Science Connection

KENTUCKY DEPARTMENT OF EDUCATION

A Collaborative Resource for Teachers **April 2015** Volume 2 Issue 2

EVERY CHILD PROFICIENT & PREPARED FOR SUCCESS
KENTUCKY DEPARTMENT OF EDUCATION

In This Issue

Editor's Note

The wheels of innovation and collaboration continue to move us further in our understanding of the Next Generation Science Standards in the great state of Kentucky. From Thursday night #NGSS chats to the newly-created professional learning mentor network on Twitter, shifts are happening. Accolades to the 21st Century teachers involved in the development of these online tools and to the many teachers who interact through these venues. More information on both online tools is provided in the newsletter under "Be In The Know".

This edition of the Science Connection focuses primarily on Earth and the solar system. Have you noticed that there is a plethora of current events that support this content? Perhaps you engaged your students in a discussion about the recent total lunar eclipse or the phenomena resulting from the eclipse, the Red moon. Maybe your students are participating in Pluto Observing Challenge or explored the solar system in 3D using Eyes on the Solar System, both of which have NASA resources developed to support teacher and student learning. You may already know of the numerous quality resources that NASA has developed for teachers and students. If you have not visited the NASA site, take a minute to explore this gems located on the teacher page. Whatever your current topic of study, be sure to incorporate the science and engineering practices throughout your unit in order to foster student thinking and problem solving as well as to create stellar learning experiences.

Happy Spring! Christine

Earth and the Solar System: Observations, Patterns, and Scientific Modeling from Grade 1 – Middle School

By **Dr. Thomas Tretter**, science education professor and director of Gheens Science Hall & Rauch Planetarium at University of Louisville; **Bill Thornburgh,** science education doctoral student at University of Louisville; **Mark Duckwall**, planetarium educator at University of Louisville

1-MS

Supporting K-12 student understandings of ideas related to Earth and the solar system can be challenging, given the time and distance scales of many of the scientific phenomena of interest. This can be particularly challenging for our students prior to high school because cognitive development up to that age is often not yet ready for large-scale abstractions. However, with effective use of several of the cross-cutting concepts (patterns, cause & effect) and science and engineering practices (observation, scientific modeling), important ideas within this content domain are accessible to our K-8 students.

This article offers instructional ideas targeting the Earth and the solar system (ESS1B) Disciplinary Concept Idea (DCI), organized into two strands. First, instructional approaches are organized in an age-dependent longitudinal manner, offering suggestions for how one could approach this instruction in a coherent, connected way across the years as the students get older, appropriately increasing sophistication as students age. Although typically there is not one teacher who would teach across this entire age spectrum (grades

Continued on Page 2

NEXT GENERATION SCIENCE STANDARDS

Practice
Asking questions and defining problems

DCI
ESS 1B
Earth and the Solar System

Crosscutting Concept
Cause and effect

Continued from Page 1

1 – middle school) it is helpful to consider potential prior experiences students may have had, and/or subsequent ones, in order to best situate your instruction within a longitudinal framework. Plus, many of the instructional approaches for younger students can be easily adapted for older students and offer useful pedagogical ideas at many different ages.

The second organizing strand of this article is to offer instructional approaches that are grounded in either an Earth-based perspective or a space-based perspective. The Earth-based perspective connects directly to what students can observe in the real world by looking up at the sky or making other direct observations such as (for older students) accessing web information. This perspective connects the targeted science concepts to real-world direct experiences, which is important for building student understanding of the idea that science attempts to characterize and explain the natural world, and that science is ultimately grounded in observational evidence. Sometimes that evidence takes the form of outputs from very sophisticated machinery such as large particle accelerators, and sometimes that evidence is from a person's own eyes. By contrast, a space-based perspective often offers a new way to think about phenomena since the observer can essentially remove him/herself from the picture and look on from 'above.' Certainly with our youngest learners, the ability to mentally displace oneself from the surface of the Earth to a space-eye view, and to connect how the two are related to a given set of observations, is much more limited compared to when they are older and their cognitive abilities develop to begin to manage more abstract thought. However, even our youngest learners can benefit from taking this different perspective, and helping them to navigate both perspectives is an important element of instructional effectiveness for this topic.

Overview of instructional tasks

Table 1 offers an overview of the specific instructional activities and tasks described in this article, followed by sections which offer details for each activity. Table 1 is organized longitudinally from top to bottom (grades 1, 5, and middle school), which is where the topic Earth and the solar system – ESS1B – appears in the NGSS, and with two columns for emphasizing Earth-based and space-based perspectives. It is often instructionally helpful for a teacher to choose to sequence these experiences in an interwoven manner, shifting from Earth-based to space-based and back again over the course of instruction – the numbers are intended to offer a recommended sequence for students' to experience these, but in some case there is flexibility in this sequence for different orders.

These ideas are presented in this article in separate sections to facilitate description, but it is certainly viable and often effective to interleave them even within one instructional day, and teachers are encouraged to integrate these experiences as their professional judgment suggests for their own students.

In fact, within the details of each activity, you are likely to find that sometimes that perspective shifts back and forth within the individual activity even though it is labeled in the table under one or the other.

Finally, although the instructional experiences are identified within a particular grade for Table 1, it is often helpful to use some of these at different age levels as well. For example, it may be helpful to use an activity that the table puts with a younger grade as a way to either refresh students' thinking on prior ideas they encountered, as a formative assessment for the teacher to evaluate where their particular class of students is starting in terms of these ideas, or as a way to fill in potential gaps in students' prior experiences given that they may not have experienced instruction on this topic previously.

Likewise, for students who demonstrate readiness for additional, more sophisticated ideas, it may be helpful to use some of the activities from an older age group for either individual students or the class as a whole.

You can access this article in its entirety here. Note that specific pages have been provided in the table below to assist you in locating grade level components.

Earth-Based Perspective	Space-Based Perspective
Grade 1 Grounded in observation (science practice), predictability, patterns (cross-cutting). Includes scientific modeling (science practice) • (1) East-to-West movement of sun, moon, and stars (daily pattern). Page 5 • (4) Sunrise/Sunset times and altitude vary regularly over year (annual pattern). This pattern leads to observations of the length of daylight changing predictably. Page 6	**Grade 1** These experiences are helpful to explore the cause/effect relationship (cross-cutting) to explain Earth-based observations. • (2) Day/Night. Half of Earth is in light, half in dark. See night lights from space. Page 7 • (3) Earth rotating – daylight comes to different parts of world. page 8 • (5) Earth orbiting the sun (year) page 8-9

Earth-Based Perspective	Space-Based Perspective
Grade 5 Can do much of the Grade 1 material at appropriate pace for older students to review/remind and to set context for Earth-based patterns. One core difference is that students at this age represent some of the observed patterns quantitatively and/or graphically. • (1) Patterns in the sky: East-West movement and shape of moon (daily pattern) page 9 • (3) Annual patterns: Charting length of day, altitude of sun (annual pattern) Represent quantitatively or graphically these annual patterns page 9-10 • (5) Constellations visible at different times of year. Document and graph rise time for specific constellations (e.g. Orion) over course of a year. Page 10	**Grade 5** Emphasis on modeling (science practice) dynamic interaction of sun, Earth, moon (rotation, revolution) to cause these patterns (cause and effect; cross-cutting). • (2) Earth rotation causes movement pattern in sky. Identify the cause of the East-West movement seen from Earth's surface. Page 11 • (4) Earth orbital period causes change in daylight. Identify the cause of the annual pattern of longer days in summer, shorter in winter and make initial connections to seasonal pattern. Page 11-12 • (6) Constellations patterns of stars are really 3-dimensional. An optional extension whereby students fly in virtual spaceship well beyond the solar system to note that constellation patterns distort as we move out into the galaxy. Highlights that stars are really 3-D and our Earth perspective allows us to imagine they are 2-D for creating pictures. Page 12
Middle School By middle schools, students can explore these phenomena more quantitatively (e.g. documenting moonrise and moonset as well as shapes; graphing length of day at several latitudes) and more thoroughly explore causes of observed phenomena. • (1) Patterns in the sky: Phases of the moon and eclipses (monthly pattern, including phenomena of eclipses) page 13 • (3) Patterns in the sky: Seasons (annual pattern) Page 14	**Middle School** • (2) Patterns in the sky: Phases of the moon from space and eclipses (monthly pattern, including phenomena of eclipses) Page 15 • (4) Reason for seasons from space-eye view (length of day, Polaris, tilt of Earth, and direct v. indirect rays) Page 16

Note. Recommended sequence for instruction within grade level is noted by numbers

Mathematical Modeling in Science

Using Titius-Bode Law

By **Chris Bently,** KDE Instructional Specialist, KVEC

MS

April's DCI deals with the Earth and the Solar System. Specific to this content is the PE 06-ESS1-3 Analyze and interpret data to determine scale properties of objects in the solar system.

ESSIB

The Content:

One of the most commonly taught properties of scale and the Solar System is orbital radius or how far the planets are

Continued on Page 4

Continued from Page 3

from the sun. Oftentimes, teachers use the old standby of building models to show locations of planets within the solar system. While effective in memorization of planetary sequence, this sometimes leads to misconceptions of planetary orbital distance and scale. We all have seen the models that depict the solar system with equal distances between all planets. Just as troublesome, building these models in sixth grade completely misses the intent of this particular performance expectation. Thinking in line with the intent of the standard let us examine an approach to scale without using Styrofoam balls and coat hangers.

Titius-Bode Law or Bode's Law, as it is commonly known, is a hypothesis that uses math to approximate the relative distances of each planet from the sun. Named after astronomers Johann Elert Bode and Johann Daniel Titius, this mathematical procedure is super-easy to understand, is very accurate (except for Neptune), and coolest of all, has baffled scientists and mathematicians since its proposal in the late 1700s. It was used to predict the locations of yet unknown planets, Uranus in particular, and as better telescopes were developed that could see farther into our solar system, these predictions were proven true time after time.

The Math:

Let's begin with the number sequence 0, 3, 6, 12, 24, 48, 96, 192, and 384. Obviously a pattern can be determined in which we begin at zero, add three, and then double each subsequent number.

Next, the number 4 is added to each number in our sequence.

0+4 equals 4
3+4 equals 7
6+4 equals10
12+4 equals16
24+4 equals 28
48+4 equals 52 and so on.

Finally, with the 4 added to the sequence, this sum is divided by 10.

4/10---.4
7/10---.7
10/10---1
16/10---1.6
28/10---2.8
52/10---5.2 and so on

Application of the math:

So what do these numbers represent? (.4, .7, 1.0, 1.6, 2.8, 5.2, 10, 19.6, and 38.8) The numbers correspond to the orbital distances, in astronomical units, of the objects in our solar system. Remember that an astronomical unit (AU) is the mean distance from the Earth to the sun. Therefore, the Earth will have an orbital distance of 1AU, and an object one half as far from the sun would have an orbital distance of .5 AU.

Examination the data reveals the following:

Body	Bode Calculation AU	Actual Distance AU
Mercury	.4	.39
Venus	.7	.72
Earth	1.0	1.00
Mars	1.6	1.52
?????	2.8	2.77
Jupiter	5.2	5.20
Saturn	10.0	9.54
Uranus	19.6	19.2
Neptune	38.8	30.06

Continued on Page 5

Continued from Page 4

As you can see, other than Neptune, the accuracy is uncanny.

Conspicuously absent is the name that corresponds to the 2.8 AU distance. This bothered early astronomers too. Until, a small object was faintly detected by Giuseppe Piazzi in the early 1800s. He named this object, originally thought to be a comet, Ceres Ferdinandea, Ceres for the patron goddess of Sicily, and Ferdinandea for Piazzi's royal patron. Ceres, as it has come to be known, was not a comet after all. It is the largest asteroid in the asteroid belt that lies between Mars and Jupiter. As we are all aware the asteroid belt is believed to have once been a planet, like the four inner, terrestrial planets, but was destroyed in a mammoth, celestial collision leaving a debris field where the planet used to be.

Student takeaways:

Obviously the purpose of this article is to demonstrate a different approach for students to investigate scale of the solar system using the mathematical hypothesis of Bode's Law. Examining the science and engineering practices for this performance expectation one can observe where error analysis would be conducted for the calculated verses actual distances. While scale, proportion, and quantity are readily apparent within the crosscutting concepts related to this standard. That is not to say that other content, science/engineering practices as well as crosscutting concepts cannot be explored with this approach. With the apparent question, "Why does this math work?" Teachers could lead class discussions and research projects into possible theories that attempt to explain this phenomenon. Additionally, with the new discoveries of planets outside of our solar system, teachers and students could explore together the application of Bode's Law within the latest astronomical findings.

Summary:

As NGSS is implemented across our state and nation we, as teachers, must shift practices within our classrooms. We must turn our focus away from teaching a body of science content to facilitating science practices within this content. Students must be given an opportunity to experience these practices in order to gain an understanding of what science truly is and what it is not. The concept of scale and the practice of data analysis as presented in this performance expectation, weave together to foster the understanding of the size and arrangement of our solar system. Using Bode's Law to explore this, I feel, will strengthen students understanding of how science works with mathematics to predict and describe certain phenomena.

Could there be dinosaur fossils in Kentucky?

An engaging question

By **Karin Ceralde**, Shelby County High School

HS

NGSS HS-ESS1-6 states:

Apply scientific reasoning and evidence from ancient Earth materials, meteorites, and other planetary surfaces to construct an account of Earth's formation and early history. *[Clarification Statement: Emphasis is on using available evidence within the solar system to reconstruct the early history of Earth, which formed along with the rest of the solar system 4.6 billion years ago. Examples of evidence include the absolute ages of ancient materials (obtained by radiometric dating of meteorites, moon rocks, and Earth's oldest minerals), the sizes and compositions of solar system objects, and the impact cratering record of planetary surfaces.]*

I've taught radiometric dating using the standard candy decay lab. Students enjoyed the M&Ms, but left with less than a full understanding of the process or real personal connection. Then came the snow days; ten off in a row. You know what that does to your learning cycle. Blown.

I knew I needed to hook my students with an irresistible question to explore. Meteorites are so abstract. Craters? I needed to find a way to connect with their personal experiences. I needed something they were curious about. It's all about sparking curiosity, and allowing students to explore, fail, learn, and experience the messy process along a twisted road to true understanding. As we worked through each part, students were asked to write their thinking in their science notebooks so that they could document their progress.

The Hook: Were there any dinosaurs in Kentucky?

The Pre-Test: Students voted with their feet by physically moving to signify their initial thinking. Remarkably, most thought there were dinosaurs sometime in the past in Kentucky.

The Brainstorm: Students were asked to generate a list of topics to explore that would allow them to fully answer the question. They built these lists together, and then shared out as a class. If they missed something, I asked questions of them until they came up with a complete list.

What we know: Students looked back in their science notebooks to locate useful information we had already explored in class. Some students volunteered their connections to a half-life lab done with M&Ms. In small groups, students reviewed the concepts of isotopes and radiometric dating using guided questioning.

Building background knowledge: Students explored the geologic time periods and the corresponding fossils. An

Continued on Page 6

Continued from Page 5

internet search provides a wealth of options to view visual representations of the time periods. From this search, students were asked to build a simple time period graphic in their science notebook. They were asked to explain in their notebook how radiometric dating related to geologic time scale.

Applying Knowledge: Students were shown the geologic map of Kentucky from this website: http://www.uky.edu/KGS/geoky/. As a reflection, they were asked to synthesize this information with background knowledge to write down their current understanding. They used the map and their geologic time scale to predict the types of fossils they might expect to find in their county.

The Next Day

The second hook: Students were shown the image from this page: http://whyfiles.org/2011/live-birth-in-ancient-marine-reptile/ and asked to write down observations and inferences in their science notebook. What could they see in the bonds? How did they know? What could they infer? What was their EVIDENCE? The little cluster of bones in the bottom center of the fossil was highlighted. I did not reveal the answer, and left them wondering.

Building background knowledge: Students were given one of two articles, each with guided questions. The articles I used were: How do scientists determine the age of dinosaur bones? http://science.howstuffworks.com/environmental/earth/geology/dinosaur-bone-age.htm ; and

Earth's Earliest Dinosaur Possibly Discovered http://www.livescience.com/25246-oldest-dinosaur-fossils-discovered.html .

After reading and synthesizing, students then paired and shared their article with a peer who had the other article. I then called on a few students to share with the whole group. In their science notebooks, students were asked to reflect on these questions: "What from the reading supported your thinking? What in your thinking has changed as a result of the readings/discussions?"

Synthesizing: To give a definite answer to our original question, students read the final article: (http://www.csmonitor.com/Science/2011/0812/Pregnant-fossil-found-in-Kentucky). They then reflected once more in their science notebook by looking back at their initial thinking on the fossil, and answering these questions: Were any of your inferences correct? Where was the fossil found? How old was the fossil? Is it likely you will find a fossil from this time period in your back yard? What kind of fossils might you find in your back yard? How will you know how old they are?

This sequence was followed by practice with radiometric dating of Earth's oldest rocks, meteorites, and moon rocks to allow students to construct an account of Earth's formation and early history.

To address the evidence provided from cratering data on planets, students explored portions of a NASA activity called "Crater Comparisons." This guide was utilized to allow students to explore how impact craters give clues to Earth's formation and early history.

Students explored background information on impact craters, researched craters on a specific planetary body, compiled their information into a spreadsheet, and shared their findings. They then incorporated this information into their final explanation of Earth's formation and early history.

How well does my lesson sequence meet NGSS ESS1-6? You be the judge. Please send comments, suggestions, and praise to Karin.ceralde@shelby.kyschools.us .

Other resources of interest:

For a laminated Geologic Map of your Kentucky County, see http://www.uky.edu/KGS/announce/landuse_teacher.htm. My students love the one of our county. They are drawn to it because of their personal connections.

Fossils of Kentucky, Kentucky Geological Society, University of Kentucky http://www.uky.edu/KGS/fossils/

Build your background with Bozeman http://www.bozemanscience.com/ngs-ess1c-the-history-of-planet-earth/

NGSS ESS1-6 Evidence Statements http://www.nextgenscience.org/ngss-high-school-evidence-statements

Exploring Orbits using Interactive Computer Simulation

By **Kevin Crump**, Science Instructional Specialist - KDE

5-12

Introduction:

Searching for resources to teach about the Earth and Solar System (ESS1.B) can take a very long time. There are so many Astronomy Apps, websites and models it can be difficult to determine what is best for your students. The University of Colorado's PhET Interactive Simulation called My Solar System is an excellent teaching tool that can develop a student's understanding of the dynamics of planetary motions.

Continued on Page 7

Disciplinary Core Idea from NGSS ESS1.B: Earth and the Solar System

- The orbits of Earth around the sun and of the moon around Earth, together with the rotation of Earth about an axis between its North and South poles, cause observable patterns. These include day and night; daily changes in the length and direction of shadows; and different positions of the sun, moon, and stars at different times of the day, month, and year. (5-ESS1-2)

- The solar system consists of the sun and a collection of objects, including planets, their moons, and asteroids that are held in orbit around the sun by its gravitational pull on them. (MS-ESS1-2),(MS-ESS1-3)

- Kepler's laws describe common features of the motions of orbiting objects, including their elliptical paths around the sun. Orbits may change due to the gravitational effects from, or collisions with, other objects in the solar system. (HS-ESS1-4)

Addressing a common misconception

One consistent misconception about orbits that I noticed over the years has been the role of gravity, tangential velocity and inertia. Students often think that gravity alone is the reason for orbits. They recognize that the force of gravity pulls planets towards the sun but reasoning why the orbital path is maintain is not understood. Students struggle to see that gravity is only part of the reason. After all, without gravity there could be no orbit. The entire solar system would be inside the sun. There has to be something else that is necessary in order to explain this phenomenon.

Newton's First Law of Motion, referred to as Inertia, states that objects in motion will continue in a straight line and constant speed unless acted upon by another force. Inertia is not a force but a property of matter related to its mass. A planet has tangential velocity because it is moving in an orbit. Gravity is the inward force acting on a planet perpendicular to its motion or tangential velocity. Ask students to imagine a tug-of-war between the gravitational pull of the Sun and a planet's tangential velocity. Then pose the question, "what happens if one of them wins?" This game of tug-of-war has been going on for a very long time and there is still no winner. Thank goodness!

The reason for this misconception is unclear. It could be that gravity is much more familiar to students. The role of gravity is so persistent across grade levels and all science content areas. Newton's law of universal gravitation is simply more popular compared to tangential velocity or inertia. Figure 1 demonstrates what influences a planet for an orbit to be maintained. It is important to point out here that a force vector is shown for the pull of gravity and a motion vector is shown for tangential velocity. The diagram could also show the orbit of a moon by changing the word Sun to Planet and the word planet to moon.

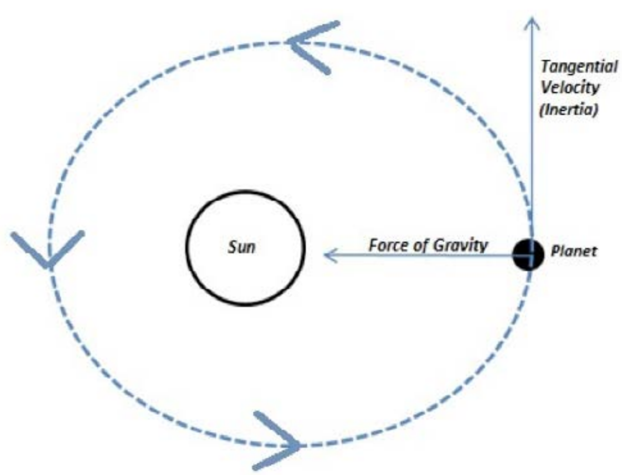


Figure 1. A diagram showing the stable orbit of a planet around the Sun. The arrows indicate vectors of the Sun's gravitational pull and the tangential velocity (inertia) of the planet. Not drawn to scale.

Instructional Tool:

When teaching this concept, consider asking students to describe the motions of the solar system. Can students explain that planets orbit the sun and moons orbit planets? This initial formative step provides insight as to where to begin your instruction. It is essential that students have this basic conceptual understanding prior to engaging in the following recommended simulations.

The University of Colorado has developed a website that offers numerous PhET simulations (http://phet.colorado.edu/en/simulations/category/new). I suggest engaging students in My Solar System which is found on the Earth and Space Science Simulations page. This simulation enables students to change variables as a smaller object orbits

Continued on Page 8

Continued from Page 7
a larger object as well as factor in gravitational pull and tangential velocity. This provides opportunity to address the before mentioned misconception.

When engaging in My Solar System PhET simulation, ask students to predict what would occur if they enter the value of zero. They then can see a visual model of would happen if this is done for the mass of the Sun. The planet flies off into space and if a zero is entered for velocity, the planet crashes into the Sun. What makes this simulation so unique is the vast array of variables students are able to manipulate and the number of different tests that can be conducted by changing the number of orbital bodies. It can show a moon's path around a planet at the same time the planet is orbiting the Sun. You can also demonstrate having more than one planet. This interactive simulation allows students to plan and carry out their own investigation by deciding what variables to change and which ones to keep constant. This simulation also promotes math and computational skills because students must get the mass, velocity and distance from the Sun correct for a planet to remain in orbit.

Personal Note:

I had the good fortune to attended a session at the Next Generation Physics Teaching Conference, by Dr. Christopher Palma ,Senior Lecturer of Astronomy and Astrophysics at Penn State. His research corroborates my experience related to the addressed misconception. Dr. Palma's extensive work with teachers using the PhET simulations encouraged me to incorporate this tool within my instructional plan. You can access an article written by Dr. Palma in The Earth Scientist Volume XXIX • Issue 2 • Summer 2013 (http://essp.psu.edu/sites/default/files/tes_esspissue.pdf) Dr. Palma provides a lesson outline using the PhET simulation of My Solar System for teaching the Role of Gravity in Planetary Orbits.

One last note, high school students can use the My Solar System PhET simulation as an introduction to Kepler's Laws. When the orbit is animated you can actually see the speed increasing the closer it gets to the Sun. The larger body will stay at one focus to demonstrate a true elliptical orbit.

Project- based learning - My second attempt

A continuation from "Moving forward, but not there yet" in the March edition of the Science Connection.

By **Cindy Combs**, 7th Grade Science, Simons Middle School

MS

My first attempt at engaging my students in the practice of obtaining, evaluating, and communicating information left me with a classroom full of posters that were somewhat attractive yet only contained information primarily quoted from articles my students sourced off the internet. Presentations consisted of students standing in front of the class reading off the information they had pasted to their board. There was a lack of enthusiasm in the presentations, little if any engagement from peers and the results gave me little information about student learning. When prompted with questions, my students demonstrated that they had learned much more than they were sharing through their presentation. This activity did little to elicit student understanding. After discussing the results of this project with my colleagues, we concluded there must be a better way to have our students creatively and authentically communicate their learning.

Brandi Cooper, an 8th grade science/language arts colleague, shared information she had read about project-based learning (PBL). Brandi had previously engaged students in PBL and eagerly shared her experiences. "PBL places students in real world settings and gives them a choice in how to create a solution to a problem. When using PBL's in the past, I have had great success," she said. Together we decided to revise the unit and give PBL a try.

So what exactly is project-based learning? I had to do my own research to truly understand what made PBL so different than my typical lessons. I found that PBL follows an instructional sequence which introduces students to a real-world problem; then they research the problem, and move on from there to design a solution. The students are provided with support documents that guide their research and rubrics to assess each step of the project. I found that PBL promotes more authentic learning that is aligned to 21st Century learning skills.

"Project-based Learning is an instructional approach, which addresses the needs of the 21st Century classroom as well as the standards-based curriculum, to prepare students for college and careers using real world scenarios, authentic documents and situations. Through the use of a problem-solving sequence or the engineering design process, students create products and solutions developed with student autonomy and choice (Accelerate Learning, 2015)."

I began by providing an entry event intended to provoke student thinking and group discussion. As students read an article on energy drinks (found at AcceleratedLearning.com)which addressed the controversy surrounding energy drinks and viewed a video clip from the Today Show related to the same topic, a great flurry of discussion and student questioning erupted. This proved to be an engaging topic. Many students enjoy energy drinks on a regular basis and had no idea of the controversy surrounding these drinks. Students stated their opinions on whether or not our school should continue to sell these drinks based on the evidence they gained from the article and the video. The task then became for students to conduct further research on this topic in order to obtain information needed to support a 10-minute presenta-

Continues on Page 9

Continued from Page 8

tion targeting the school concession purchasing committee. Collaboratively, the students and I determined the criteria/constraints for this experience as well as a scoring guide for success.

Students were placed into multi-ability teams and assigned roles (Team Leader- Producer/Director, Investigative Analyst, Food Science Engineer, and FDA Regulatory Agent) for completing the project. Note that this was more controlled as it was a first attempt at releasing responsibility to the students. While teams work on brainstorming their initial thoughts about the effects of energy drinks and ways to present the information, I held mini-workshops to provide an overview of the responsibilities associated with individual team member roles. The teams spent several days researching and developing their presentations and engaging in small group lessons that allowed me to gain evidence of their understanding. They then presented their information to the whole class for feedback based on a predetermined scoring rubric. This allowed students to revisit their presentation and make revisions based on feedback. The next step will be to arrange a meeting with those responsible for purchasing snack for concessions. Students are eager to address this issue with their intended audience.

My colleagues and I chose to utilize project-based learning in order to get more authentic ppresentations from our students. This type of project allowed me to know if my students were able to obtain information and communicate their ideas clearly with given criteria and constraints. The end products for the PBL project provided more evidence of what students learned than presentations I received prior to using PBL. My students were more engaged in the learning process and developed much stronger research skills. The presentations were more creative and very authentic since students had buy in and personal connections to the topic. Even though student growth was evident through the engagement of this PBL experience the realization that continued engagement in activities that support the practice of obtaining, evaluating and communicating information are needed. Project-based learning may not be suitable for every unit but I plan to design my instruction to incorporate problem-solving tasks and to continue to release the responsibility of learning to the 21st Century learners in my classroom. My students keep asking me when they will get a chance to do a project like this again so they can do even better?- Words I thought I would never hear!

References

National: Project Based Learning. (2015, January 1). Retrieved January 14, 2015, https://ali1.acceleratelearning.com/scopes/436/elements/15504

KCAS Connections

Laying a foundation for future science learning related to ESS1B

By **Karen Holbrook**, Gallatin County Lower Elementary School

EARLY EDUCATION

Children are naturally inquisitive about their surroundings. I use these curiosities to elicit questions from children for investigation, resulting in improved learning through increased student engagement. At an early age, all children have the capacity and propensity to observe, explore, and discover the world around them (NRC 2012). Students can become lifelong problem-solvers, collecting evidence while searching for understanding in a variety of contexts, as they continue to make sense of their world.

One way to involve students in inquiry based learning is through problem solving. Fostering a child's curiosity and excitement about the world lays the foundation for future science learning. These unplanned learning experiences children encounter in their environment are important to their development. Intentional learning experiences are equally important. Preschool students need guidance, modeling, and practice as they learn to use investigative tools and strategies. We, as teachers, should provide experiences specifically planned to promote learning. We can structure the environment to invite play around science concepts by strategically placing materials and planning experiences that will engage students and promote questions.

Young learners have limited experience with investigative tools, so we need to directly teach the skills required to make observations while collecting data. I begin by exploring the five senses, using each to make observations. Next, I model the scientific process, providing scientific language while making observations and predictions, collecting data, testing hypotheses, and forming conclusions. I, then, present an array of activities that allow opportunities to investigate, using a variety of tools to support observations and assist in data collection. Students explore ways to measure, making predictions and using tools to verify, using both standard and nonstandard forms of measurement. Throughout the investigation children take lab notes, including sketches, as they collect data. These skills are vital for inquiry based learning and often lead to in-

Continued on Page 10

vestigative studies. I use these experiences to develop a KWL chart (Know, Want to Know, Learned), focusing on children's prior knowledge as a basis for future learning. The children develop the questions, help set up the investigation, collect data, and report their findings in a culminating activity.

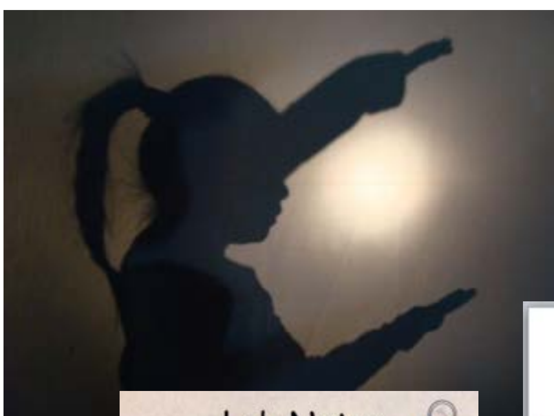
Things to consider when designing an investigative project/integrated study:

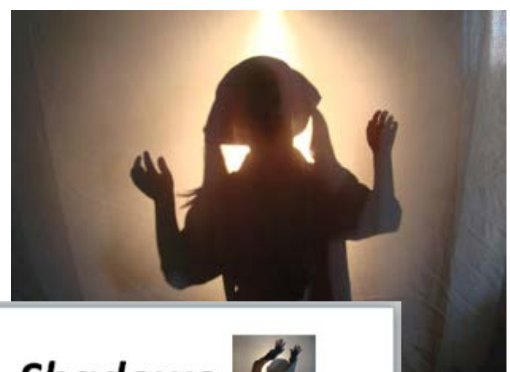
1– What is the project's purpose?
2– Can the arts, technology, math, and literacy be integrated naturally?
3- How might students take an active role/lead?
4– What resources are available?
5– What tools/technology is needed?
6– How will students take data?
7– How will students report their findings?
8– Is this an extended study or short unit?

Earth and the solar system:

Earth and the solar system is an abstract idea for young children since they cannot directly interact with the sky. They can, however, begin to make observations about objects in the sky; describe the differences between day and night; collect data as they observe the sun, clouds, stars, and the moon; and explore other scientific concepts as a result of those observations. What child isn't fascinated by shadows? As students begin to make observations and play with light, an exploration of shadows follows naturally. The daytime sky and shadows can be explored during gross motor time or on nature walks as they make observations. Flashlights can be used in the classroom to explore shadows. An investigative study might include such activities as discovering what makes shadows bigger or smaller, tracing and measuring shadows, creating shadows using a variety of objects, observing shadows from different angles and at different times during the day, and creating shadow pictures or sketches. Teachers can set up more exploration opportunities in dramatic play using a camping theme and projecting stars on the ceiling or adding glow in the dark stars to simulate the night sky. Other props can be added such as flashlights, a pretend campfire, tents, pillows, nocturnal stuffed animals or puppets, and night time sound effects. These activities could easily lead to further investigative studies such as light exploration, nocturnal animals, water exploration, bubbles, air, or rocks to name a few. Extended opportunities for learning are limitless.

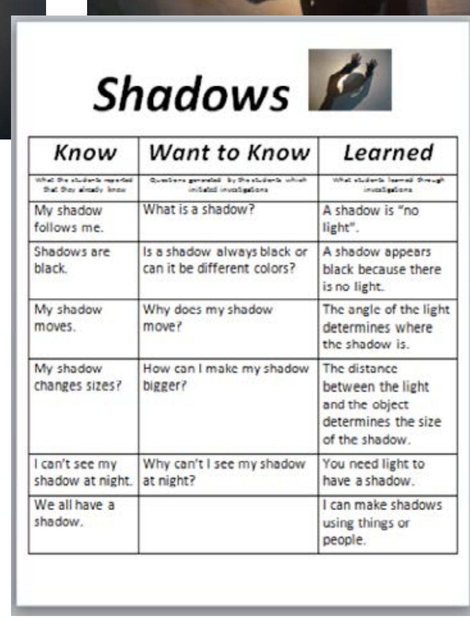
Young children encounter science experiences through play. We should guide those natural curiosities intentionally as we provide opportunities to engage in exploration and discovery. Preschool students need concrete experiences to make sense of abstract concepts.





Children create shadow letters and play "guess whose shadow this is?"

Student lab notes



Shadows

Know	Want to Know	Learned
What the students reported that they already know	Questions generated by the students which initiated investigations	What students learned through investigations
My shadow follows me.	What is a shadow?	A shadow is "no light".
Shadows are black.	Is a shadow always black or can it be different colors?	A shadow appears black because there is no light.
My shadow moves.	Why does my shadow move?	The angle of the light determines where the shadow is.
My shadow changes sizes?	How can I make my shadow bigger?	The distance between the light and the object determines the size of the shadow.
I can't see my shadow at night.	Why can't I see my shadow at night?	You need light to have a shadow.
We all have a shadow.		I can make shadows using things or people.

Class KWL chart

To the moon and back!

By **Anita Witt**, Preschool Teacher South Green Elementary

EARLY EDUCATION

Preschool children get excited to begin exploration about Earth and the solar system. When asked an essential, yet simple question, “What happens in the sky?”, preschool children respond based on their early observations of what naturally happens throughout various time periods of the day and year. Answers from the children include observations about the sun, moon, stars, clouds, and changes in the weather.

It is important to think about the crosscutting concept of cause and effect when facilitating learning about Earth and space. With our earliest scientific learners in preschool, this begins with looking at patterns.

There are a variety of reasons this inquiry is so important. First of all, it is a disciplinary core idea which aligns with Kentucky’s early childhood standards.

The following is a strategy that is useful when helping preschool students explore patterns in the sky during the day and night. Students make predictions about what happens in our sky. Later, the children trace and cut out a sun and moon. They glue or tape the sun and moon to Popsicle sticks which are used throughout our inquiry as props when we sing songs or do finger plays.

The children draw pictures of a day or night scene and then either write or dictate what’s happening in the picture. In a large group setting, there are two different color hula hoops taped together to create a Venn diagram, a tool used often to organize data in my preschool classroom. On the left hula hoop is a picture of a sun, and on the right there is a picture of a moon. Children are asked to put their scientist hats on and share what would go in the middle of the hula hoops. A questioning strategy could be, “I’m wondering what would go here, in the middle of the hula hoops?” To further guide this activity, the teacher could ask the children if anyone can make an observation about the hula hoops to help tell why the middle would be for both the sun and the moon. Children using higher-level thinking skills provide responses such as, “The middle of the hula hoops shares two colors, so it shares the sun and moon.”

Learning as well as formative assessment takes place as the drawings are presented and the children hold up the corresponding stick of a sun for day activity or moon for night activity. Before long, there is an activity that some hold up the sun and others hold up the moon, such as sleeping. To guide the discussion, the teacher could say, “I am wondering where this card about sleeping would go in our Venn diagram?” The children begin to share why it should be a day or night activity, and within a couple of seconds, a consensus forms that we can sleep at night or take a rest during the day at school. When asked where the activity fits on the Venn diagram, the children excitedly shout, “In the middle!”

To begin getting the children to ask questions about the Earth, they explore what our Earth looks like by going outside, recording what is seen through drawings, dictation, and writing. A variety of tools are taken outside so the children have an opportunity to dig, rake, hoe, and shovel; other tools such as magnifying glasses, binoculars, and a telescope are also utilized. After exploring outside and looking toward the sky, the children talk about what materials the moon is made of and how that compares to the earth. To provide a hands-on approach, the class follows a recipe to make salt dough in order to create three-dimensional models of the moon’s surface. A variety of media suggested by the children including rocks, dirt, and sand is provided to use to embellish the moon models.

For students to fully become engaged in an inquiry about Earth and the solar system, it is helpful for classrooms to transform every center, so for a substantial part of the day children engage in learning opportunities of core ideas focusing on Earth and space.

Teachers act as facilitators by asking questions to help them explore, which allows the natural curiosity of the children to emerge as they use hands-on approaches to learning. These interactions with the children allow authentic opportunities to ask children questions and guide their learning.

Be in the Know

Where can you find ongoing professional learning and support? Check out these two online resources!

http://www.ngsspln.com/

http://ngsschat.wikispaces.com/

Professional Learning Opportunities/ Information/Resources

Engaging Students Using Participation Techniques

Creating a classroom where everyone is engaged, thinking and learning
Western KY: June 11-12
Eastern KY: June 22-23
Lexington: June 25-26
This two-day session provides participants with strategies that increase student engagement and promote critical thinking skills — both of which are essential to student's conceptual understanding of content.
Audience:

- Classroom teachers of any content and any grade level!
- Instructional coaches grades K-12

$250 per person includes a copy of the book Total Participation Techniques: Making Every Student an Active Learner by Pérsida Himmele and William Himmele
For complete details and registration, visit www.uky.edu/pimser and click on "All Content Areas".

EKU

"How can we best incorporate active science learning into our classrooms consistent with NGSS?"

ANNOUNCING

CHEMISTRY FOR SECONDARY TEACHING
CHE 801 SUMMER 2015 through Eastern Kentucky University
Instructor: Dr. Martin Brock

A 3-cr. hr. hybrid course (on-line components plus a few on-campus meetings) with graduate credit in chemistry. To register for the course, go to the EKU Graduate School website at http://gradschool.eku.edu/ then click on "Admissions", then "Visiting & Non-Degree". You will need to follow directions for Non-Degree admissions. The course will be offered from 8 June through 30 July.

Continued on Page 13

2015 Spring and Summer Professional Learning Presented by PIMSER

Join us for exceptional professional learning opportunities for teachers of every grade level and every content area! Click on the workshop titles for complete descriptions and registration, or go to our website at www.uky.edu/pimser to see a full listing of workshops, including those specifically for math and science teachers.

Elements of Effective Formative Assessment
May 5
This one-day overview will outline the essential infrastructure and other essential elements of formative assessment (learning culture, planning, learning targets, success criteria, talk and questioning, and feedback). Learn practical strategies for incorporating the elements of formative assessment in your classroom.

Engaging Students Using Participation Techniques
Western KY June 11-12; Eastern KY June 22-23; Lexington June 25-26
Create a classroom where everyone is engaged, thinking and learning! In this two-day session, participants will learn strategies that increase student engagement and promote critical thinking skills - both of which are essential to student's conceptual understanding of content.

Developing a School Culture of Learning
July 16-17
During this two-day session, participants will learn strategies to develop a learning culture that enable the student to take ownership of the learning experience, including growth and fixed mindsets, student talk and questioning techniques, and using feedback.

Continued on Page 14

Hubble National Teach-In

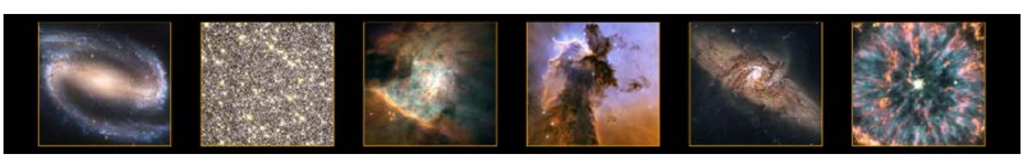
Calling all teachers and students!
Celebrate the Hubble Space Telescope's 25th anniversary in your classroom with the Hubble National Teach-In on April 24, 2015 at 1 PM EDT.

Join Hubble educators and astronomers for an online exploration of the remarkable history and still-bright future of a telescope that has transformed both the way we do astronomy and our understanding of the universe. Discover the trials and triumphs of NASA's first Great Observatory, learn about some of its remarkable scientific achievements, and experience a compendium of some of the greatest imagery the universe has ever known. Our featured speaker will be Dr. Frank Summers, outreach astronomer at the Space Telescope Science Institute.

Go further by investigating Hubble in your class. Pose questions to be addressed during the event. Join the Nationwide Galaxy Count, and analyze a section of one of Hubble's most important images. Provide your data for a coast-to-coast group estimate of the number of galaxies across the universe!

For more information visit: **http://hubble25th.org/go/Teach-In**

Bring Hubble's universe directly into your classroom!



Please Help Populate the Kentucky Informal Educator Science Hub

The goal of the Kentucky Informal Educator Science Hub is to provide a pool of knowledgeable volunteers from a wide range of backgrounds that are willing to offer their time and expertise by working with local K-12 science educators as they implement the new Kentucky Core Academic Science standards.

Please submit the name of a person/organization that has supported you in science education. Once your submission is reviewed, an invitation to become a participant in the KDE Informal Educator Hub will be sent to the person/organization you have named in this form. Thank you in advance for helping to build this resource for all Kentucky teachers.

The Kentucky Informal Educator Science Hub submission form can be accessed here.

Thank you in advance for your support in the development of this resource and for your submissions! Christine

Continued on Page 15

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 SC focus dimensions:

MAY	Engaging in argumentation from evidence	PS2 B Types of interactions	Patterns

Please send 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 with your colleagues.