Patterns Are Observable, Predictable, and Explainable

By Christine Anne Royce

Pattern identification is a key element to students' understanding natural phenomena and is important in making connections across varying content areas in the sciences. The activities developed for this month's column use everyday phenomena to help students understand what a pattern is and how it connects to understanding science.

This Month's Trade Books

Cloudy With a Chance of Meatballs
By Judi Barrett
Illustrated by Ron Barrett
ISBN: 978-0689707490
Grades K–3

Synopsis

This traditional favorite tells the story of the tiny town of Chewandswallow where food and weather were very predictable. According to the tall-tale, the weather occurred three times a day—breakfast, lunch, and dinner. While food falling from the sky three times a day presented challenges for the townsfolk, the book provides a great introduction to discussing patterns in the "weather."

The Moon Book
By Gail Gibbons
ISBN: 978-0823413645
Grades 2–5

Synopsis

Gibbons provides an overview of the Moon and describes how its path around the Earth creates the phases of the Moon that can be observed each lunar cycle. The book provides information on observing the pattern as the Moon moves throughout its phases.

Curricular Connections

The *Next Generation Science Standards* state that "in the earlier grades, students begin by recognizing patterns and formulating answers to questions about the world around them" (NGSS Lead States 2013, p. 2) and that "observed patterns of forms and events guide organization and classification, and they prompt questions about relationships and the facts that influence them" (Appendix G, Volume 2, p. 81). The relationship among variables is one of the types of patterns that students can begin to understand. As students gain more experience in identifying and recognizing patterns, they can begin to explain that "similarities and differences in patterns can be used to sort and classify natural phenomena" (p. 24).

This month's activity for younger children helps students "use and share observations of local weather conditions to describe patterns over time" (performance expectation K-ESS2-1; NGSS Lead States 2013, p. 17) but also helps teachers meet the need to explicitly teach patterns. *Cloudy With a Chance of Meatballs* may be a tall-tale (which is pointed out in the book), but it prompts the question of what weather is—and if there's a pattern. By the end of kindergarten, "students are expected to develop understanding of patterns and variations in local weather and the purpose of weather forecasting to prepare for, and respond to, severe weather." The second activity using *The Moon Book* asks students to represent data about Moon phases "in graphical displays to reveal patterns of daily changes" (performance expectation 5-ESS1-2; p. 49). While the performance expectation focuses on patterns associated with shadows, day and night, and the seasonal appearance of stars in the sky, the use of the Moon's phases to determine patterns at this level is also appropriate and a good starting point related to the patterns that result from the Earth, Moon, and Sun system. ■

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Grades K–2: Weather Patterns

Purpose

Students will make and share observations about the local weather conditions in order to describe weather patterns over time.

Materials

- *Cloudy With a Chance of Meatballs*
- Student data sheet (see NSTA Connection)
- Chart paper for recording data
- Outside thermometer

Engage

Read *Cloudy With a Chance of Meatballs* to the class first from the beginning to the end. Once completed, ask the students if they think food falling from the sky could happen in everyday life. Since this is a fictional story and young students may develop misconceptions from a story such as this, it is important to clarify that this story is pretend or as page 4 in the text states a "tall-tale bedtime story." After students have heard the story once, re-read pages 7–14 of the story to the students and have them focus on *when* the food fell like precipitation from the sky as well as *what* fell from the sky (CC ELA Connection: K–5 – Key Ideas and Details). Engage the students in a discussion about observations they can make about the type of food and any patterns that are evident. Examples of patterns are that breakfast foods fell for breakfast and items we would normally consider lunch foods, such as frankfurters, fell for lunch. Another pattern is that meals happened at a certain part of the day and that drinks fell after the meal was over so that people could wash down their food. Ask students to explain what they think a pattern means at this point and allow students to use examples from the text to illustrate their explanation (CC ELA Connection: Speaking and Listening Standards K–5 – Presentation of Knowledge and Ideas). Continue to read beginning on page 16 and ask the students what happened next in this part of the story. The next part of the story is that food begins falling at random intervals and the types of food were not what we would consider normal for meals. Point out the comparison of these random food events with the patterns they noticed earlier and have them further clarify their understanding of a pattern. Students may indicate that a pattern is something that can be predicted based on past observations or something that is repeated. The goal of this probe is to begin to evaluate students' understanding of what a pattern is and guide them toward looking for patterns as they continue the activity. Using their own words and an example from the book, have them record their ideas on the student data sheet which can be found online (CC ELA Connection: Speaking and Listening Standards K–5 – Presentation of Knowledge and Ideas).

Explore

Not only will students be using their student data sheet to demonstrate individual understanding, they will also be using a classroom chart for data collection to allow for collaboration and discussion. Create a chart for the classroom that provides the days of the week and the following questions:

- Is it sunny today?
- Is it rainy today?
- Is it cloudy today?
- What is the temperature in the morning? (Temperatures should be recorded in whole numbers.)
- What is the temperature in the afternoon?

Over the period of a week or two depending on the length of your units, have the children gather the data to answer each of the above questions and record it on the chart each day. It is important to determine the outside temperature at approximately the same time in the mornings and afternoon to keep this a constant variable. Good times to record are first thing in the morning after the morning meeting or housekeeping tasks and again following lunch. As students are gathering this data daily, introduce key terminology associated with the weather such as *temperature, sunny, cloudy, rainy, Fahrenheit,* and *Celsius* (CC ELA Connection: Language Standards – Vocabulary Acquisition and Use) and encourage students to learn how to manipulate a thermometer and other basic scientific tools.

After several days of recording the data, ask the students to make observations about what they notice regard-

ing the type of weather and temperature. What do they see happening to the temperature as the day progresses? The *NGSS* indicate that students as young as kindergarten should be able to record whole numbers for the temperature. Having students record the temperature with numbers will assist in the identification of the pattern. In working with students, the teachers will need to explicitly model how to interpret the change in temperature from morning to afternoon for students initially (CC Math Connection: Mathematical Practices #2 – Reason abstractly and quantitatively). Students can use symbols such as a sun, cloud, or raindrops for the type of weather they are experiencing to assist students in connecting the two. In most locations, general patterns will develop showing that rainy or overcast days are not as "hot" as sunny days and that generally the temperature is cooler in the morning and warmer in the afternoons. Students may ask questions about why it gets cooler after a storm. Tell students that severe weather can impact the general patterns they observe and these changes are also part of broader weather patterns. Ask students to identify a pattern and record it on their student data sheet. Have the students share the patterns they recorded, and if necessary assist students in clarifying if something is or is not a pattern through questioning.

Explain

In this part of the lesson, the students need to begin to try and construct explanations for the patterns and engage in arguments about their explanations by providing evidence from their observations (CC ELA Connection: Speaking and Listening Standards K–5 – Presentation of Knowledge and Ideas). If you return to the example from *Cloudy With a Chance of Meatballs* they could give the example, "Drinks are at the end of the meal following breakfast and lunch," stating that evidence is that the story narrator said. Taking the following patterns that are likely to emerge from the data students gather, ask them to explain why it is a pattern, what may have caused the pattern, and finally what evidence they have from the data collected. Likely patterns are:

- Sunny days are warmer than cloudy or rainy days.
- The temperature increases from the morning to the afternoon.
- There were a certain number of rainy days or sunny days in a row.

This activity and the acceptable answers provided by students may need to be adapted based on the developmental level of your students. Students in kindergarten are more capable of describing what happened using anecdotal concrete examples, whereas older students will be able to quantify those examples with the temperatures and connect both temperature and weather type.

While young students will not understand (nor should it be introduced here) the scientific reasons for each of these patterns, they can construct basic explanations based on their knowledge of the weather, research on the web (e.g., how many sunny or rainy days were there in a row?,) and the data they gathered (CC Math Connection: Measurement and Data). Keep in mind that according to the assessment boundary for the K-ESS2-1 Earth System's performance expectation, quantitative observations are limited to whole numbers and relative measures such as warmer/cooler.

Elaborate

Ask students to consider one other weather element—observations in the sky. Have them make observations several times a day by describing what they observe in the sky and the type of weather they are currently experiencing (e.g., rainy, cloudy or overcast, and sunny). Ask students to use their understanding of patterns to develop a prediction about what they observe in the sky and the type of weather that occurs (see Internet Resources). Have the students record a sentence or illustration that explains this relationship—a pattern (CC ELA Connection: Language Standards – Vocabulary Acquisition and Use). For teacher background knowledge but not necessarily for student use, the following types of clouds are linked to certain types of weather: Cirrus or cumulus clouds bring fair or sunny weather; stratus clouds produce overcast skies and often rain; and nimbus clouds will bring rain.

Evaluate

Assessment is ongoing and can be done through student discussion, explanations, and teacher review of what students are recording on their student data sheet. A final evaluation could be to ask students to make a prediction regarding the temperature on a day that is sunny versus rainy or a day that has cirrus clouds versus nimbus clouds.

Grades 3–5: Patterns in the Sky

Purpose

Students will collect data from observations and research in order to explain the patterns found in the sky are related to the Moon's phases.

Materials

- *The Moon Book*
- Pictures of the Moon at various stages for each group of 2–3 students (see Internet Resources)
- Student data sheet (see NSTA Connection)
- Tag board, tape, and glue sticks for each group
- Chart paper
- Moon phase calendar
- Wall calendars with Moon phases
- Monthly calendars for the next three months without Moon phases listed

Engage

Read *The Moon Book* pages 1–10 to the students. Stop on page 10 where it reads, "The Moon appears to change shape, but it doesn't. The different shapes we see are called phases of the Moon" and ask students what they think that means (CC ELA Connection: Reading Standards for Informational Texts K–5 – Integration of Knowledge and Details). Allow students to provide their own statements related to what they understand about the Moon phases and record these statements on chart paper. Some students may be able to demonstrate their ideas through illustrations or explanations based on their prior experiences.

Show the students individual images of the Moon phases in a random order. Ask the students if they can explain what the images are and any similarities or differences that they notice about the images. Potential misconceptions include that the phases of the Moon happen due to the Moon entering the Earth's shadow; different places on the Earth see different phases of the Moon each day; and the Moon makes its own light. See Internet Resources to read more about misconceptions related to the Moon. After students have had an opportunity to engage in a general discussion as a class, provide each group of 2–3 students a complete set of the images. Ask them to place the images in an order that demonstrates a pattern and explain their reasoning on the bottom of a piece of tag board. Have the students tape the phases of the Moon to the piece of tag board in the order they developed so that there is a pre-assessment and explanation of their understanding of the Moon phases. Note: Student groups may actually begin at any single point in the Moon phase cycle. The key concept is to see if students can explain what a pattern is by placing the eight phases of the Moon in an order that shows a pattern of either increasing and then decreasing in visibility (waxing to waning) or the reverse (waning to waxing).

Explore

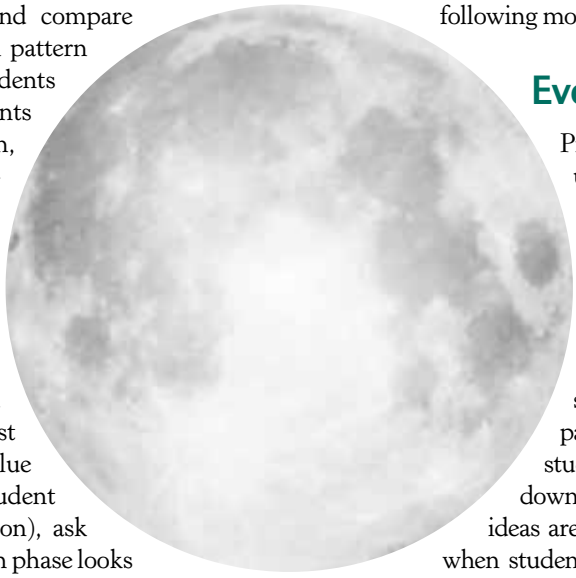
Provide each student with a Moon observation calendar that has the proper month and days labeled for when this activity will be completed. Explain to the students that they will be making observations of the Moon each night Students should never look directly at the Sun and a letter should be sent home to parent explaining the observations. An alternate version of this activity would be to look up the current phase of the Moon each day (see Internet Resources). Regardless of which method you use, students should record their observations with the time and date and sketch on the calendar provided how much of the Moon is visible during their observation. This will allow students to see the sequence or change in the amount of the Moon that is observable as it progresses through the phases. After two or three days of observation, ask the students to make observations about what they notice. Again, since the same amount of the Moon is visible no matter where on Earth you are, the teacher can always have students refer to the online Moon calendar in the event of several cloudy days or days that the Moon appears later than a student's bedtime. Depending on where in the lunar cycle students began their observations, they may indicate that they can "see more" or "see less" of the Moon each night. Teachers may want to do some advance preparation and be selective when choosing the day students start their observations to ensure the Moon is visible at night. Selecting the starting date that will allow for several nights of observing will provide opportunities for discussion. Teachers can determine this through the use of the StarDate calendar (see Internet Resources). Based on the observations, ask the students to make a prediction about what pattern they think they will see develop over the next several nights. Students may want to return to their original sequence of pictures that they had glued down to determine where they are in the sequence and what comes next. Even after a few days, a pattern emerges and can be discussed.

Explain

Ask students to compare their sketches with their group members. Individual student's perceptions may show more or less than others, but a pattern should still be consistent. Once all of the observations have been recorded and sketched,

ask the students to explain the pattern they observe related to the Moon's phases. Students may say that the part of the Moon they saw increased or decreased (this is also accurate). The phases of the Moon are due to the position of the Earth, Moon and Sun since we see different amounts of light being reflected off the Moon. In order to place names with the phases, return to *The Moon Book* and read pages 11–14 to the students where the name of the phase and what happens during that phase is described to the reader. A crescent Moon will be seen twice in the pattern. Students can refer back to the text in the book or one of the web resources provided to label the phases and explain what they learned about that phase (CC ELA Connection: Reading Standards for Informational Text K–5 – Key Ideas and Details).

After students have had a discussion related to the pattern that they observed, ask them to return to their original sequence of pictures and compare their initial order with the actual pattern of the Moon phases. Ask the students to locate the picture that represents the first day's observation. Then, moving to the right in the sequence, determine if they need to adjust their order. Depending on where a student started in the process, they may have the proper order but it may not align to where in the process of the lunar cycle they started to observe. If necessary, ask students to adjust the order of their images and glue the pictures in place. Using the student data sheet (see NSTA Connection), ask the students to illustrate what each phase looks like, beginning with a new Moon. Have students label each phase and, using both their observation calendars and the text, explain the approximate number of days between phases (CC ELA Connection: Reading Standards for Informational Texts K–5 – Integration of Knowledge and Details; Writing Standards K–5 – Text Types and Purposes).



Elaborate

The pattern that develops demonstrating the lunar phases happens in 29.5 days, the time it takes to go from new Moon to new Moon, and then repeats. This repeating creates an additional pattern that allows for an expanded investigation. Ask students if they have ever seen a calendar that has the phases of the Moon marked on it. Show students a current calendar and the date that a full Moon appears and ask them how someone could determine when to put "full Moon" or "new moon" on the calendar for months in advance. Allow student discussion and answers while guiding them toward the idea that the Moon phases occur in a pattern each lunar month as well. After this discussion, provide students with the information of the length of a lunar cycle and a monthly calendar for the next several months that does not list the Moon phases, and ask them to make a prediction about when the next full Moon or new Moon is based on their understanding of the phases of the Moon, the lunar cycle, and patterns. Most students will count ahead 29 days and then say "half way through" the next day since it is 29.5 days (CC Math Connection: Mathematical Practices #2 – Reason abstractly and quantitatively).

Since you are not asking for the actual time a new Moon or full Moon will occur, estimating either 29 or 30 days will work for students to observe the pattern. Students can then return to one of the online lunar calendars, look at other monthly calendars that list the phases, or wait until the following month to confirm their prediction.

Evaluate

Preassessment related to students' understanding of the phases of the Moon is determined through their initial thoughts that are recorded on the chart paper and their statements about why they sequenced the Moon phases in the way that they did. It will be apparent if the student placed the phases in any pattern through observing the order students selected to glue the phases down and their explanation. These initial ideas are revisited at the end of the lesson, when students are asked to repeat this process and also explain what they learned based on their periodic observations of the Moon.

Internet Resources

Farmer's Almanac Moon Phase Calendar
www.farmersalmanac.com/calendar/moon-phases
NASA Common Moon Misconceptions
http://moon.nasa.gov/moonmisconceptions.cfm
StarDate Moon Phases
http://stardate.org/nightsky/moon
U.S. Naval Observatory Moon Phase Calendar
http://tycho.usno.navy.mil/vphase.html
Weather Wizkids: Clouds
www.weatherwizkids.com/weather-clouds.htm

NSTA Connection

Visit *www.nsta.org/sc1410* for the student data sheets and an annotated list of additional resources.

Connecting to the Common Core

This section the *Common Core for English/Language Arts and/or Mathematics* standards addressed in this column to allow for cross-curricular planning and integration. The standards state that students should be able to do the following at grade level.

English/Language Arts

Reading Standards for Informational Texts K–5:
Integration of Knowledge and Ideas

- Grade 3: Use information gained from illustrations and the words in a text to demonstrate understanding of the text.

Key Ideas and Details

- Grade 1: Ask and answer questions about key details in the text.
- Grade 4: Refer to details and examples in a text when explaining what the text says explicitly and when drawing inferences from the text.

Writing Standards K–5:
Text Types and Purposes

- Grade 4: Write informative/explanatory texts to examine a topic and convey ideas and information clearly.

Speaking and Listening Standards K–5:
Presentation of Knowledge and Ideas

- Kindergarten: Add drawings or other visual displays to descriptions as desired to provide additional details.
- Grade 1: Add drawings or other visual displays to descriptions when appropriate to clarify ideas, thoughts, and feelings.

Mathematics

Mathematical Practices #2: Reason abstractly and quantitatively
Measurement and Data

- Kindergarten: Describe measurable attributes of objects, such as length or weight [and] directly compare two objects with a measurable attribute in common, to see which object has "more of"/"less of" the attribute, and describe the difference.

References

National Governors Association Center for Best Practices and Council of Chief State School Officers (NGAC and CCSSO). 2010. *Common core state standards.* Washington, DC: NGAC and CCSSO.

NGSS Lead States. 2013. *Next Generation Science Standards: For states by states.* Washington, DC: National Academies Press. *www.nextgenscience.org/next-generation-science-standards.*

NGSS Lead States. 2013. Appendix G – Crosscutting Concepts. In *Next Generation Science Standards: For states, by states.* Washington, DC: National Academies Press. *www.nextgenscience.org/next-generation-science-standards.*

Connecting to the Standards

Standard K-ESS2 Earth's Systems

Performance Expectation:
K-ESS2-1 Use and share observations of local weather conditions to describe patterns over time.

Science and Engineering Practices:
Analyzing and Interpreting Data
Engaging in Argument From Evidence

Disciplinary Core Idea:
ESS2.D Weather and Climate

Crosscutting Concept:
Patterns

NGSS Table: K-ESS2 Earth's Systems
www.nextgenscience.org/kess2-earth-systems

Standard 5-ESS1 Earth's Place in the Universe

Science and Engineering Practices:
Analyzing and Interpreting Data
Engaging in Argument From Evidence

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

Crosscutting Concept:
Patterns

NGSS Table: 5-ESS1 Earth's Place in the Universe
www.nextgenscience.org/5ess1-earth-place-universe

Standard 1-ESS1 Earth's Place in the Universe

Science and Engineering Practice:
Analyzing and Interpreting Data

Disciplinary Core Idea:
ESS1.A The Universe and Its Stars

Crosscutting Concept:
Patterns

NGSS Table: 1-ESS1 The Universe and Its Stars
www.nextgenscience.org/1ess1-earth-place-universe

Christina Curriculum Course: Science 4 DELAWARE Date: February 10, 2012 ET Curriculum: Topic: Sky Watchers Subject(s): Science Days: 14 Grade(s): 4th Key Learning: There are observable, predictable patterns of movement in the Earth, Moon, and Sun System. Unit Essential Question(s): What are the observable, predictable patterns of movement in the Earth, Moon, and Sun System? Concept: Concept: Patterns of Movement Solar System 4.1.1, 4.1.2, 4.1.3 4.1.4, 4.2.1 Lesson Essential Question(s): How does the Earth's rotation cause day and night? (A) Lesson Essential Question(s): How are the planet Simple - Reduced boilerplate, minimal interface, refined patterns. Observable - Subscriptions to value changes are automatic, eliminating unnecessary renders. Predictable - Unidirectional data makes it easy to test, debug and reason about your application. Immutable - Frozen state along with thaw/replace updates provide baked in immutability. DevTools - Helpful tools, including time travel, provide clear visibility of your state, actions, updates & observers.