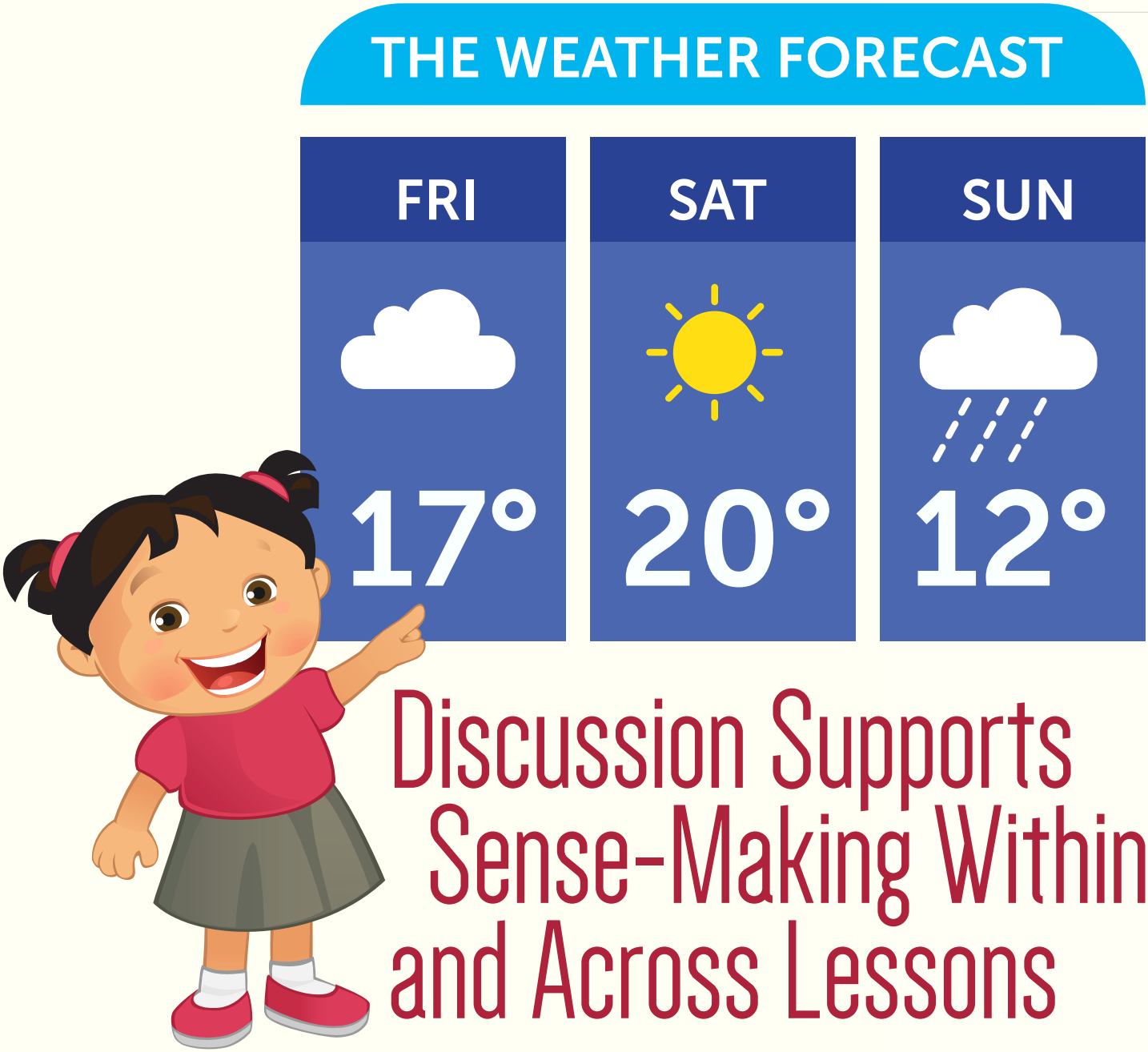


Discussion Supports Sense-Making Within and Across Lessons

Promoting coherent learning about weather forecasting in kindergarten

By Tanya S. Wright, Christa Haverly, JoAnne West, and Amelia Wenk Gotwals

A key focus in *Next Generation Science Standards* (*NGSS*)-aligned instruction is moving from having children "learn about" science ideas to supporting them in "figuring out" and "making sense of" science phenomena, driving questions, and/or engineering design problems. Children should be given opportunities to engage with science and engineering practices as they build deeper understandings and explanations of science phenomena over time. To support this type of learning, it is critical that children do not experience science learning as a series of disconnected pieces of information or activities. Rather, children need opportunities to synthesize their learning within and across lessons. An important way to support this type of synthesis work for young children in the elementary grades is through one-on-one, small-group, and whole-group discussions (Wright and Domke 2019; NRC 2012).

Classroom discussion can help young children monitor their thinking and share their ideas in order to be understood (Donovan and Bransford 2005). Particularly for children who are not yet reading and writing independently, opportunities to discuss ideas can support engagement and sense-making during science instruction (e.g., Wright and Gotw-

als 2017). Discussion can also be used to build coherence for children as they make sense of ideas within a single lesson and across the lessons of a unit.

We provide an example of the ways discussion can be used to support coherence within and across science lessons from one kindergarten classroom where the teacher, Ms. Nelson, was using SOLID Start curriculum materials (Wright et al. 2017) to teach about weather forecasting. The SOLID Start project focuses on supporting teachers in enacting ambitious science discourse in their classrooms in order to deepen science learning and promote science language development (Wright and Gotwals 2017). In the project curricular units, children are presented with a puzzling phenomenon and driving question, and then, through a series of coherent activities, they build and revise their understandings of *how* and *why* the phenomenon happens.

In alignment with the *NGSS* performance expectations (PEs) K-ESS2-1 and K-ESS3-1, the goals for the Weather Forecasting unit are for kindergartners to become familiar with how meteorologists gather and interpret data about weather, how to prepare for different types of weather, and how weather patterns change over time (for instance, over the school year; see *NGSS* alignment table on page 56). The unit is centered around the puzzling phenomenon of why children playing on the playground at different times of year wear different clothing, which leads to an exploration of the driving question, "How does the weather in our location change over time?" Over the course of seven, hourlong lessons (lessons take about an hour in total but can be broken into smaller amounts of time as needed) in the fall, children set up a weather station. They then have the opportunity to track the weather in their location once each month through an entire school year. Throughout the year, they draw conclusions about the patterns that emerge from their data and see firsthand the importance of forecasting for both daily weather and severe weather events. To support this coherent learning over the year, Ms. Nelson engaged children in regular discussions.

FIGURE 1

Talk poster sentence stems.

Ways to Talk with Classmates:

- Can you say more...
- What do you mean by...
- Can you help me understand...
- I agree with you because...
- I disagree because...
- An example from the book is...

Discussion to Synthesize Learning Within a Lesson

In Lesson 1, Ms. Nelson began by showing pictures of children playing on the playground during different seasons and wondered aloud about why the children are wearing different clothing in the different pictures. This puzzling phenomenon opened the unit with an opportunity for children to discuss their thoughts with the whole class. Ms. Nelson supported this conversation by asking open-ended questions related to these pictures, such as:

- What do you notice?
- What do you think?
- Why do you think that?
- Where have you seen that before?

She also facilitated the discussion and helped the conversation progress by restating ideas provided by children and then making connections to new contributions of a classmate. "Sebastian said you have to dress in warmer clothes when it gets cold, and Olivia said she wears a jacket when it rains. Sophia, do you want to add on to this idea?"

After the discussion of the images, Ms. Nelson read, *What's the Weather?* (Scholastic 2009). During the read-aloud, she facilitated discussion by asking questions in order to clarify ideas in the text. After reading, she helped children synthesize ideas in the text with the earlier conversation about photos of children on the playground and encouraged them to use sentence stems on a talk poster (Figure 1). "What did we learn from this book that helps us to understand why the children in the playground pictures were wearing different clothes? Can you turn and talk to your group about this and then we'll discuss our ideas together? Remember to use the talk poster if you need help with what to say." Ms. Nelson then proceeded to review a few of the talk stems that she anticipated would be useful to students in their conversations.

After small-group discussions, children shared their group's ideas with the whole class. For example, one group shared that they all use umbrellas outside when it rains. Another group described wearing snow suits to play outside last winter. Ms. Nelson synthesized these and other ideas to guide the class toward the driving question for the unit. "It sounds like many children are sharing ideas and wondering about different types of weather on different days. I wonder how the weather in Easthollow will change during the school year, and what we will wear on the playground? Let's be scientists and collect data to find out."

Next, the class went outside and Ms. Nelson introduced the routine that the class would use to collect weather data throughout the year. The kindergartners observed the weather and recorded their observations by drawing and labeling their drawings in weather journals. Ms. Nelson reminded children not to look directly at the Sun during their observa-

tions. Ms. Nelson walked around having conversations that enabled individual children to discuss their work. She asked, "What observations did you include in your drawing?" "What do these observations tell us about the weather?" Sebastian said he was drawing the sky because "weather is in the sky." Gracelynn shared that, "I see sunshine but looks like it is going to start raining any minute."

Many children drew the blue sky and a tree on their playground with just a few yellow leaves in early October. They included themselves in their schoolyard dressed in long sleeves but without jackets or coats (Figure 2).

The class went back inside and sat in a circle on the rug. The class discussed what they learned today and what they wondered about or hoped to learn about weather. Ms. Nelson prompted children to use the words, "I think," "I know," and "I wonder" and also recorded children's ideas on a PowerPoint slide so that the class can return to these ideas later in the unit (Figure 3).

Across this lesson, children looked at photos of children on playgrounds, they participated in a read-aloud about weather, they explored and observed outdoors, and they began to collect data by drawing their observations. While these could seem like separate activities, the discussions throughout this lesson helped to bring these experiences together, enabling young children to make sense of and connect ideas and experiences into coherent learning.

Discussions to Synthesize Learning Across Lessons

In Lesson 1, the kindergartners went outside to record the weather conditions in their weather journals. Over the course of the next seven lessons, the teacher guided the children in creating an outdoor weather station to monitor and measure weather conditions. In alignment with both math and science standards for kindergarten, the class focused primarily on relative measurement using a large, plastic thermometer to measure temperature (cold, warm, hot), a class-made rain gauge to measure the amount of precipitation (none, a little, a lot), and a wind sock to examine wind

FIGURE 2

Student drawings.

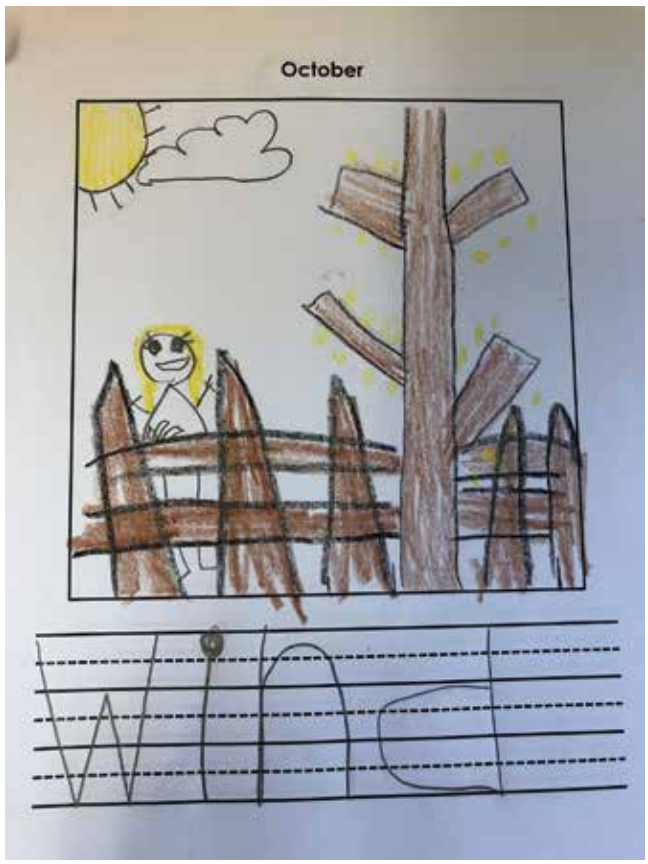


FIGURE 3

Student wonderings about weather.

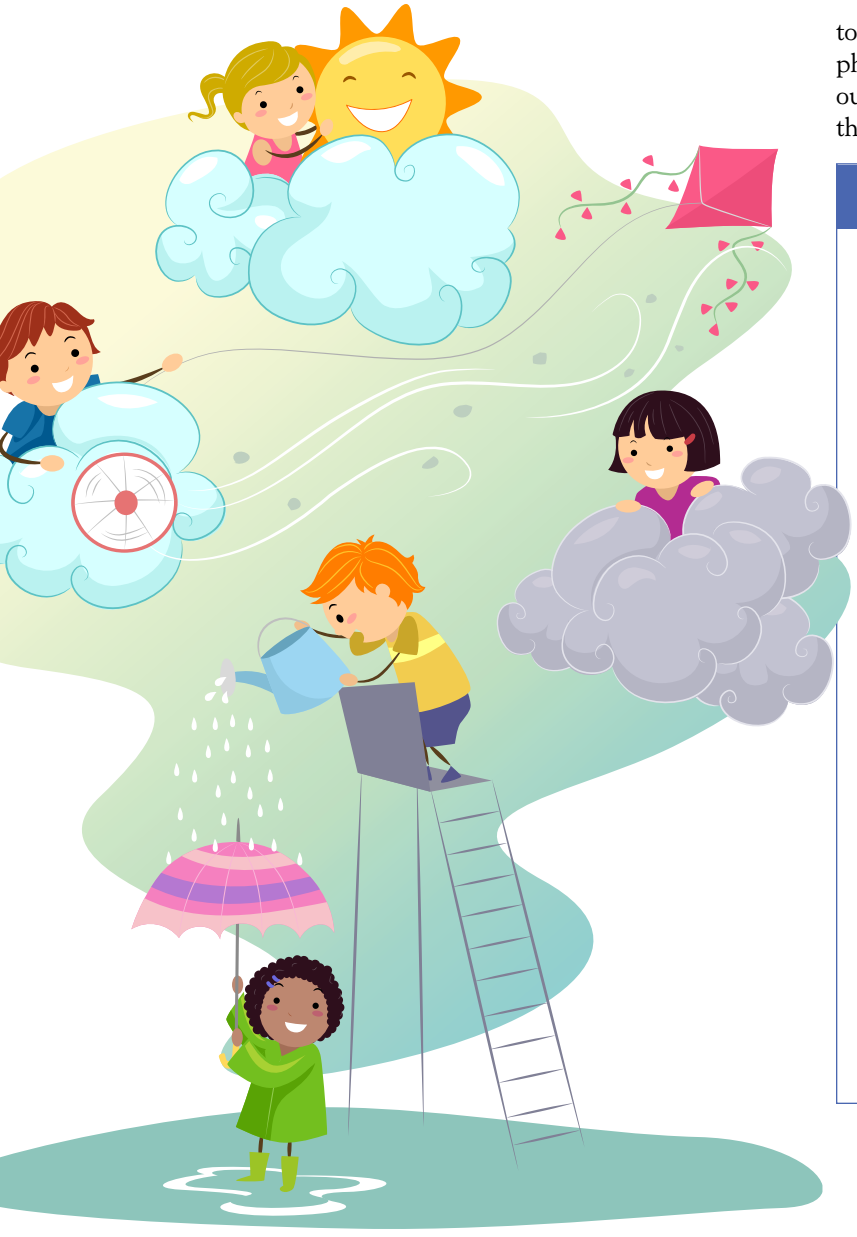
What Is the Weather Like Today in Easthollow?

What is weather? What do you know about weather? Students partner-talked.
I think... or I know...

1. Avery: Weather is in the sky.
2. Reece: Partly sunny.
3. Brielle: I see sunshine but looks like it is going to start raining any minute.
4. Marvin: My mom said it is a rainy day.
5. Braylen: I see sun shining through the windows.
6. Cooper: I think rain might come and it will be sunny when it rains so rainbows might come.
7. Paula: It is partly sunny outside right now.

What do you wonder about weather? Students partner-talked.
I wonder...

1. Erik: I wonder how the sky is blue.
2. Heidy: I wonder if the sky is going to rain.
3. Jade: I'm curious how does the sky change into a darker color at night.
4. Dhruv: I wonder how the wind comes.
5. Alisa: I'm curious because I don't know how the sun and moon come back and forth, back and forth.
6. Harper: I wonder how snow is made.
7. Raegan: I wonder if it rains up in the sky.
8. Camilla: I wonder how sun and moon come back and forth.



speed (calm, breezy, windy). The class also kept track of the amount of cloud cover (e.g., no clouds, partly cloudy, cloudy) and the type of precipitation (e.g., rain, snow, sleet, hail) using their observations and continued to conduct these on a monthly basis. Each time children completed their monthly weather observations, they had opportunities to discuss patterns that they noticed. For example, Ms. Nelson's kindergartners completed an October weather chart (Figure 4).

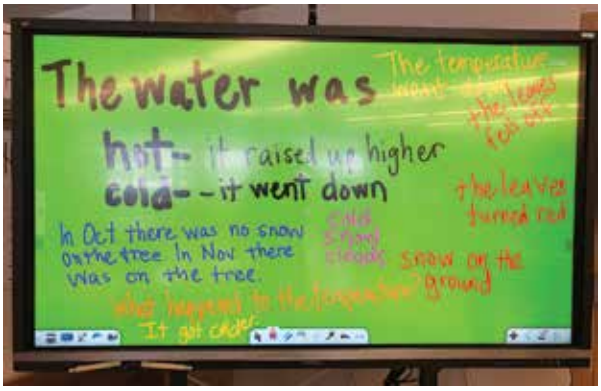
On these weather charts, children practiced measuring and recording the temperature and cloud cover, using tools (the thermometer), numbers (52°F), and words ("chilly"). They recorded observations in their weather journals, some of which were selected to be displayed on the chart. The children also took a class photo in front of a tree, and they used the same tree throughout the year to look for seasonal changes (in their clothing, the tree, and the surrounding area).

FIGURE 4

October weather chart.

FIGURE 5

November discussion notes.



The discussions children had as they created these charts synthesized learning across the first several weather forecasting lessons in which children learned about measuring temperature and cloud cover. Ms. Nelson asked questions such as, "What did you observe outside? What did you feel? See? Smell? Hear?" "What are you curious about the weather? What are you wondering about?" "Does everyone agree that today is chilly? Why or why not?" and "Do you think it will always be like this? How about next month, in November? Was it like this last month, in September?" Children discussed their data first in pairs and then as a whole class. From these discussions, Ms. Nelson selected children's words to include on the weather charts, such as "cloudy" and "chilly." The class also added images and words for new science vocabulary such as *meteorologist* and *precipitation* to the science word wall after these words were discussed during lessons. Finally, the class recorded their predictions on a separate anchor chart to keep track from one month to the next whether their predictions matched with the actual weather conditions.

The discussions helped Ms. Nelson to select other artifacts to include on the charts. The monthly charts became a public display of ideas that children shared in their monthly weather discussions (Figure 5).

After gathering monthly data from October and November, Ms. Nelson led her class in a discussion about the changes they were already noticing in the weather conditions from one month to the next. Ms. Nelson publicly displayed children's ideas from these discussions on her Smartboard. The class began by reviewing what they learned about distinguishing hot from cold on the thermometer (is the red liquid moving "higher" or moving "down"?). Ms. Nelson's kindergartners had many ideas about what was happening outside because of the temperatures turning colder: "the leaves turned red," "the leaves fell off," "snow on the ground." Therefore, a discussion which started as a review in the context of the monthly weather charts, became a robust conversation synthesizing learning across monthly weather patterns. In Ms. Nelson's classroom, discussion of the monthly weather chart data created an opportunity to support coherent learning across the school year. In the spring, the class examined all of their monthly weather data to look for patterns across the year in temperature, precipitation, cloud, and wind data. Students noticed that the tem-

perature got cooler and then warmer from fall to winter to spring. They also noticed that during winter, precipitation was often in the form of snow; whereas in spring and fall, it could be either snow or rain. They noticed that certain types of clouds meant it was more likely to rain, but they did not find many patterns in their wind data.

Class discussions also helped Ms. Nelson be responsive to both individual and collective needs. At various instances during the unit for each of the targeted PEs, Ms. Nelson used formative assessment tables to keep track of what she heard students saying during class discussions and what she saw them doing or writing during other points of the science lessons. This helped Ms. Nelson keep track of children's understanding of the performance expectations about using observations of weather to find patterns (K-ESS2-1) and the usefulness of weather forecasting (K-ESS2-3). The kinds of things she made notes on during discussions included the questions students were asking, the evidence from their observations of the weather that students used to support their claims, and the science language students used. She used these notes to support children's learning about weather and the usefulness of weather forecasting across the unit. At the end of the unit, Ms. Nelson was able to synthesize these anecdotal records in conjunction with artifacts (e.g., students' drawn weather observations) to compile a portfolio of evidence of student learning for each child in the class. She then completed a summative assessment rubric for each student (see NSTA Connection) based on their portfolios. These summative assessment rubrics were useful for parent-teacher conferences as well as for completing standards-based report cards.

Conclusion: Discussion Supports Sense-Making

As we shift to implementing *NGSS*-aligned instruction, we need to find ways to help young children make sense of ideas within and across lessons. The examples above show how each lesson included a variety of experiences, allowing children many different entry points to the content. Lesson components like discussion of the unit phenomena, observations, data analysis, or read-alouds allowed different types of student-driven conversations to take place.

Ms. Nelson used many scaffolds to support science discussions in this kindergarten classroom:

- using images to prompt discussion
- asking open-ended questions
- acknowledging and restating children's ideas
- helping children connect their discussion contributions
- teaching new vocabulary that align with science explorations and texts
- using sentence stems
- facilitating pair and small-group student discussions
- synthesizing ideas from across contexts (i.e., readings, observations, ongoing data collection)
- making connections across the unit and the school year

These scaffolds support all young children to engage in science discussions, including English Language Learners who benefit from opportunities to develop and practice language in the context of learning new content (Walqui 2006). By providing opportunities and scaffolds for discussions, teachers can enable all children to synthesize ideas from multiple activities, and over time, support deeper and more coherent learning. ●

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NSTA Connection

Download the rubric at *www.nsta.org/SC1119*.

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Connecting to the *Next Generation Science Standards* (NGSS Lead States 2013)

Standard

K-ESS2 Earth's Systems

www.nextgenscience.org/dci-arrangement/k-ess2-earths-systems

- The chart below makes one set of connections between the instruction outlined in this article and the *NGSS*. Other valid connections are likely; however, space restrictions prevent us from listing all possibilities.
- The materials, lessons, and activities outlined in the article are just one step toward reaching the performance expectation listed below.

Performance Expectation

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

DIMENSIONS	CLASSROOM CONNECTIONS
Science and Engineering Practices	
Asking Questions **Analyzing and Interpreting Data** **Obtaining, Evaluating, and Communicating Information**	Students ask questions about different weather conditions they observe. Students record observations of outdoor weather conditions as drawings, words, and numbers in weather journals. Students identify patterns in monthly weather condition changes during discussion of the class weather chart. Students compare their predictions to actual weather conditions from month to month. Students participate in an interactive read-aloud, which introduces children to different types of weather conditions. Students record whole-class observations on monthly weather charts to communicate changing weather conditions.
Disciplinary Core Idea	
ESS2.D: Weather and Climate Weather is the combination of sunlight, wind, snow or rain, and temperature in a particular region at a particular time. People measure these conditions to describe and record the weather and to notice patterns over time.	Students record observations about different types of weather conditions including cloud cover and temperature in order to identify seasonal patterns over time.
Crosscutting Concept	
Patterns	Students use monthly weather charts to identify patterns in weather conditions over time.

Connecting to the *Common Core State Standards* (NGAC and CCSSO 2010)

ELA/Literacy	
W.K.7 - Participate in shared research and writing projects	Students participate in interactive read-aloud about different types of weather conditions and participate in shared writing in order to construct the monthly weather charts.