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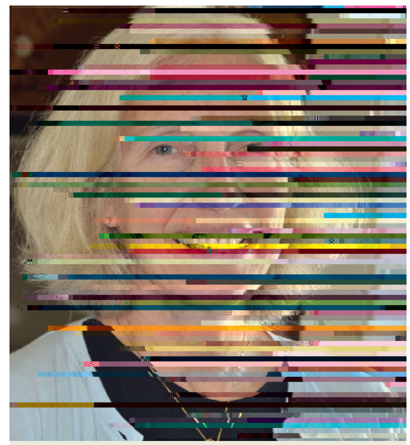

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Before entering formal learning settings, children have had a variety of direct experiences with their physical environment thanks to their parents and caregivers (National Research Council, 2007)—hearing sounds of animals, experiencing rain, splashing in puddles, dropping objects, feeling the sun, etc. Children are naturally curious about the world and learn a lot just by participating in everyday activities and observing what is happening around them. Their knowledge may not be deep, but they have had a wide range of observations and interactions by the time they begin school.

Parents are instrumental in continuing to provide opportunities for their children to interact with the world at all ages, and a rich, formal science education can also build on this natural sense of wonder about the world and its happenings. Teachers can spark a desire to learn more. Personal interests, experiences, and enthusiasm are critical for sustaining the learning mindset embraced by young children. The nature of science is to deepen our understanding of the world, especially about observed events we are motivated to explain. Schools must provide the context for students to continue adding to and refining their prior learning.

In recent years, science education has transitioned from conveying facts-based knowledge to a model of learning that is based on active, student-directed inquiry. The writers of *[illegible]* (2012) proposed a vision in which all K–12 students actively use science and engineering practices and apply crosscutting concepts to deepen their understanding of core ideas. Students engage in this three-dimensional learning by asking relevant questions, solving genuine problems, and acquiring tools to use in their future careers and lives.

[illegible] (NGSS) (2013), written in response to the *[illegible]*, focus on students using science and engineering to make sense of observable events, or phenomena, in the natural and designed worlds. Phenomena provide a springboard for teachers to build on students' natural curiosity and encourage active learning (Achieve, 2016). Students are challenged to figure out why or how phenomena happen and to apply that understanding to solve real-world problems. Learners work much like scientists and engineers. Through the process of working, they gain a deeper understanding of valuable information.

[illegible]?

The seemingly magical, real-world happenings experienced by young children are examples of phenomena and can be explained scientifically. The word "phenomenon" refers to an observable fact or event occurring in the universe. Most phenomena are not especially flashy or unexpected, but rather are everyday occurrences. Examples include weather, changing seasons, patterns of stars, water boiling and freezing, soda fizzing, fruit ripening, and lifecycles of plants and animals, to name a few. Scientists work to explain phenomenal phenomena, but most phenomena are less remarkable.

It's also important to provide students with opportunities that allow them to dig deeply into a phenomenon to uncover core science ideas they are expected to learn. Watching a model of a volcano explode can be an exciting activity, but it doesn't necessarily help students understand the natural and geologic mechanisms that cause the formation of landforms due to volcanic activity. Teachers should feel free to use discrepant events, but phenomena need to go beyond engaging students. They need to drive units and keep students working to figure out scientific explanations or solve problems.

7. Plan and sequence possible lesson activities in which students:
    a. Observe or experience the phenomenon
    b. Engage in exploratory discourse, noticing and wondering things about the phenomenon, and then they share observations and ask questions
    c. Try on ideas as they develop initial models of what they think is happening or try to explain the phenomenon
    d. Use science and engineering practices to try to answer a driving question about the phenomenon. For example, students can conduct science investigations and analyze data they collect
    e. Create or refine their explanations/models of the phenomenon
    f. Learn more about existing scientific theories behind the phenomenon by reading, interacting with an expert in the field, etc.
    g. Revise their explanations and models as they learn new information. They incrementally build models to add on to their explanations of the phenomenon
    h. Share explanations/models and move to a class-consensus explanation/model for the phenomenon
8. Review the plan for assessing students' understanding of the phenomenon, revise if needed, and complete the assessment.

Students build their ideas piece by piece, over time. This process of inquiry is repeated multiple times during a unit and is sometimes referred to as the storyline of learning. Teachers support and guide students as they question, figure out, and fit pieces of the puzzle together.

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I recently led a facilitation for a group of teachers and informal educators in which we explored phenomena and what it means to use them in instruction. Because it was October, and we live in Wisconsin, it seemed natural to think about the fall season and the numerous observable events that occur that time of year. I chose the anchor phenomenon of leaves changing color, and we worked together to figure out how and why some leaves experience a color change. Most of us hadn't thought very deeply about the science behind this event, even though it occurs annually, and we had observed it for decades.

As we informally talked about leaves during the exploratory discourse portion of our inquiry, we generated many questions about leaves related to the phenomenon. We wondered why all leaves didn't change color, why some leaves turned yellow versus orange or red, how leaves knew when to change color, and if the shapes of the leaves played a role in the color-changing process. We were also curious about where else in the United States this phenomenon occurs.

We did a simple chromatography investigation to find out what colors were present in the leaves we were examining. This didn't help us explain why leaves change color, but we found out that although different colors were present in leaves, not all of them were visible at the same time of year. We were all engaged in the inquiry process, and some participants were driven to do more investigating after our session together.

Our endeavor to explain the phenomenon of leaves changing color in fall led us to talk about other fall phenomena. We discovered that there was much more to explore about the season. Someone brought up the migration and hibernation of area animals, and we wondered how they knew what to do and when to do it. We also pondered where the animals went and whether they stayed in the area or traveled far away. In Wisconsin, our growing season ends in fall, and that sparked an interest in seeds, plants, and the ripening process of fruits and vegetables.

A big takeaway for us was that phenomena are all around us, all the time. It wasn't challenging to identify them, it didn't cost much to investigate them, and it wasn't difficult to find online or print materials to learn more about them. Through the process of exploring one phenomenon (leaves changing colors in fall), we realized our students would benefit from learning in this way. We wondered, though, if a phenomena-based learning sequence would align with the NGSS content that students need to learn. We decided it's not an all-or-nothing game.

We were also reminded that observing and explaining phenomena is not something reserved only for school. Parents and other caregivers can play a critical role in encouraging and supporting their children's science learning at home and in their community. Teachers can cultivate partnerships with parents to encourage and support science learning. Providing positive, safe environments at home and in school can encourage children to observe, ask questions, experiment, and seek their own understanding of phenomena.

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