Quick Reference Guide: Phenomena in the Classroom

Every PreK-12 learning experience in Science and Technology/Engineering (STE) should be centered around phenomena or design problems. Even when students are interacting with design problems, phenomena must be addressed repeatedly during design, testing, and revision. What phenomena means, and how to use phenomena in the classroom is commonly misinterpreted or ignored. The purpose of this guide is to support educators in understanding and using phenomena in their classrooms.

A scientific phenomenon is an observable event that can be investigated and explained by students using STE knowledge and skills.

STE educators must position students as scientists and engineers by providing experiences to observe and interact with phenomena and facilitate evidence gathering through investigations. **Teaching with phenomena is providing students with an authentic experience that engages students in asking questions and then establishing evidence of the content principles that will help them make sense of that experience.** Teaching with phenomena is not supplying students with the content they need in order to investigate. The student, therefore, is the primary owner of the experiences, skills, and content-knowledge building. The following table shows what classrooms should look like when using phenomena properly.

Teaching with phenomena looks **MORE** like this…	Teaching with phenomena looks **LESS** like this…
• PHENOMENA is the leader that drives student questioning, and then followed by investigations discovering evidence for conceptual understanding • An experience (e.g., firsthand investigations, demonstrations, data sets, videos) that interests students, needs scientific knowledge to be explained, and is present throughout the learning sequence • Investigations to collect data that serves as sensemaking evidence to build the content explanation and make sense of the phenomena • Robust explanations of phenomena including scientific evidence gathered by the student through multiple means (e.g., investigations, models, text)	• CONTENT explanation is the leader, followed by examples that students will explain with the content • A hook introduced at the beginning of a learning sequence that may be explained as the assessment at the end • An extension at the end that gives a real-world context to the content explanation in a lecture with little student interaction with the extension • A lab done after a lecture to prove a concept

Designing learning experiences with phenomena is essential for equity in science.

In order to engage all students, it is important for students to have relevant experiences with phenomena in the classroom that provide opportunities to observe, react, develop questions, and connect the phenomenon experience to their prior experiences. To enhance the equity and access in your classroom, it is important to consider both the **selection** of a relevant and high-quality phenomenon experience, and the **facilitation** of that phenomenon experience. STEM Teaching Tools defines the qualities of a good anchor phenomenon to support educators with selecting high quality phenomena experiences. Next Generation Science Storylines suggests five routines to support educators with facilitating an equitable phenomena experience for all students, from exposure (Anchoring Phenomena Routine) to explanation (Putting the Pieces Together Routine).

Rigorous learning happens when students make sense of phenomena through investigations that support explanations for the phenomena.

To develop the habits of mind of scientists and engineers in our students, students must experience, investigate, and use evidence to explain phenomena as a scientist or engineer would. When students experience phenomena, students react as a scientist or engineer would by stating observations and formulating questions about the phenomena. Students then investigate and collect evidence to try to answer these questions. Educators must use their knowledge of science concepts to carefully plan experiences where students can lead themselves to the same conclusions as scientists and engineers. Although educators may have the answers readily available, the collection and interpretation of evidence is an invaluable step that students need in order to own a truly rigorous science experience. Educators should expect all students to participate in the rigorous task of using evidence in interpreting and explaining scientific conclusions about phenomena. Achieve's Task Annotation Project in Science discusses the importance of phenomena in rigorous

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assessments. Their resources on Phenomena and Sense-making can be used to better understand what makes a task rigorous, especially the relationship between evidence-based explanations of phenomena and rigor.

Teaching with phenomena requires significant changes to instructional methods and materials.

The following table shows the resulting shift in rigor when instructional methods and materials use phenomena effectively in the science classroom.

Standard	MORE like this…	LESS like this…
5-LS2-1	Phenomena as leader: Over time, dead things disappear! • The teacher presents the students with a strange thing they have observed – a dead racoon on the side of the road – and asks students to predict what they think will happen to that racoon over time • Students are asked how they might test their predictions • The next day, students watch a time-lapse video of a badger decomposing and record observations and questions they have • The class shares their observations and questions in a class discussion recorded on chart paper; the teacher uses this information to help inform the next lessons on matter cycling and decomposition. • Over the next few days, students conduct investigations that will provide evidence for what they saw in the time-lapse, such as conducting investigations about insects, mold, diffusion, and conservation of matter • The goal of the unit is to scientifically make sense of what happened to the badger in the video from the evidence collected in investigations. CURRICULUM SOURCE: Next Generation Science Storylines – Why do dead things disappear over time?	Content as leader: Everything is broken down by decomposers. • Students read about decomposers and answer questions about decomposers, and construct food webs including decomposers using the reading and notes from class. • Students take notes on a lecture that reviews the reading and includes some full class and partner discussions about decomposers and food webs • At the end of the unit, the teacher shows students a fruit that has been kept in a bag for a few weeks – it has become soft and moldy. Students describe what happened to the fruits using their readings and notes from class.
HS-PS2-4, HS-PS3-5	Phenomena as leader: Pie pans fly off a Van de Graaff generator without being touched! • Teacher presents students with some strange things they have observed – hair gets staticky in winter, and packing peanuts seem to stick to cats. Students make predictions and express initial ideas for what is happening. • Students observe a Van de Graaff generator with pie pans stacked on top of it – each pie pan flies off the top without anything touching it (video)! Students generate observations and questions about the phenomena. • Over the next few days, students conduct investigations to discover patterns in how things stick together or push apart, and investigate how charge influences this behavior • In the second half of the unit, students investigate how changing factors influence this behavior (Coulomb's Law) • The goal of the unit is to scientifically make sense of what happened with the Van de Graaff generator using the evidence collected in investigations. CURRICULUM SOURCE: Concord Consortium – Interactions - Unit 1	Content as leader: Coulomb's Law shows the relationship between magnitude of change, distance, and force. • Teacher delivers a presentation on Coulomb's Law and electrostatic forces that defines terms and explains connections. Students practice problems calculating the force on both charges and establishing how forces change as the distance and magnitude of charge change. • Students do a static electricity lab with balloons, charging a balloon with different levels of charge and recording the distance from a wall where the balloon falls or sticks. • Student conclusions from the lab require evidence statements based on the content from the lecture and calculations from sample problems

Additional Resources

Use the following resources to learn more about phenomena and how to use it in the science classroom effectively.

Evaluating phenomena in comprehensive curricula: CURATE STE Rubric (Criterion 2)	Evaluating phenomena for units and lessons: NGSS@NSTA's Criteria for Evaluating Phenomena	Evaluating phenomena in tasks: Next Gen Science's Screeners
Anchoring, Investigative, and Everyday Phenomena: Achieve's Phenomena Resource (p.2)	Difference between phenomena and content: ACESSE's Resource E (Phenomenon Game)	Databases of phenomena by standard: Louisiana, San Diego, Wonder of Science