Science Connection
KENTUCKY DEPARTMENT OF EDUCATION
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In This Issue

Editor's note

Hang on! Winter break is just around the corner. Surely you are ready for a well -deserved break from deep thinking on how to engage students in the 3 dimensions of the new standards. Perhaps you can warm yourself by a fire while reading this month's contributions to the Science Connection. Those who have provided us with their insight this month are involved in various levels of implementation of the new science standards, from classroom teacher to college professor, but all share a common passion for ensuring that we are engaging students in authentic science experiences. There is definitely a cross cutting theme among the contributors – one of dedication to students and advancement of the NGSS.

Speaking of dedication to science education, kudos to three of Kentucky's awesome teachers, who were recently recognized for their excellence in science teaching. The 2014 KSTA Excellent Science Teaching awardees are Stephanie Harmon, Physics and Earth Science instructor from Rockcastle County High School; Cindy Combs, Middle School teacher from Simons Middle School in Fleming County; and Vivian Bowles, 4th grade teacher at Kit Carson Elementary. Those of you who have been privileged to collaborate with these ladies know that they are well deserving of this recognition. For more information about these educators, go to http://www.ksta.org/index.cfm.

As we come to the half way mark of year one of statewide implementation of the Kentucky Academic Standards for science, I hope that you take time to reflect on the pedagogical shifts you have made as well as how you view science education. I encourage you to blog about your journey so that others can benefit from your experiences. Please remember to join the MTOC at http://tinyurl.com/ngssmtoc and to submit the names of those who support you in your work to the Informal Science Educator Hub. Oh, I almost forgot! Please consider sharing your expertise through this venue as we continue to learn more about NGSS! Remember, this is about sharing in the journey, not about being perfect!

Solar System Scale Walk

Scaling diameters and distances to same ratio

Dr. Tom Tretter, Director, Gheens Science Hall & Rauch Planetarium, Associate Professor, Science Education

ALL

The distances in space are vast, and it is hard to get our heads around those distances even with telescopes that extend our ability to explore objects at tremendous distances. The

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NEXT GENERATION SCIENCE STANDARDS

Practice
Planning and Carrying Out Investigations

DCI
ESS1B: Earth and the Solar System

Crosscutting Concept
Scale, Proportion and Quantity

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solar system scale walk is designed to generate an experience for students that helps them grasp a sense of the scale of the solar system, and to use that scale model in order to model, describe, and explore a number of celestial phenomena. There are a number of different solar system scale experiences described in various outlets, but what makes this particular approach unique from many of them is that it will simultaneously scale both the planetary sizes and the planetary distances to the same scale. By contrast, many times a teacher may have students use one particular scaling ratio to create models of planets (e.g. if Jupiter is the size of a large 50-cm diameter beach ball, then Earth would be a small 5cm jawbreaker), but then simply hang them in order from the ceiling of the classroom, or use a different scaling factor so that all planets fit within a classroom. The reason for this compromise of using different scaling factors is clear when looking at the above Earth/jawbreaker example. In this case, the farthest planet, Neptune, would be about 11 miles away if using the same scale ratio for distances as well as diameter. And since I like to keep dwarf planet Pluto in the mix for historical nostalgic reasons, that would be even further away.

However, not using the same scale factor often leaves students with conceptual misrepresentations about the scale of the solar system. The model described in this article does manage to use the same scaling factor for both diameters and distances, but you will need a relatively large area – longer than a football field – for students to have this kinesthetic experience. Based on prior efforts using this model with both K-12 students and adults, the actual kinesthetic experience is central for full impact – simply verbally describing just doesn't have the same impact.

After being clear with students that they will be creating a model of the solar system using the same scale ratio, it would be helpful to be sure to solicit from students the value and purpose of the science and engineering practice of modeling (to think about the science). So even as the activity is about to start, students will have already been explicitly alerted to connections to both the crosscutting concept of scale, proportion, and quantity and to the practice of scientific modeling.

Materials

The scale ratio I chose to use was based on one convenience that was my starting point – I wanted to use walking strides to measure distances between planets rather than crawling around with a meter stick. And, playing with the ratios, the scale factor that worked out to still leave Earth visible (barely) was one in which 10 of my strides (of about 60cm each) would be the distance to Earth. This resulting scale factor was 4×10^{-11}. This meant that the Sun could be represented by a tennis ball (conveniently yellow), Earth by a tiny grain of sand barely visible, and the other planets with objects (or other objects of equivalent size) as shown in Figure 1.

Planet	Diameter of Model (mm)	Object (Suggestions-others are possible)	Steps from prior object
Sun	55.68	Tennis Ball	—
Mercury	0.2	Hair Width (not length-essentially invisible)	4
Venus	0.5	Barely Visible Grain of Sand	3
Earth	0.5	Barely Visible Grain of Sand	3
Mars	0.3	Hair Width (not length-essentially invisible)	5
Jupiter	5.7	Plastic Jewelry bead or styrofoam	37
Saturn	5.0	Plastic Jewelry bead or styrofoam	43
Uranus	2.0	BB Sphere For Air Guns	43
Neptune	2.0	BB Sphere For Air Guns	109
Pluto	0.1	Invisible	94

Figure 1. Objects to model planets, and number of steps to take to reach it from the prior one.

For preparing these materials for the walk, I taped the tiny grain of Earth on a contrasting color of 8.5" x 11" construction paper (e.g. if a light-colored sand, on black paper; if dark grain, on white paper), labeled "EARTH" in big letters and with a big arrow pointing to it since it isn't obvious because of its tiny size (note that the size of Earth in Figure 2 is exaggerated so that you can see it in the figure). I then attached this to a cheap sign that could be easily stuck in the ground – the kind of signs with stiff metal wire posts pushed into the ground that you often see used for election

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signs or "For Sale" signs. In fact, post-election is a great time to go out and collect a dozen or so candidate election signs to recycle. Repeat for each of the other planets so each is mounted on its own sign.For the tiny ones, I would put a big arrow pointing to nothing in the middle saying it is too small to see (see Figure 2).

One additional element is added to the EARTH sign – a circle showing the orbit of our Moon. The circle should be about 15mm (width of your thumb) away from the Earth grain.

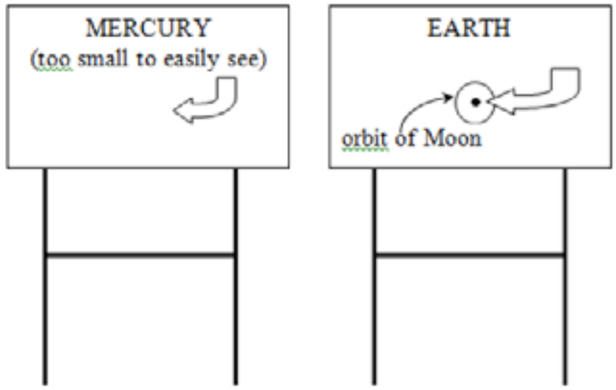

Figure 2. Examples of planet signs

Beginning the Walk

Giving different students the planet placards and sun, have the sun placed at the beginning of the walk, and then let students know that at this scale (tennis ball = sun), that Mercury would be four strides away (See Figure 1 for steps to take between each planet). Or if interacting with small children it would become four giant strides. That student plants the Mercury sign. Then ask for a demonstration for how Mercury would orbit the sun, after which ask whether that would take more or less time than Earth (88 days – see Figure 1). Depending on age of student, you could include comments and ideas about other topics such as gravity of the sun and inverse square law, the elliptical but nearly circular orbital paths and so on. You can comment that if we lived on Mercury, instead of being 10 years old (or whatever age you are working with), you would be 40 Mercury years old (roughly 1:4 ratio in orbital times for Mercury:Earth) and that I (the teacher) would have been drawing social security long ago. Next the Venus student is asked to predict how many steps (given what is known about Mercury) and then told to take three steps. Repeating the process, after planting the Venus sign a student is asked to demonstrate Venus orbit (225 days). Then a Mercury and Venus orbit are simultaneously walked, illustrating the different orbit times and, if done reasonably circularly with similar walking speeds, Mercury is complete before Venus even gets half way. Make explicit for students that these types of activities are using the model for thinking about science – orbital speed, for example – which is exactly what scientific models are for. This explicit attention to the practice of modeling will be woven in periodically.

Students predict steps, walk three more steps, and place Earth. Having simultaneous Mercury, Venus, and Earth orbits walked continues to illustrate the earlier point about orbital times. Highlight the tiny size of Earth in the vast reach of space it orbits around the tennis ball sun, and also highlight how close and tiny our moon is. Depending on student age, you could use this to illustrate why solar eclipses are rare (the scale of the system is key, along with a 5-degree tilt to the Moon's orbit that you could introduce). Then Mars is added to the model, completing the inner solar system.

When asked to predict Jupiter steps, most of the time students are way under. Walking out 37 more steps, it quickly becomes clear as the whole class follows that there is a big scale difference between the first four inner planets and the next one. Having students walk Jupiter's orbit can take a bit of time, so you can decide if that is helpful or not by this point. This is a good opportunity to discuss issues like sending manned spacecraft to the Moon (done in 1960s and 1970s – was a three-day journey), to Mars (some plans being made – typically at least a six-month journey one-way), and the feasibility of sending humans to Jupiter (long distance, hence much longer journey, more lag time in communications and so on. This can be used to highlight why this isn't really being seriously considered now. Depending on your curricular goals, you can include comments about spacecraft that have visited Jupiter, some properties such as how huge it is (why, you can even see it easily on the paper!)

From here on, the distances continue to grow. In essence, as the outer planets are placed, the emptiness of space really starts to come home. I have students try to image that these plastic beads and grains of sand plus tennis ball are the only stuff here, and then imagine them moving through that empty space around the sun. By the time you get to Saturn, it is hard or impossible to even see the signs for the inner planets, and yet Saturn is visible to the naked eye from Earth, in part because it reflects the weak sunlight that reaches it fairly well. This (Saturn) was the extent of knowledge about the solar system until the invention of the telescope about 400 years ago.

At Pluto, and beyond

By the time the class arrives at Pluto, they are well out of sight of the central tennis ball sun and inner planets, and

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sometimes complaining of getting tired. At this stopping point, you can include comments about Pluto's eccentric, tilted orbit and why it was reclassified as a dwarf planet in 2006. People often think of this as the edge of the solar system, but it turns out that the sun's influence extends much further. Pluto is about five light hours away from the sun, but the sun's gravitational influence is felt as much as one light year (8,760 light hours) away!

Questions that are interesting to think about here at cold Pluto include:

How far is it to next star? (To reach Proxima Centauri, 4.3 light years away, would mean you'd have to walk to Phoenix, AZ to reach it from Louisville, Ky.)

Will we send human spacecraft to other stars? (It would take many generations of lifetimes to reach another star with current technology.)

Is there possible alien life out there that visits Earth and cuts circles in our crops and weird things? (There is no known life forms, except on Earth, in our solar system, and the vast distances between stars means that it is unlikely that there would be a ship from another star coming by, unless there was some dramatic discovery of new physics for moving much faster. Certainly the standard cartoon of a tiny saucer with room for two big-headed aliens and not much else doesn't work with the food/waste/air/other requirements for life for many years.

This scale walk of the solar system is a kinesthetic experience that tends to be strongly retained and available to connect with other parts of the curriculum. For example, in the last decade we've had a number of unmanned spacecraft visit nearly every major body in our solar system, which is a feat more fully appreciated when you realize from this experience how big and empty our solar system really is. Or take the Mars Curiosity mission – landing a car-sized rover on a planet many millions of miles away, within a tight zone – on the order of hundreds of meters – of land to be near an interesting mountain but NOT in a nearby zone of rocky and uneven ground.

This is just one example where attention to the crosscutting concept of scale, proportion, and quantity helps to underpin student sense-making. Some other examples I've written about, targeting content ideas appropriate for high school students, are:

Tretter, T. & Jones, M. (2003). A sense of scale: Studying how scale affects systems and organisms. *The Science Teacher*, *70*(1), 22-25.

Tretter, T. (2005). Godzilla versus scaling laws of physics. *The Physics Teacher, 43*(8), 530-532.

Tretter, T. (2006). Conceptualizing nanoscale. *The Science Teacher, 73*(9), pp. 28-31.

The 'sense of scale' article offers an overview of spatial scaling phenomena across a range of science contexts, including several in the physical sciences and several in biological sciences.

That article includes classroom activities to support student thinking about scientific notation and developing intuition to attach to the numbers. The Godzilla article turns attention to a specific set of biological systems and scaling effects, centering on the physical impossibility of a Godzilla-sized lizard stomping around New York City by comparing the necessary bone strength in the fictional character with student-measured correlates of themselves. The nanoscale article highlights classroom experiences to help support high school student sense-making of invisibly-small phenomena, with special attention paid to the nanometer scale because of a growing nanotechnology industry.

Collectively, these can offer a sense of the widespread applicability of saavy thinking about scale in the sciences (hence the reason it is a crosscutting concept) along with a few detailed concrete classroom tasks and experiences that a teacher can consider for directly supporting student development of this interesting way of thinking.

Excerpt from the new science standards – A teacher's testimonial

Ryan Wright, Bracken County HS Biology Teacher

HS

I have always felt that as a science teacher, it's not the facts that are important, it's the processes that we teach students. Yes, students may never need to cite specific facts we've covered in class in their futures, but one thing we can say with 100% certainty is that they *will* use the skills, techniques, and processes we used when learning these topics during the course of their lives. Think about the skills we teach our students that they will undoubtedly use in their every days lives – problem solving, critical thinking, research skills, and designing and implementing plans to help conquer whatever life might throw at them.

These skills are what science classes are most responsible for teaching our students, and it's what I've always tried to personally focus on in the classes I teach. It is also one reason I am very excited for the move to the new science standards as we move forward.Are there challenges that we as teachers must face in implementing these new standards? Absolutely. These new standards often involve us teachers taking a more "hands off" approach to let students make discoveries on their own, which can be an intimidating thought when dealing with a classroom of 30 high school students. We need to grow comfortable letting students make their own decisions and approaches without us constantly pointing them in the right direction – *but that's ex-*

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actly what students are going to have to do in the real world, which is why it's so important in the first place.

We also wonder how we are going to get our students to this point?Where does it all begin? It has to start at an elementary level, being built upon year by year. This means that it will take time and a lot of flexibility and adaptability on the part of us teachers, which can also be intimidating as well. Finally, as teachers we can't help but wonder what the answer to one question in particular is – how will our students be assessed on these skills? All of these questions/concerns are very important and will need to be addressed over time, but the bottom line remains the same – these new standards will benefit our students in ways that the current standards do not, and that is what should be the single most important goal of anyone involved in education.

Change can often be scary. We are talking about some rather large changes in how we do things in our classrooms. This is our livelihood, and that can make it even more intimidating. In the end, though, our job as educators is to do everything and anything we can to best prepare our students for what lies ahead in the future. The new standards guide teachers as they plan and implement authentic learning experiences that focus on the skills and abilities our students need to succeed in the future.

The heart of elementary science: Planning and carrying out investigations

Patti Works, UK PIMSER Regional Teacher Partner

ELEMENTARY

The Next Generation Science Standards provide an opportunity for us to rethink the way we have been teaching science, and reinvent our programs based on research about how students **learn** science, rather than continuing to teach the way we were taught ourselves. Many of us learned science in textbooks, studying the conclusions of what scientists had learned over time.

Knowing science was learning definitions and memorizing facts. Being "good" at science was being able to reproduce this information, and the focus of science was on *what scientists know.* However, this is in conflict with what learning research shows us is the most effective way for students to *learn* conceptually. (Bransford and Donovan, 2005).

Students need to know how to go about engaging in inquiry practices and uncovering new information for themselves, while critically evaluating their observations, data, and models they've developed (and will revise). At the heart of this in elementary school is the Science and Engineering Practice #3, Planning and Carrying Out Investigations.

What does planning and conducting investigations mean for students K-5? Planning and Carrying Out Investigations in elementary school first involves the teacher being aware of misconceptions/preconceptions that students may hold, and carefully structuring questions and scaffolding experiences that will lead students to develop content knowledge about scientific phenomena as they engage in the practices.

As the *Framework* suggests, some questions may be structured by the teacher in order to bring to light a question or issue that it is unlikely students would explore on their own. Other investigations will emerge from students' own questions (NRC, 2012). In either case, students should be involved in the procedure and experimental design process so that they learn to plan and conduct their own tests, rather than following a "cookbook" process. As students develop their own investigations (teacher led, collaboratively, and eventually individually) they will not only be discovering what scientists know and how they know it, but learning how to uncover and test ideas for themselves.

What is so different about this? Haven't we always done experiments?

This is an *evolution* of the science teaching process, not a total revolution. The Disciplinary Core Ideas may be emphasized at different grade levels, but some science content, in many cases, may not be vastly changed. The change is in ***the way we approach the learning***, letting students "uncover" many of the ideas through the science and engineering practices, and connecting them to other learning through the crosscutting concepts. The change is in **what we expect *students to be able to do***, as evidenced in the performance expectations.

They need to be able to apply scientific and engineering practices. Scientific discoveries and engineering feats create new knowledge daily. Knowing how to be a critical consumer of information and how to apply the enduring skills will give them a toolkit for life.

Appendix F of the Next Generation Science Standards gives us a deeper look with the grade band progression below. I have highlighted some differences in the K-2 and 3-5 grade bands (see Appendix F for continuation of progression).

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Grades K-2

Planning and carrying out investigations to answer questions or test solutions to problems in K-2 builds on prior experiences and progresses to simple investigations, based on fair tests, which provide data to support explanations or design solutions.

- With guidance, plan and conduct an investigation in collaboration with peers (for K)
- Plan and conduct an investigation collaboratively to produce data to serve as the basis for evidence to answer a question.
- Evaluate different ways of observing and/or measuring a phenomenon to determine which way can answer a question.
- Make observations (firsthand or from media) and/or measurements to collect data that can be used to make comparisons.
- Make observations (firsthand or from media) and/or measurements of a proposed object or tool or solution to determine if it solves a problem or meets a goal.
- Make predictions based on prior experiences.

Grades 3-5

Planning and carrying out investigations to answer questions or test solutions to problems in 3-5 builds on K-2 experiences and progresses to include investigations that control variables and provide evidence to support explanations or design solutions.

- Plan and conduct an investigation collaboratively to produce data to serve as the basis for evidence, using fair tests in which variables are controlled and the number of trials considered.
- Evaluate appropriate methods and/or tools for collecting data.
- Make observations and/or measurements to produce data to serve as the basis for evidence for an explanation of a phenomenon or test a design solution.
- Make predictions about what would happen if a variable changes.
- Test two different models of the same proposed object tool, or process to determine which better meets criteria for success.

How do we teach elementary students to develop their own investigations?

It's a process that will develop after repeated experiences, and it will take time. As an elementary science lab teacher, I used the following questions when helping students with the investigative process.

Testable Question – What do we want to test to find out? It all starts here! This may require some time spent looking at what an investigable question looks like, and what constitutes a question that involves research or can't be investigated with our means. (Examples of testable questions might include: How do different materials interact with light? What effect does the strength of a force (interaction) have on the movement of an object? Do isopods (pill bugs) prefer bright, dim, or shady areas?)

Exploration – What did we observe as we interacted with the materials? Students need time to tinker and explore. This helps them understand which aspects of the investigating may be important to control and manipulate, and may give them background information to help them make predictions about what will happen in their test.

Identification of Variables – What influences the investigation? Students can help generate a list. At the K-2 level, the emphasis is one developing a fair test.

Isolate one variable to change or manipulate - Which condition do we want to test? At this point, we circle the one in our list that will be the focus of our investigation. (This increases to multiple variables in Grades 6-8.)

Control other factors (variables) – What do we need to keep the same to make it a fair test? Can we control all the factors we didn't circle during step 4?

Develop a procedure with identified materials – How can we test this systematically with the materials we have? Can technology help us here? (There are a number of free apps for smartphones that can help measure data.)

Collect data –What kind of data can we collect? How much do we need to make a claim or reach a conclusion? What formats are helpful to record this information? (A variety of formats for data collection can be applied to help students develop a large repertoire of methods.)

Analyze data - Can we find a relationship or patterns in our data to help us make sense of this and turn data to evidence? At the elementary level this is a skill that may require scaffolding questions, developed by the teacher. Observations alone, without thoughtful analysis, may not constitute evidence. Note in Grades 3-5 in the progression it specifies that investigations provide evidence to support explanations and design solutions, as opposed to K-2 providing data to support explanations or design solutions. (This is often where the crosscutting concepts naturally weave through discussion.)

Generate a claim or conclusion in answer to the question – What did our evidence tell us about our original question? What else do we want to test now?

Why change the way we have been doing things?

As we begin implementing NGSS and building three dimensional instruction, there are many commonalities with the research based set of teaching behaviors found to be effective by Charlotte Danielson in Framework for Teaching and teaching behaviors that promote Practice 3, Planning and Carrying Out Investigations. In Domain 3, Instruction, the document encourages engaging the students in inquiry, allowing students to formulate questions to study, and linking the instructional purpose of the lesson to the students' interests. By organizing instruction to address possible misconceptions, the teacher is helping students overcome areas of misunderstanding on their own. Student choice in procedure and topic of investigation provides intellectual challenge that encourages engagement. Collaboratively planned investigations provide multiple opportunities for formative assessment embedded throughout instruction. Flexibility and responsiveness is demonstrated as the teacher adjusts

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the procedures to the learners' needs (Danielson, 2011).

A student driven investigative process is rich in many ways. Students have authentic reason to read to gain information to support or refute their claims. They have an authentic reason to write and compare their findings. They will need to apply mathematic and computational thinking to analyze data, in some capacity. During the course of planning and carrying out an investigation, students ask questions and define problems, develop and use models, analyze and interpret data, use mathematics and computational thinking, construct explanations and design solutions, and obtain, evaluate and communicate information. The practices are so intertwined, before you realize it, you may have incorporated them all. Planning and conducting investigations is the heart of elementary science.

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Watching and wondering - Earth and the Solar System

Jane Thompson, 4th Grade Science, Emma B. Ward Elementary

ELEMENTARY

Providing students with opportunities to watch and wonder is essential for developmental progression of sophisticated thinking about the relationship between Earth and the Solar System.

Young children are fascinated with objects in the sky. Teachers can take advantage of this fascination to help students demonstrate understanding of Earth and the Solar System.

Grade 1 performance expectation asks students to *make observations at different times of the year to relate the amount of daylight to the time of year*. To accomplish this, students make predictions, collect data, and compare seasonal patterns of sunrise and sunset.

Prior to the study, encourage students and their families to observe sunrises and sunsets. Students can record their observations in a variety of ways. Digital photos, photographs, or drawings of observations provide a basis for dialogue of things wondered about. These wonderings form questions to investigate. Discussion of things noticed multiple times presents a starting point for seeing a pattern. The pattern provides an opening for making predictions. An informational literature connection, *Next Time You See a Sunset,* NSTA Kids Publication, by Emily Morgan is a resource to help students add new learning and ask more questions to continue learning.

During the study, one idea for data collection to provide a visual representation for primary students is using yarn to show the amount of daylight for the time of year. Using a predetermined scale and a sunrise/sunset chart, students, with assistance, decide on the length of the string for that day. Each string will be shorter or longer, depending when data collection begins. Any sunrise/sunset mobile app or website can provide a monthly calendar aid. Each time, a string is added, students predict the amount of change for the next string. Starting several days before the Winter Solstice and continuing to the Spring Equinox helps student compare seasonal patterns.

The Grade 5 performance expectation asks students to *represent data in graphical displays to reveal patterns of daily changes in length and direction of shadows, day and night, and the seasonal appearance of some stars in the night sky*. To accomplish this, students focus on the motions of the earth around the sun and the moon around the earth.

Grade 5 students are excellent observers of the world around them. Keeping a science notebook allows students to observe in the length and direction of shadows. As students measure the length of the shadow at a given time each day for several days, they record the location of the sun in the sky relative to a specific landmark like the school flagpole. Over time, information and diagrams in the notebook will display the patterns of shadows. If begun in the fall, and continued on a prescribed timetable, the patterns of change will reveal seasonal changes as well.

Fifth graders can determine the amount of daylight and nighttime, noting different patterns such as amount of time change +/- minutes depending on the time of year data collection begins. Kids' Zone: Create a Graph http://nces.ed.gov/nceskids/createagraph is a useful website for students to construct a digital graphic and reveal patterns of changes.

Keeping a moon journal is an opportunity for Grade 5 students to step outside to watch and wonder as they sketch the moon while they note the pattern of stars in the night sky paying attention to the constellations present during a specific season. Using a mobile app or a weather website, a moon calendar can assist information gathering when the moon is obscured

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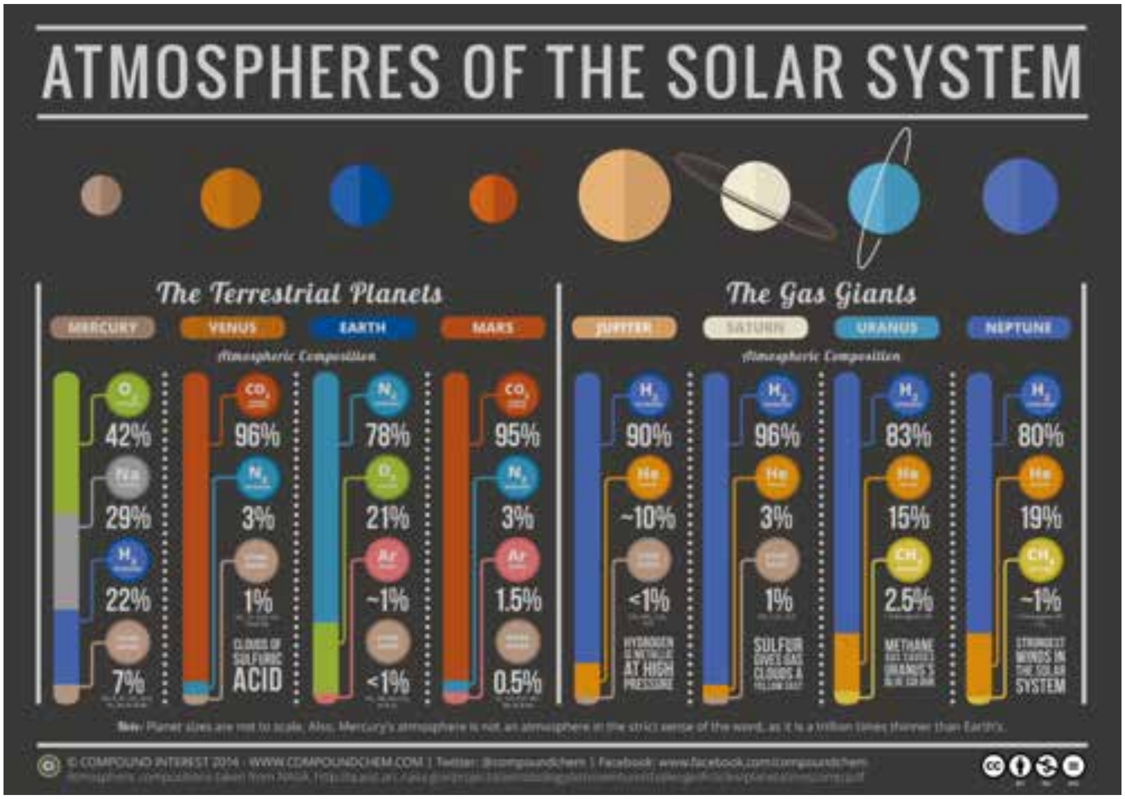
by clouds in the sky. Knowing a New Moon is 0% and a Full Moon is 100% illumination, students can predict the percentage of daily change in appearance whether the moon is waxing or waning. Students can also note the time of moon rise and moon set to determine a pattern of what time, the moon "rises" when it is New, First Quarter, Full, or Third Quarter. Again, students can predict the time the next day's moon will rise and set.

Providing students with time to watch and wonder helps make an abstract topic be more concrete with graphical representations of phenomena associated with Earth and Space Science.



Many of the crosscutting concepts presented by the Framework and NGSS directly apply to infographics, especially "patterns," "scale, proportions, and quantities," "cause and effect," and "systems and system models." By creating infographics, students also gain experience with scientific and engineering practices such as "developing and using models," "analyzing and interpreting data," and "obtaining, evaluating, and communicating information" (NGSS Lead States, Volume 2, Appendix F, p.48).

KCAS Connections

Ellen Sears, former KDE consultant

ALL

Scale and proportion in art

"…recognize how changes in scale, proportion, or quantity affect a system's structure or performance."

When we refer to an artwork's size we use the term scale. More than just the size of the object, it is the size in relation to another object. The relative size can be compared to the size of the human body – life-sized, miniature, large or enormous. Proportion refers to the relative size of parts of a whole (elements within an object).

Manipulating proportion and scale can dramatically change the mood, meaning and composition of an artwork.

Sculptors 'sketch' ideas in the form of a maquette. A maquette is a small mock-up of a fully realized three-

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dimensional sculpture or architectural project. It may be made from paper, clay or wax or other material in order to provide a visualization of what the actual sculpture or project would look like when fabricated or built.

Alexander Calder was an American sculptor known as the originator of the mobile. In 1971, when the East Building of the National Gallery was under construction Calder was asked to create a giant mobile for the atrium space.

He created a maquette to submit his design, and after it was approved Calder was presented with the challenge to construct the mobile at thirty-two times the size of the model.

Figure 1 *Untitled*. 1976. National Gallery of Art, Washington, D.C.

The original plan called for the mobile to be constructed of steel. At 6,600 pounds, the enlargement would become so heavy that a motor would be needed to make it move.

Calder collaborated with other artists to solve the weight and movement complications.

To maintain scale when enlarging the maquette an artist can use several methods. An artist can 'eyeball', use a grid or calculate using measurements of the original. Each method can create its own set of problems.

Proportional relationships, reasoning, and visual awareness are skills an artist needs to maintain scale.

Changing the scale of an object of art creates challenges and problems for artists. During the planning and concept stage it is important to ask the right questions.

- Many large-scale artworks do not hold to realistic proportions because they will appear misshapen when viewed. Classical sculptures, the *David*, for example change proportions to compensate for the viewing angle.
- The artist must understand the properties of the medium or media used. Changing the scale of the maquette may create constraints for the artist. Many times enlargements mean that the artist needs to problem-solve and investigate new materials.
- How will the viewing angle changed? If a sculpture is going to be placed in an unusual position viewing angles become more complex. How will proportion and scale need to be adjusted?
- What additional supports, counterbalances and structures need to be in place for installation? How will the sculpture be attached?

Investigate the following to learn more about scale and proportion in art:

Alexander Calder
Henry Moore
Christo and Jeanne-Claude
Claes Oldenburg
Chuck Close
Michelangelo
Florentijn Hofman
Powers of Ten Charles and Ray Eames
Palm Islands, Dubai
Spiral Jetty, Utah
Size Matters: A group exhibition that addresses ideas of scale through physical and conceptual explorations http://sjica.org/detail.html?eid=717

Assessment

Ken Mattingly, MS Science Teacher, Rockcastle County

ELEMENTARY

Formative assessment is a valuable part of the teacher toolkit when used effectively. Black & Wiliam (2001) identified the following practices as requirements for attaining the gains attributed to formative assessment:

- Use discussions, classroom tasks, and homework to determine current student understanding, and take action to improve understanding.
- Provide descriptive feedback focusing on improvement during the learning.
- Develop student self- and peer-assessment abilities.

These practices demonstrate that formative assessment is not a particular assessment item, but a suite of skills and competencies that teacher and students need to use to push learning forward. Just as crucially, they point out that successful formative assessment happens as a normal part of instruction. Teachers begin with specific goals or targets for student learning. These targets will shape the discussions, activities, and homework students will engage in. That will inform the teacher and student on where they are in the learning and what actions to take next. The key question

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becomes how do we build these formative assessment opportunities into our instruction?

For example in first grade, performance expectation 1-ESS1-2 reads:

Make observations at different times of year to relate the amount of daylight to the time of year. [Clarification Statement: Emphasis is on relative comparisons of the amount of daylight in the winter to the amount in the spring or fall.] [Assessment Boundary: Assessment is limited to relative amounts of daylight, not quantifying the hours or time of daylight.]

This performance expectation bundles DCI *Earth and the Solar System*, SEP *Planning and Carrying Out Investigations*, and CCC *Patterns*. Students are being asked to consider whether there is a connection between amount of daylight and time of the year. It is tempting to think of this as just a "fact" to teach students, however the performance expectation requires students to go beyond this and engage in reasoning as well. Students have the question, "Does amount of daylight have anything to do with the time of year?", now they are called on to design an investigation to collect data for comparison.

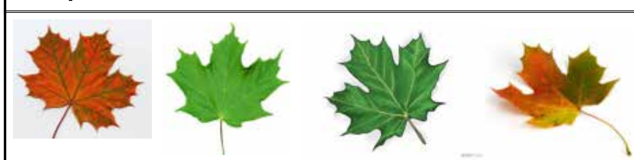
At this point, consider what you want to know as students work on their investigation. Do they understand what data is? Can they identify sources of data? Do they know what data they need to answer their investigation? This can be assessed by giving students a series of choices orally and having them use a yes/no checklist.

	Yes	No
Would **knowing** temperature help answer the question?		
Would **knowing** the amount of daylight yesterday and today help?		
Would **knowing** the temperature throughout the year help?		
Would **knowing** the different seasons help?		
Would **knowing** the amount of daylight at the beginning and end of school year help?		
Would **knowing** the day of the week help?		

Based on student responses, you can determine who is focused on the investigation question and is able to determine key information that is needed. his would allow you to group your students based on their needs during the instruction, rather than find out at the end of the unit who gets it and who doesn't.

Additionally, this performance expectation asks for students to find patterns in their observations to use as evidence. Here we need to think about the experiences our students have had with patterns. What are some patterns that they can identify? When have they used a pattern to figure out a problem?

How can you use a pattern to figure out what comes next? This could be assessed using leaves and asking students to find the pattern or patterns that are present in their structure.

Maple Leaves	What's the Pattern?
	
Oak Leaves	**What's the Pattern?**
	

This assessment would serve two purposes. First, it would tell you who can identify patterns and to what degree. Second, it provides students with an opportunity to begin self-assessing. They can determine which patterns they found and think about what kept them from finding others.

Each of these assessments provide teachers and students with information. Using that information *during the learning* to *promote learning* is what makes them formative. In these examples, the teacher has information to determine readiness to engage in the investigation. Those students who

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need further instruction can receive it before they become lost or overwhelmed by the larger task.

The process would be the same regardless of the performance expectation. What knowledge, reasoning, skill, and/or product do they call for? How can I determine student thinking and understanding of these pieces? When and where will I plan to collect evidence of this? How will I use it to adjust instruction and student learning? An additional question we should ask is where and when can I involve *students* in this process through self-assessment and reflection?

When formative assessments are intentionally planned and embed in our instruction, teachers and students gain access to a wealth of decision-making information. It is the use of this information, by students and teachers, to promote learning that gives formative assessment its acclaimed power.

References –

Black, P., & D. Wiliam. 2001. Inside the Black Box: Raising Standards Through Classroom Assessment

Kentucky Core Academic Standards for Science

Professional Learning Opportunities/ Information/Resources

Amazon Rainforest Workshops

$1000 Scholarships for Amazon Rainforest PD Workshop

Get your explorer on and apply for a scholarship to explore the Amazon rainforest next summer!

Educator Academy in the Amazon Rainforest + Machu Picchu

The July 1-11, 2015 Educator Academy in the Amazon Rainforest of Peru is a cross-curricular professional development workshop for K-12 formal and informal educators to learn and use:

21st Century Instruction: 5E Lesson Design ~ Inquiry-Based Exploration ~ STEM

Junior Duck Stamp contest

If you are looking for something interesting and fun for your students to do the rest of this semester or at the beginning of next semester, please consider the Junior Duck Stamp Contest!

The Junior Duck Stamp Contest is a worthwhile contest for students in grades K-12! It teaches students about wetlands, waterfowl, land stewardship, migratory birds, conservation, and appreciation of art and writing. This contest can be incorporated into almost any subject, and they have copies of the newly designed curriculum guide if you are interested. The contest is a great learning experience for all types of talent from beginners to more experienced.

If you would like more information, check out our website (http://www.fws.gov/refuge/clarks_river/KJDS.html) or contact us. We will be more than happy to help walk you through the program, provide more information, and answer any questions you may have. We can be contacted by email: stacey_hayden@fws.gov or by phone 270-527-5770 ext. 202. We are also on Facebook under Kentucky Junior Duck Stamp.

Get the details and download a syllabus and scholarship application at: http://www.amazonworkshops.com/educator-academy.html

Contact christa@amazonworkshops.com or 1-800-431-2624 for more information.

World of 7 Billion Video Contest

Back by popular demand, the World of 7 Billion student video contest can help you bring technology and creativity into your high school environmental education classes. The contest challenges your students to create a short (60 seconds or less) video illustrating the connection between world population growth and one of three global challenges dealing with either the sixth extinction, available farmland, or global education. Students can win up to $1,000 and their teachers will receive free curriculum resources. The contest deadline is February 19, 2015. Full contest guidelines, resources for research, past winners, and more can be found at worldof7billion.org/student-video-contest.

Kentucky Association for Environmental Education
For a Sustainable Environment through Education

Visit kaee.org for current EE information and to read the latest KAEE Email Digest. Also, visit eeinkentucky.org for more activities, grant opportunities and information about EE happenings throughout the state.

Why Files

Created at the University of Wisconsin-Madison under the auspices of the National Institute for Science Education, the Why Files web site provides scientific information to explain and expand on current news stories. This witty web site updates weekly and provides a searchable archive of stories and articles. A list of National Science Education standards that link to support Why Files articles is included. Additional classroom activities are offered that can be used with an entire class or for extra credit. There is enough intriguing information, as well as cool science images, to entice older students to explore the site on their own. Grades 5-12.

Tip: This site provides an easy way for social studies and science teachers to collaborate on classroom activities focusing on current events and the science behind the news.

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:

January 2015	Analyze and Interpret Data	PS1B Chemical Reactions	Energy and Matter
February 2015	Obtaining, Evaluating and Communicating Information	LS1B Growth and Development of Organisms	Stability and Change

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

All submissions are needed by the 20th of the month.

If you want to subscribe to KYK12SCI or others LISTSERV for the Kentucky K-12 Science Teachers, go to http://www.coe.uky.edu/lists/kylists.php . Please share this link and the newsletter with your colleagues.