develop your plan.
     * Trade one piece of ramp for a different sized ramp piece with a neighboring team or get another piece from the facilitators.
     * As a team, discuss "What changes do you need to make the ramp design so the object stops at the target spot?"
     * Sketch ramp design changes on your whiteboard.
   - Conduct (implement) your plan.
     * Make necessary changes to ramp.
     * Roll ball down the ramp.
     * Continue to make design changes until you achieve goal - object stops at the target spot.
3. **Problem #3**: Roll a ball down a ramp to knock objects over.
   - As a team, develop your plan.
     * Get some objects to use as obstacles. Place the obstacles at a point beyond your targeted spot.
     * As a team, discuss "What changes do you need to make to the ramp?"
     * Sketch ramp design changes on your whiteboard.
   - Conduct (implement) your plan.
     * Make necessary changes to ramp.
     * Roll ball down the ramp to knock over obstacles.
     * Continue to make design changes until you achieve goal - the obstacles are knocked down.

Draw conclusions

* What discoveries did you make? Record your conclusions in the space below and/or on the back.

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Professional Learning Opportunities

2014 Kentucky Association for Environmental Education Conference

"Sustaining Our Future", September 12-13, 2014

Fun for you AND your whole family!
Picnic Dinner and Hike at McConnell Springs • Live Auction
Tours of Local Sustainability Practices • Pre-Conference Workshops
Discounts on Family Activities • Mystery Table
Over 30 Great Sessions • And more!

Science Teacher Professional Development Opportunities
Presented by PIMSER at the University of Kentucky College of Education

NGSS Short Courses for Teachers

One-day short courses for elementary, middle, and high school teachers focused on strengthening content understanding, developing and using models, and using mathematics and computational thinking. Teachers will leave with a deeper understanding of the NGSS, both content and practices, along with sample activities that can be used with students.

Date	Topic	Grade Levels
June 16	Light	1 and 4
June 23	Force and Motion	K and 3
June 30	Properties of Matter	2 and 5
July 21	Developing and Using Models	6 through 8
July 25	Using Mathematics and Computational Thinking	9 through 12

Complete details on each course here: http://www.rsvpbook.com/ngssshortcourses

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Engineering Teaching Kit Training for Middle School Teachers

April 10 – 7th Grade Teachers: Save the Black Footed Ferrets
April 11 – 8th Grade Teachers: Save the Seabirds

Teachers will experience a research-based engineering teaching kit (ETK) that is tightly aligned to science content standards for that grade level. They will leave with a deeper understanding of the science content being addressed, an understanding of how engineering design is used to promote science content understanding, critical considerations for developing integrated units for other standards, and a copy of the curricular materials.

$100 per session

Complete details on each session here: http://www.rsvpbook.com/etkspring2014

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Collaboration and Connections:

The Science Connections Newsletter offers a forum for science professionals across Kentucky to collaborate and share classroom experiences. You are encouraged to share instructional strategies, resources and lessons that you have learned with colleagues across the state. Note that your entries should relate to one, or all, of the topics for the next month as noted below.

Below are the upcoming SCN focus dimensions:

Coming up:	Science and Engineering Practice	Disciplinary Core	Crosscutting Concept
April	Constructing Explanations and Designing Solutions	ESS2: Earth's Systems	Energy and Matter
May	Engaging in Arguments From Evidence	PS2: Motion and Stability: Forces and Interactions	Stability and Change

E-mail your contributions to christine.duke@education.ky.gov.

All submissions are needed by the 25th of the month.

KDE Revised Consolidated Compliance Plan for Non-Discrimination Available

Please be advised that the Kentucky Department of Education has revised its Consolidated Compliance Plan for Non-Discrimination. The revised plan has been posted on the Legal and Legislative Services page on KDE's website and includes a Discrimination Complaint Form that can be filled out by anyone alleging discrimination against KDE staff and/or KDE program areas.