Science Connection

KENTUCKY DEPARTMENT OF EDUCATION

A Collaborative Resource for Teachers **August 2014** Volume 1 Issue 8

In This Issue

Editor's Note by Christine Duke

The 2014-15 school year looks to be an adventurous one! Why adventurous? Because we are going where man has only attempted to go…a place where engagement in authentic science learning permeates ALL Kentucky classrooms… a three dimensional place where students are encouraged to think like scientists as they investigate the phenomena that exists all around them. Of course, I'm talking about the three dimensional learning required by our new science Kentucky Core Academic Standards (KCAS). Science teaching must shift so that Kentucky students engage in Science and Engineering Practices to construct meaning for the Disciplinary Core Ideas and Crosscutting Concepts that define our new standards. This newsletter is but one mechanism to support Kentucky teachers as they shift their practice to embrace the vision of the new science KCAS.

For example, much work has been done over the summer by the Science Teacher Leadership Network participants at all regional co-operatives. Teacher leaders worked together on the deconstruction of performance expectations, the development of model units and course outlines, corresponding story lines and a guidance document. These items are meant to provide Kentucky teachers with MODELS to examine as they venture into this new territory. Keep in mind that these models represent the collective current thinking of the teacher leaders who collaborated on each document; hence, they are not the one and only way to organize or make sense of the new science KCAS. The MODELS can be assessed through the regional cooperative network websites found here. Other resources posted on these sites could prove useful to you as well.

Also, Achieve and NSTA have produced items that support the implementation of the new standards. Achieve released an instructional materials assessment tool, the EQuIP Rubric http://www.nextgenscience.org/equip-rubric-science-released), to provides criteria to measure the alignment and overall quality of lessons and units with respect to the NGSS. NSTA recently release a short Q&A about the NGSS that will help you communicate the importance of the new standards and the role they play in education. This and many more resources are available through the NGSS@NSTA Hub.

Further, articles in this and future editions of the Science Connection are indented to support you in this transition to a new world for science teaching and learning. This resource is for you and by you, the teachers and supporters of science education in Kentucky. Your experiences, expertise and questions are powerful forces that can provide support to colleagues across the state. Your contributions to the Science Connection are welcomed. The journey through the 14-15 school year is not to be solo mission but rather one that relies on the power of a collaboration that will beam Kentucky students to a new frontier of science learning that will positively impact their future.

Boldly go where no man has gone before…embrace the new standards and encourage your students to navigate through all dimensions of science!

NEXT GENERATION SCIENCE STANDARDS

Practice	DCI	Crosscutting Concept
Using Mathematics and Computational Thinking	LS3: Heredity: Inheritance and Variation Traits	Structure and Function

Plant inheritance

MS/HS

William J Staddon PhD, *Associate Professor, Biological Sciences, EKU*

Genetics and inheritance can be challenging subjects in biology. As I hope to show, part of the challenge comes from the content specific language and introducing these topics to elementary students in an accessible way.

I teach an introductory biology class for pre-service elementary and middle school teachers. Genetics and inheritance are among topics I cover. In my class, I try to avoid human traits as the inheritance patterns can be complicated. Further, I like to stay away from teaching genetics using traits that are specific to one particular group, such as brown- and blue-eyed inheritance.

One approach I use for my pre-service teachers is Wisconsin Fast Plants (WFP) as they overcome the issues surrounding human inheritance and can be used by student teachers in their future classrooms.

Inheritance is based on DNA. My favorite analogy for DNA is that it is like a cookbook. It contains all of the "recipes" for the organism. The DNA of most organisms exists in the form of chromosomes (Fig. 1).

Fig 1. Chromosomes come in pairs. Genes are locations on the chromosomes that contain two alleles (recipes). In this example one allele is for purple stems (P) the other for green (G).

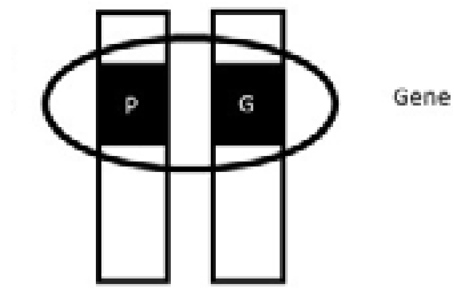
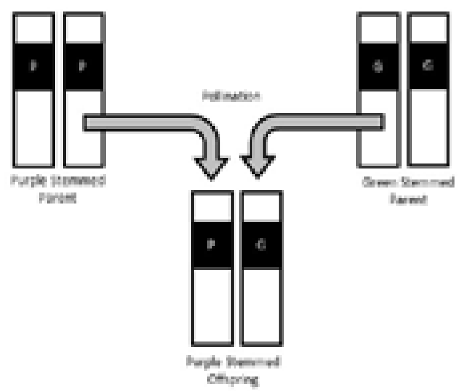


Fig 2.



The second analogy I like to use is that DNA is like yarn. When you buy yarn from the store it comes in a nice bundle. When DNA is in a nice neat bundle inside the cell it is called a chromosome. Chromosomes come in pairs. Humans have 23 pairs and other species have different numbers.

Gene refers to particular spot ("page") on the chromosomes where "recipes" for a trait are found. As there are two chromosomes, each gene has two separate recipes each of which is called an allele. If the alleles or recipes are the same they are said to be homozygous, and if they are different they are heterozygous.

Further, some alleles or recipes are dominant to others.

This may be bringing back some high school biology. Right away we see that the vocabulary of genetics is challenging and is really not suitable for elementary school students. However, the principles of inheritance can be illustrated with WFP's without introducing the vocabulary. One variety of WFP is homozygous for purple stems (Fig. 2).

These plants have two alleles that cause anthocyanin to be made (the "cake") that gives the stem its purple color. Another variety is homozygous for green (non-purple) stems. Neither allele allows the purple anthocyanin to be made. When the plants pollinate each one passes on an allele and the resulting seeds are said to be heterozygous. This plant will grow to become a purple stemmed plant because the purple allele is dominant to the green allele. This example illustrates that there is variation in traits (purple and green stems) and that one of these traits is seen in the offspring. It should be noted that if two purple stemmed plants were to pollinate then the offspring would be purple. Two green stemmed plants would produce green stemmed offspring. Crossing a purple with green, purple with purple and green with green would give an elementary class a nice introduction as to how inheritance works.

If the purple stemmed plants that grew from the purple-green cross were allowed to pollinate amongst themselves genetics are little more involved. Each plant is heterozygous and can pass on either a purple allele or a green allele. There are several possible results. The new seed may get a purple allele from each parent making it homozygous dominant and the plant will have purple stems (Fig. 3a).

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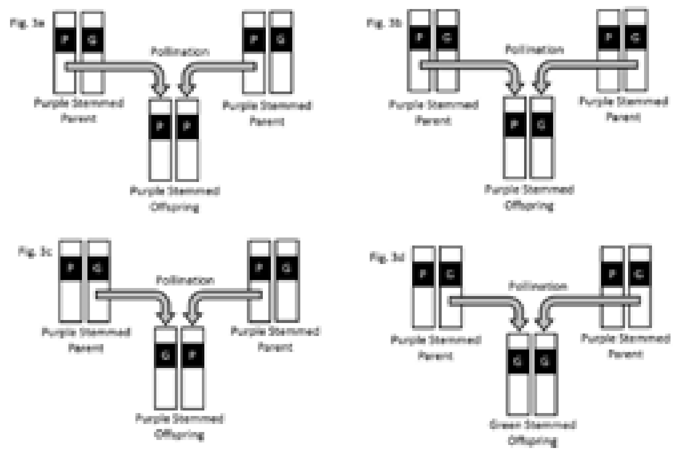

Alternatively, one plant may pass on a purple allele and the other a green (the opposite may also occur; Fig. 3 b, c). In both cases the result will be the same. The seeds will be heterozygous and will develop purple stems due to the dominance of this allele. Finally, each plant may pass on the green allele (Fig. 3 d). The new seeds will be homozygous recessive and the plants will have green stems.

It can useful to talk about the founder of genetics, Gregor Mendel, who did similar studies with peas in the 19th century. He examined a variety of traits including seed color. Mendel found that yellow seeds were dominant to green seeds. After years of experiments, he came to conclude that inheritance was due to parents passing on "factors" to their offspring, which today we would call alleles. On the web it is easy to find pictures suitable for elementary classes of the traits Mendel studied. The inheritance of these traits works in the same way as stem color in WFP's.

I hope this sheds some light on how inheritance can work in plants. If you have any questions, please contact me at bill.staddon@eku.edu.

It all starts with a seed

ELEMENTARY

Jason Lindsey, *Hooked on Science I Executive Director/Founder/K-12 Science Educator*

From pumpkin pie to jack-o'-lanterns, we use pumpkins in many different ways. It all starts with a pumpkin seed. The seed grows from a seedling, to a young plant, and eventually to an adult plant. Flowers growing on the adult plant can produce fruit, which contains seeds. These seeds allow the pumpkin plant to continue living on Earth after the adult plant dies. From seed to death, the changes a pumpkin plant goes through is called a life cycle. These changes form patterns, which can help us make predictions about the plant. To better understand a pumpkin plant life cycle, we can design a model by using detailed drawings, clay, and/or other materials. A detailed model can visually show how a pumpkin plant has a unique and diverse life cycle.

Using a small, medium, and large pumpkin, you can reinforce these science concepts as you discover how many seeds are actually in a pumpkin and then plant the seeds and watch them grow from a seedling to an adult plant. Weigh each pumpkin, determine the diameter of each pumpkin, determine the circumference of each pumpkin, and count the lines on each pumpkin. Record your information.

Weigh each pumpkin, determine the diameter of each pumpkin, determine the circumference of each pumpkin, and count the lines on each pumpkin. Record your information.

PUMPKIN DATA

	SMALL PUMPKIN	MEDIUM PUMPKIN	LARGE PUMPKIN
Weight			
Diameter			
Circumference			
Number of Lines			

Using a knife, create an opening at the top of each pumpkin. Place each pumpkin on a piece of newspaper. Remove the seeds and pulp from each pumpkin. Separate the pulp from the seeds. Look closely at the seeds. Notice how the pumpkin seed has a thick outer coat. Using this evidence you can construct an explanation to why this characteristic is an advantage. For example, if an animal eats the seeds from a pumpkin, this thick "coat" protects the seeds as they pass through the animal's digestive system. Once passed, the seeds are still intact and able to grow from a seed to an adult plant. Count the seeds from the small pumpkin, the medium pumpkin, and then the large pumpkin. Record your information.

PUMPKIN DATA

	SMALL PUMPKIN	MEDIUM PUMPKIN	LARGE PUMPKIN
Number of Seeds			

Continued on Page 4

Analyze and interpret the data to conclude which pumpkin has the most seeds. Research why some pumpkins create more or less seeds than others and use logical reasoning to make sense of the phenomena. Using this evidence construct an explanation.

You can never tell how many seeds are in a pumpkin, until you cut open the pumpkin. There are some clues that might help you determine the number of seeds inside a pumpkin. For each line on the outside of the pumpkin there is a row of seeds on the inside of the pumpkin.
You can also look at the color of the pumpkin. The longer a pumpkin grows, the darker the pumpkin and the more lines on the pumpkin, therefore the more seeds inside the pumpkin. By analyzing and interpreting the data gathered during this experiment, you can provide evidence that a pumpkin plants can produce pumpkins with many similarities and differences.

Plant the seeds from the large pumpkin and monitor the changes as the pumpkin plant grows from a seed to an adult pumpkin plant. While these seeds have produced pumpkins with fewer seeds in the past, these traits can be influenced by the plant's environment.
For example, if the pumpkin plant receives an insufficient amount of water, it may not be as large as previous pumpkin plants, which received the correct amount of water.
Reinforce growth and development of organism concepts by reading "How Many Seeds in a Pumpkin?" by Margaret McNamara. In the book, students in Mr. Tiffin's class discover how
counting pumpkin seeds is messy business, but once the slimy job is done, to everyone's surprise, the smallest pumpkin has the most seeds!

In conclusion, reproduction is critical for the continued existence of the pumpkin and every living organism. From seed to adult, the life cycle of a pumpkin is unique.

KCAS Connections

Science and Engineering Practice 5: Using mathematical and computational thinking

ALL MATH

Simone Parker, *Trigg County High School*

"If people do not believe that mathematics is simple, it is only because they do not realize how complicated life is. ~ John Louis von Neumann

By the time that many students get to high school, there is a huge disconnect where mathematics and science are concerned. The NGSS strives to have students make those connections between mathematics and science at very early ages so they can help develop a deeper understanding of the topics they are studying. I have had numerous students ask me why they have to use mathematics, isn't this science class? It is important for students to make those connections between mathematics and science as soon as they start to learn to count. This will allow your students to develop a deeper understanding of how mathematics is not an abstract concept on a worksheet but how it applies to science concepts and helps explain how the world works.

As soon as it is developmentally appropriate, students can begin counting, taking measurements with thermometers and rulers and other scientific equipment, then analyzing that data and forming conclusions based on their scientific measurements. The first time that **Using Mathematical and Computational Thinking** is used in a Performance Expectation is in the 5th grade: **5-PS-1-2**. Students are asked to measure and graph quantities to provide evidence that regardless of what changes occur, the total weight of matter is conserved. **5-ESS-2-2** asks students to describe and graph the amounts and percentages of water and fresh water in reservoirs to show the distribution of water on the planet. Students need to be able to understand the concepts

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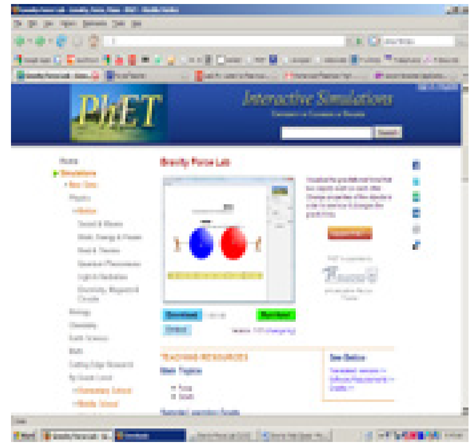
of volume and area (and apply that knowledge) to be able to explain where the fresh water is located on our planet, how much of that fresh water is usable and how small that percentage really is in comparison to all the water found on Earth. When students are allowed to make those mathematical connections of scale, proportion and quantity; it will bring a greater understanding of the underlying science concepts being studied.

(All graphics are found here: http://phet.colorado.edu/en/simulation/gravity-force-lab)

As students progress through middle school, they are asked by the NGSS to apply mathematical knowledge by using words and symbols through algebraic thinking. Our students should also been given the opportunity to use computer programs to help them change their data into graphs to help them identify patterns in their data. Using data analysis programs such as spreadsheets and creating graphs allow students to visually see patterns in their data and allow them to draw conclusions about their experiments and real world examples to draw understanding about complex scientific concepts. Visual learners can sometimes get lost in the numbers, but graphing their data allows them to make sense of those concepts, so they can SEE the big picture.

When I was researching activities to teach Newton's Law of Gravitation (HS-PS2-4), I chose to use one of the simulations found on the University of Colorado's PhET website, Gravity Force Lab. I chose an activity written by Steve Banasiak called Universal Gravity – building formula, quantitative with graphing. This activity, data analysis and graphing will allow my students to see the connection between mass, force and distance. I hope that they will be able to see the patterns and the end result should be the student creating Newton's Law of Gravitation from this simulation by understanding the ratios involved in this equation.

HS-PS2-4.	**Use mathematical representations of Newton's Law of Gravitation and Coulomb's Law to describe and predict the gravitational and electrostatic forces between objects.**



Using mathematics can be scary for students. But it is the mathematical relationships that allow students to delve deeper into science topics such as magnetic fields or explain how natural selection may lead to increases and decreases in specific traits in populations over time. Allowing and reinforcing these mathematical and computations concepts helps paint a picture for our students, gives them the chance to make real world connections to what they are learning and forge that important knowledge in their long term memory so it can be used in the future. Allowing your students to visualize numbers with graphs, charts and tables will allow them to see connections with patterns and cause and effect relationships.

Links and further information:

Bozeman Science Explanation:
http://www.bozemanscience.com/ngs-using-mathematics-computational-thinking/

Framework for Teaching Science: http://www.nap.edu/openbook.php?record_id=13165&page=64

NGSS Science and Engineering Practices: http://www.nextgenscience.org/sites/ngss/files/Appendix%20F%20%20Science%20and%20Engineering%20Practices%20in%20the%20NGSS%20-%20FINAL%20060513.pdf

University of Colorado PhET: http://phet.colorado.edu

The power of mathematics in a science classroom

ALL MATH

Teresa Emmert, *GRREC Instructional Specialist*

Mathematics is a tool key to understanding science. In order for students to truly delve into the Performance Expectations, they must engage in mathematical and computational thinking.

Although there are differences in how mathematics and computational thinking are applied in science and in engineering, mathematics often brings these two fields together by enabling engineers to apply the mathematical form of scientific theories and by enabling scientists to use powerful information technologies designed by engineers. Both kinds of professionals can thereby accomplish investigations and analyses and build complex models, which might otherwise be out of the question. (NRC Framework, 2012, p. 65)

So must science teachers now become math teachers? Of course not! But we do have a wonderful opportunity to collaborate with our math colleagues and help students understand the mathematics by applying it in the science

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classroom. This overlapping of content has been structured in the standard documents so that teachers can plan instruction where mathematics comes alive with the science performance expectations.

The development team of the Next-Generation Science Standards consulted the Common Core mathematics writing team members so the alignment of the two documents is congruent. Science standards do not outpace the grade-by-grade standards of KCAS-Mathematics2. To enhance the science classroom, mathematical thinking must be included in instruction.

When analyzing NGSS, the first time this practice of mathematical and computational thinking appears in the foundation boxes is in 5th grade. As the standards progress into high school, this practice occurs more frequently. Yet, the progression of this practice in Appendix F begins at K-2. One must remember that the practice embedded in the performance expectation is the one to be used in the assessment process. During instruction, the eight practices are interwoven. The practice of mathematical and computational thinking should be utilized to encourage students to think deeply about the relevant connections between math and science.

The mathematics that science students use progresses from describing the world around them to using functions to analyze, represent, and model data. In elementary as soon as students learn to count and use numbers, they should be measuring. Opportunities for collecting and analyzing data as well as looking for mathematical relationships, first with words and later with symbols, should be embedded into instruction. A critical area of middle school mathematics is ratio and proportions and connections to this concept can be found in NGSS. This progression of mathematics also shows that in the ever-advancing technological world that data and models can be represented using computers and digital tools. Computational thinking centers on the capabilities of computers and has revolutionized science over the last few years3. In order for our students to be college and career ready they must be exposed to these technologies in a meaningful way.

Science teachers should be familiar with progressions in mathematics in order to set high expectations for students. We cannot dismiss instructional opportunities because we do not believe our students are capable of the math involved in a performance expectation. PLC discussions with fellow math teachers can help science teachers stay informed of when topics are introduced and taught. During a recent discussion with high school science teachers, the practice of mathematical and computational thinking surfaced. They asked how in depth to go into the math with freshmen since different types of functions were mentioned in the foundation box. Once narrowing down that linear functions would be most appropriate for that PE, they were not sure that 9th graders could manipulate a formula. When told that solving one-step equations is introduced in 6th grade and manipulating multi-step equations was mastered by 8th grade, these high school teachers were surprised. Of course, their students had told them they had never seen these equations before!

When we give students the opportunity to use mathematics in a real-world concept in a science classroom, we help them see the power of mathematics. It is not just something that is copied from a textbook. Increasing students' familiarity with the role of mathematics in science is central to not only developing a deeper understanding of how science works, but also in how mathematics is applied to help us understand the world around us4.

1. NGSS, Appendix F, page 10.
2. NGSS, Introduction, page 10.
3. http://www.bozemanscience.com/ngs-using-mathematics-computational-thinking/
4. NRCC Framework, page 65.

Using the 5E's instructional framework to implement the NGSS in your classroom

ALL PLANNING

Tricia Shelton, *Teacher, Boone County Schools*

I appreciate national science standards because they articulate a set of clear, consistent and challenging goals for science achievement for all students. This common language around a shared vision lends itself to global conversations and collaborations to enhance student learning.

At the core of the Next Generation Science Standards is a focus on the student as the constructor of meaning through immersion in the science and engineering practices to learn core ideas and make connections to unifying science concepts. This is a conceptual shift in science education, illuminating the need for classroom experiences to reflect "the interconnected nature of science as it is practiced and experienced in the real world." (NGSS, Appendix A). How can teachers begin to implement the Next Generation Science Standards and create this vision in their own classroom? The 5E's framework is an effective way to plan a learning progression around a performance expectation (or bundle of performance expectations) while supporting the

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NGSS vision of students as the active meaning makers in the classroom.
The 5 E's framework was developed by the Biological Sciences Curriculum Study (BSCS) based on the constructivist view of learning.

Table 1. Summary of BSCS 5E Instructional Model

Phase	Summary
Engagement	The teacher or curriculum task accesses the learners' prior knowledge and helps them become engaged in a new concept through the use of short activities that promote curiosity and elicit prior knowledge. The activity should make connections between past and present learning experiences, exposed prior conceptions, and organize students' thinking toward the learning outcomes of current activities.
Exploration	Exploration experiences provide students with a common base of activities within current concepts (i.e., misconceptions), processes, and skills are identified and conceptual change is facilitated. Learners may complete lab activities that help them use prior knowledge to generate new ideas, explore questions and possibilities, and design and conduct a preliminary investigation.
Explanation	The explanation phase focuses students' attention on a particular aspect of their engagement and exploration experiences and provides opportunities to demonstrate their conceptual understanding, process skills, or behaviors. This phase also provides opportunities for teachers to directly introduce a concept, process, or skill. Learners explain their understanding of the concept. An explanation form the teacher or the curriculum may guide them toward a deeper understanding, which is a critical part of this phase.
Elaboration	Teachers challenge and extend students' conceptual understanding and skills. Through new experiences, the students develop deeper and broader understanding, more information, and adequate skills. Students apply their understanding of the concept by conducting additional activities.
Evaluation	The evaluations phase encourages students to assess their understandings and abilities and provides opportunities for teachers to evaluate student progress toward achieving the educational objectives.

Source: The BSCS 5E Instructional Model: Origins, Effectiveness, and Applications.
Roger W. Bybee, Joseph A Taylor, April Gardner, Pamela Van Scotter, Janet Carlson Powell, Anne Westbrook, Nancy Landes. BSCS July 2006

The BSCS 5E's incorporates research that has advanced our understanding of the best ways that students learn and incorporates these findings into a framework to improve classroom instruction through mindful planning and sequencing of instruction and assessment. The 5E's framework requires a change in role for many teachers from "sage on the stage" to "guide on the side," as well as instruction integrating the three dimensions: core ideas, practices and crosscutting concepts. During a 5E's sequence, students begin by tapping into their own curiosity or by connecting to their own experiences and continually building on and revising their understanding. Each "E" serves a purpose in building the scaffolding necessary for students to construct their own knowledge. The teacher needs to be intentional and explicit with this planning to layer this scaffolding appropriately, address misconceptions, and not leave gaps in students' learning. Students are the thinkers, meaning makers, constructors of knowledge in all but possibly one of the E's. (During the Explain phase is the only time teachers should be communicating meaning.)

The 5E's in action: students acting and thinking like scientists.
http://collegeready.gatesfoundation.org/About/Momentum/ANewFrameworkforTeachingandLearning

As I walk down the path of NGSS implementation, the 5E's have been a very useful tool for planning my instructional and assessment sequence, and for me to facilitate student learning. I have found that to effectively support students in this learning progression, my work centered on coaching students through questioning to help them develop their understanding. This means using formative assessment data to develop those possible guiding questions for class experiences ahead of time and seeking information on possible misconceptions before doing the actual lesson. It also means providing planned and intentional time for reflection and collaboration throughout the lesson. These shifts have resulted in a vibrant, engaged classroom focused on discovery with assessment data indicating a deep understanding of the core ideas of science.

As you begin planning for the 2014-15 school year, you may want to consider starting with the 5E's as an understandable and manageable tool to support NGSS instructional planning and provide the type of coherence between lessons needed to result in student understanding. By starting with the 5E's, teachers can begin to reflect on making changes to improve their craft and provide their students with well-engineered, rich, and engaging learning experiences so they can achieve the goal of our national standards.

Literacy Design Collaborative

ALL LDC

Teresa Rogers, *KDE Literacy Consultant*

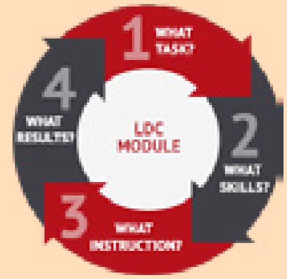
In "Assignments Matter," Eleanor Dougherty notes that students often spend classroom time going through the motions of learning but not producing solid evidence of that learning, and states that a quality assignment is the hallmark of effective instruction. Quality assignments in science requires students to grasp the conventions of complex science texts, including the nature of evidence used, an attention to precision and detail, and the capacity to make and assess intricate arguments, synthesize complex information, and follow detailed procedures and accounts of events and concepts. Writing and presenting information orally are key means for students to assert and defend claims in science, demonstrate what they know about a concept, and convey what they have experienced, imagined, thought, and learned. (Appendix M)

So how do teachers help students to acquire these skills? Many science teachers shudder at the thought of assigning writing tasks and often feel unprepared to meet the diverse needs of their students. However, there is an effective tool designed to support teachers to develop the literacy skills students need as they encounter the rigorous demands of scientific texts. In 2009, the Bill & Melinda Gates Foundation (BMGF) convened a team of literacy and curriculum experts to develop a strategy that would not only incorporate the new CCSS literacy requirements, but would meet the demands for high performance in core content instruction. LDC provides a framework that "hardwires" CCSS into the curriculum process with expert rubrics for scoring student work and protocols for reviewing teacher created tasks, integrating research-based practices throughout.

Overview

LDC's basic building block is a module, a subject-specific reading and writing assignment, or "teaching task," taught over a two – four week period, made up of four sections.

Modules



Section 1: What Task? Designing a rigorous and engaging task is the most important step in creating an LDC module. LDC provides teachers with a collection of "template tasks," that they use to write a module and drives the next module steps: what skills students must learn and what instruction needs to occur.

Section 2: What Skills? The next step is to define the skills students need to successfully complete the task. LDC provides example skills that teachers can add to, delete from, or modify to meet the specific needs of their students.

Section 3: What Instruction? After identifying the skills, teachers build the instructional plan, engaging students in "mini-tasks" to develop their literacy skills and move them toward completing the assignment. These mini-tasks provide the teacher with important information and guide instructional decisions.

Section 4: What Results? After teaching the module, teachers score student work against the LDC rubric and analyze the results, reflect on the process, and make revisions to the module for use in the future and/or to share with other teachers.

To get started and gain a better understanding of the four sections of an LDC module, visit the How LDC Works page. In upcoming issues, we will examine these components, along with tools and resources, in detail to enhance your ability to create assignments that matter.

Whole class questioning: Extended, focused cycles of questioning

ALL ELA

Melissa Shirley, *PhD, Assistant Professor*
Science Education, Department of Middle and Secondary Education
Univeristy of Kentucky

Welcome back to our series on formative assessment through whole-class questioning. This month, we're going to consider "cycles" of questioning. A cycle of questioning is a pattern of question (Q), response (R), and follow-up statement (F). Sometimes, a phase of this cycle – especially the follow-up statement – is not actually voiced by the teacher or student but is implied. Here's an example of a Q-R-F cycle that might occur as a teacher is conducting a lesson on NGSS LS2:

Teacher: (Q) Let's review what we know about genotypes and phenotypes. We're going to call the dominant allele for a trait "big A" and the recessive allele "little a". What would be the genotype for an individual who is heterozygous for this trait?
Student: (R) "Big A, little a".
Teacher: (F) That's right. A heterozygous individual carries two different alleles for a trait, so we write the dominant allele first, followed by the recessive allele.

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This type of **single-repeat Q-R-F cycle** is effective for finding out if your students have factual or declarative knowledge. But how can we find out what they really understand? This month, I suggest you consider the patterns of your questioning cycles. To start, let's see how the scenario above might be different if it were part of an extended Q-R-F cycle.

Teacher :(Q1) Let's review what we know about genotypes and phenotypes. We're going to call the dominant allele for a trait "big A" and the recessive allele "little a". What would be the genotype for an individual who is heterozygous for this trait?
Student: (R1) "Big A, little a".
Teacher: (F1) Okay, "Big A, little a". (Q2) Why do you say that?
Student: (R2) Because heterozygous means that the two alleles are different, so there's one of each.
Teacher: (F2) Good. The alleles are different. (Q3) Does it matter which order you say it in, "big A, little a" or "little a, big A"?
Student: (R3) Umm… No? I'm not really sure. I've never seen it the other way…
Teacher: (F3) Well, there's a reason you haven't seen it the other way, because geneticists normally write genotypes with the dominant allele represented first. So a heterozygous genotype would be "big A, little a".

Note that in this scenario, subsequent questions are being used to probe the student and encourage him/her to articulate his/her thinking. Here are some suggestions for ways to extend your questioning cycle:

- Would you tell me more about that?
- Could you explain your reasoning to us?
- Student 2, do you agree with Student 1? Why or why not?
- Could someone else add to Student 1's explanation?
- How did you arrive at that response?
- Which piece(s) of evidence from our experiment support that claim?
- What's another way we could explain that idea?
- Why did you reject (an alternate possibility)?
- What would be an example of how that might work?

So, how do you know how many cycles of extended questioning are appropriate to use? Great question! Consider your purpose for asking the question. If you want to elicit short responses from students so that students respond quickly and you can continue your explanation, use single-cycle questioning. If you want to encourage students to articulate their thinking, use longer cycles. A word of caution, though -- it's easy for a longer cycle to get off-track, and when this happens neither you nor the students benefit! I recommend keeping your conversations between two and four cycles. With this number of cycles, you can dig deeply into student understanding without the class losing track of what you're asking.

If you are following this series with an excerpt of your teaching, here are some suggestions of patterns to look for in your questioning. Are there specific strategies you could use to enhance some part of your questioning?

- Consider whether you are using longer cycles as a means of classroom management rather than eliciting deep student thinking.
- Determine how much you are talking compared to how much the students are talking. If you talk a great deal more than them, this could be a sign that you are providing the answers and elaborating on their responses for them – and in the process, doing the hard work of thinking about science for them, too!
- Do students ever initiate the questions or spontaneously respond to one another?

What else are you finding interesting as you examine your questioning patterns? If you have other suggestions or would like to discuss what you are finding, please email me at melissa.shirley@louisville.edu! Next month, we'll wrap up this series and examine how we can get more authentic participation from a greater number of students.

Combining art with science and technology

ALL | **ART/ COMPUTER TECHNOLOGY**

Robert E. Duncan, *Arts and Humanities Consultant, KDE*

Artists through the centuries have studied and depicted the human form. Sometimes, artists such as Michelangelo and Leonardo da Vinci studied the human figure in great detail and created anatomical studies as well as beautiful pieces of art. Mostly, though, artists through the ages have beautified their human subjects and portrayed them without flaws or attention to defects.

Fast forward to the late 20th Century and the 21st Century. As a young medical resident at Stanford University studying hand surgery, Dr. James Chang first noticed certain details of Auguste Rodin's sculptures. He used to relax on the grass at the sculpture garden of the school's Cantor Arts Center. "The more I looked at the Rodin sculptures ... and I focused on the hands, and if you look at each hand ... they're exactly like the actual medical conditions I was treating."

Today, as a Stanford University professor and surgeon who noticed these realistic details, Chang was inspired to

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incorporate Rodin into his teaching using a curriculum that combines Rodin's sculpture with medical science and computer technology.

To find out more, go the National Public Radio's June 23rd "All Tech Considered" story, *Using A 3-D Version Of Rodin's Hands To Understand Anatomy* (http://www.npr.org/blogs/alltechconsidered/2014/06/23/324875587/using-a-3-d-version-of-rodins-hands-to-understand-anatomy) about Dr. Chang and how he incorporates art, computer technology and medicine to explain his patients' diagnosis and plans for treatment.

Be in the Know

New resource from NSTA introduces parents to the NGSS

Because the Next Generation Science Standards mark a significant shift in how science is both taught and learned, parents may be curious as to what their children's classrooms will look like. To help parents better understand the importance of standards and the role they play in education, NSTA has developed a short Q&A for parents. This tool explains what standards are in general and why the NGSS in particular are so critical for developing college and career readiness in the sciences. The Q&A is a great resource for science teachers, principals, and other administrators to distribute to and discuss with parents. Find this and other great NGSS resources at the NGSS@NSTA Hub.

Information provided by NSTA Express Newsletter

PD 360 update makes professional development easier

July's release is more than a feature freshener. It's an entirely new platform with a new interface that automatically serves up the resources you need.

Easier and more useful

- Delivers incredibly specific PD content—just-in-time resources on just the right topics to help teachers tweak and improve their classroom
- Serves up exactly what teachers need, with items like assigned PD, group activity, and personal video queues delivered front and center on the home page

High performance—anytime, anywhere, on most devices

- Technology advancements dramatically improve performance, reducing load times and ensuring data stability
- Full mobility allows for anytime, anywhere access on most smart devices

More than just professional development

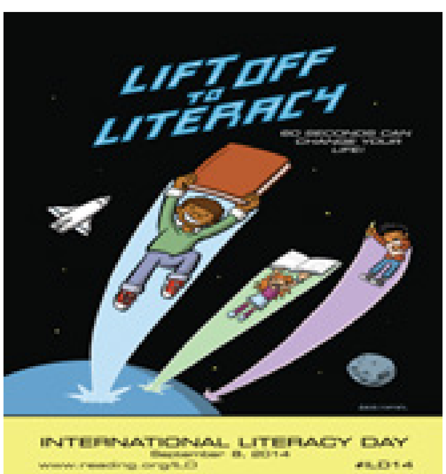
- The new PD 360 is the cornerstone of the comprehensive suite of professional learning tools that helps teachers become even more effective

Important Note:

There is no change to the way PD 360 is accessed. Continue to access PD 360 via CIITS, the way you always have.

- **Step 1**: Go to ciits.kyschools.us.
- **Step 2**: Enter your CIITS username and password. Note: If you encounter difficulty logging into your CIITS account, please follow the instructions listed on the CIITS login screen.
- **Step 3**: Once logged in, click on the green "PD 360 & Common Core 360" icon located under School Improvement Network on the left-hand side of the screen.

Click here to see all of the exciting changes to PD 360. Remember, there is no additional cost to you or your district to use this resource.



About International Literacy Day

In 1965, UNESCO declared September 8 International Literacy Day (ILD) in an effort to focus attention on worldwide literacy needs. "Lift Off to Literacy," IRA's theme for 2014, inspires students to reach for the stars. On September 8, 2014, launch your students' literacy habit by devoting an additional 60 seconds of literacy activities each day for 60 days. Celebrate ILD and share the message that developing a habit of reading, writing, listening, and speaking leads to lifelong literacy success.

For this year's celebration, "Lift Off to Literacy," the International Reading Association has partnered with *NASA* and *Story Time From Space* to inspire a literacy habit in your students. This event provides a perfect opportunity to promote integration of literacy in the science classroom. For more information see www.reading.org/ILD.

Kentucky Association for Environmental Education
38th Annual Conference

September 12-13, 2014

Register Now! @ kaee.org/conference

Join us at the Clarion Hotel in Lexington for the finest
EE networkingand professional development event in the Bluegrass!

Fun for you AND your whole family!

Picnic Dinner and Hike at McConnell Springs
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Next Generation Science Standards ◆ Family Activities
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Mystery Table ◆ Over 30 Great Sessions
And so much more!

Space is Limited for Workshops - secure yours today!
Save $$$ Now with Early Bird Discount!
Visit **kaee.org/conference** for all the details and to register NOW!

Kentucky Association for Environmental Education
P.O. Box 1208
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270.214.0587

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On Saturday, September 6th, girls in grades 5 through 12 will have the opportunity to explore various topics in math, technology, engineering and science during an exciting interactive sessions. Attendees will meet women employed in STEM careers. At the end of the day, participants will view a spectacular Chemistry show. This is an excellent field trip opportunity!

FOR MORE INFO
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www.wku.edu/ogden

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
September	Obtaining, Evaluating and Communicating Information	ESS3: Earth and Human Activity	Patterns
October	Asking Questions and Defining Problems	PS3: Energy	Cause and Effect

E-mail your contributions or ideas to christine.duke@education.ky.gov.
All submissions are needed by the 20th of the month prior to publication.

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.