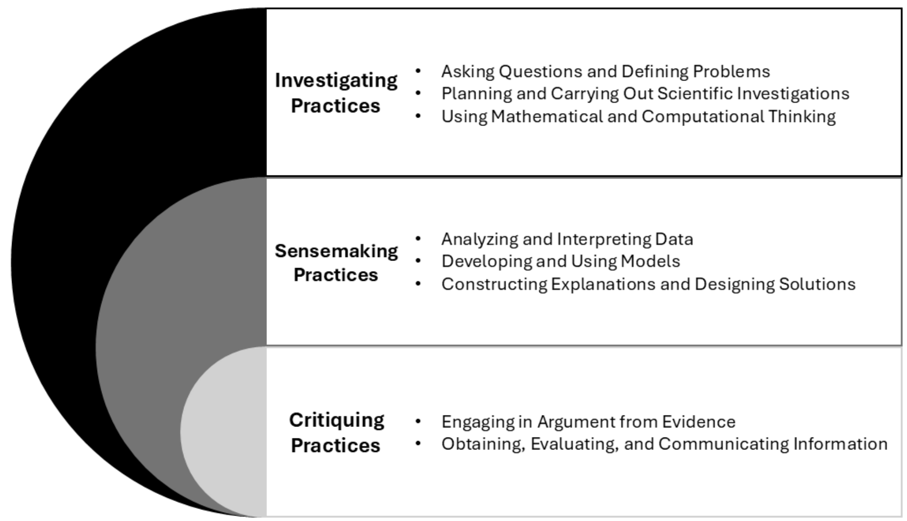
SOUTH CAROLINA
DEPARTMENT OF EDUCATION

Using Science and Engineering Practices in Secondary Science Classrooms

Organizing Science and Engineering Practices to Support Student Reasoning

One approach to organizing Science and Engineering Practices (SEPs) is to demonstrate how they support students' conceptual understanding. In a three-dimensional science classroom, students investigate phenomena or problems to make sense of the natural and designed worlds while also critiquing their own and others' understandings. Thus, SEPs can be organized into three groups:

- **Investigating Practices:** Asking Questions and Defining Problems, Planning and Carrying Out Scientific Investigations, Using Mathematical and Computational Thinking
- **Sensemaking Practices:** Analyzing and Interpreting Data, Developing and Using Models, Constructing Explanations and Designing Solutions
- **Critiquing Practices:** Engaging in Argument from Evidence and Obtaining, Evaluating, and Communicating Information



There is no single "correct" way to group or order SEPs for instruction; SEPs are designed to overlap and interconnect. When developing learning and assessment experiences, one practice may lead to another or include aspects of another practice. It is important for students to recognize the connections among the SEPs. SEPs are more than just skills, they are the tools students use to develop their understanding of phenomena or problems. Learning and assessment experiences must include opportunities for students to engage in authentic sensemaking experiences. While the skills of the SEPs are necessary, they are not sufficient on their own for comprehensive science learning and assessment.

The following general strategies support classrooms where SEPs are thinking tools that guide students as they observe, question, and explain the world around them:

- Use phenomenon-based instruction to anchor learning in real-world, complex scenarios.
- Develop a classroom culture of inquiry and evidence.
- Create opportunities for students to actively engage in doing science, not just learning about it.
- Use SEPs daily to assist in “figuring out” phenomena.
- Use SEPs to frame student-led investigations and support evidence-based discussions about complex or abstract systems.
- Connect SEPs across lessons to show their relationships to one another.
- Support metacognitive reflection on how SEPs shaped their understanding or helped them revise their thinking.

Building on these general strategies, teachers can deepen student engagement and understanding by tailoring their approach to each of the eight SEPs. The following sections provide specific, actionable example strategies for each SEP, offering practical ways to support student use of SEPs as tools for thinking, investigating, and making sense of phenomena and problems in science classrooms.

Investigating Practices

Science and Engineering Practice	Example strategies to engage students in practices	Crosscutting Concepts that often align to the practice
Asking Questions and Defining Problems Students ask questions to explore scientific phenomena and define problems that need solutions. Testable questions may guide investigations and help clarify what they need to learn. In engineering, students define problems by identifying needs, constraints, and criteria for success.	• Students observe a phenomenon/problem three times: ○ first observation: just observe, ○ second observation: record and/or discuss what they are observing, ○ third observation: generate wonderings (questions). • Model the development of scientific questions emphasizing the need for data from investigations and at least two variables to answer the question. • Present a phenomenon/problem and a question, then ask students to: ○ determine if the question is relevant, ○ develop additional sub-questions that are needed to answer the scientific question, and/or ○ revise the question to make it investigable within classroom constraints. • Present an investigation description, the scientific question, and a data set/findings. Ask students to develop follow-up questions to extend the investigation. • Present a scientific argument within the context of an investigation. Ask students to generate questions to clarify the argument and/or elaborate on the ideas present.	• Patterns • Structure and Function

Science and Engineering Practice	Example strategies to engage students in practices	Crosscutting Concepts that often align to the practice

Planning and Carrying Scientific Out Investigations
 	
Students design and conduct investigations to explore scientific questions and test engineering solutions. They develop procedures, identify variables, and collect data systematically. Through this process, students learn to evaluate the quality of evidence, refine their methods, and draw conclusions based on empirical results.
	• Students work collaboratively to develop investigative plans. Facilitate a whole group discussion to select one investigative plan to follow.
	• Present several procedures (for example: varying number of trials, different materials, different types of data tables, etc.) to students. Ask students to critique the procedures based on the phenomenon/problem the procedures are attempting to address.
	• Compare collected data across student groups (can be in the same class or across classes).
	• Present a phenomenon/problem, then ask students to:
	  ○ develop questions,
	  ○ evaluate observation and/or measurement methods to answer those questions, and
	  ○ conduct the investigation.
	• Present a phenomenon/problem and a question. Ask students to:
	  ○ identify and characterize the variables (independent, dependent, control) needed to carry out an investigation,
	  ○ design an investigation plan, and/or
	  ○ describe how the investigation will generate evidence to answer the question.
	• Present a phenomenon/problem, question, plan, and data then ask students to:
	  ○ analyze the relevance of the data and/or
	  ○ revise the plan to generate more relevant data.
		• Cause and Effect
		• Systems and System Models

Science and Engineering Practice	Example strategies to engage students in practices	Crosscutting Concepts that often align to the practice

Using Mathematical and Computational Thinking
 	
Students apply mathematics and computational tools to analyze data and solve problems. They use calculations, graphs, and digital models to identify patterns, test relationships, and support their conclusions. These practices help students think critically, make predictions, and communicate findings with precision.
	• Present a text description of a phenomenon/problem and measured quantities, then ask students to:
	  ○ develop a grade-appropriate equation/algorithm that corresponds to the text description and
	  ○ describe how the equation/algorithm represents the text.
	• Present a text description of a phenomenon/problem, measured quantities of data, and a grade-appropriate mathematical equation, then ask students to
	  ○ make a prediction about the phenomenon/problem that the equation can support and
	  ○ develop a claim for the prediction, using the equation as evidence.
	• Engage students in a simulation of a phenomenon/problem, then ask students to:
	  ○ compare the simulation results with real-world data and/or
	  ○ revise the simulation to produce more accurate results.
	• Present an investigative data set and the question the investigation is intended to answer. Ask students to identify grade-appropriate features of the dataset (for example: range, mean, etc.) that should be analyzed to answer the question.
	• Present a large dataset from an investigation, the question, and a tool (for example: spreadsheet) for analysis. Ask students to develop grade-appropriate data summaries that help answer the question.
	• Ask students to create algorithms to solve a problem.
		• Patterns
		• Scale, Proportion, and Quantity

Sensemaking Practices

Science and Engineering Practice	Sample strategies to engage students in practices	Crosscutting Concepts that often align to the practice

Analyzing and Interpreting Data
 	
Students analyze data to uncover patterns, relationships, and trends. They use tools like graphs, tables, and statistical methods to interpret results and draw evidence-based conclusions. This supports them in evaluating the reliability of their findings and communicating their understanding clearly.
	• Students support and justify their ideas by referring to data.
	• Present recorded observations of the natural world. Ask students to describe a pattern or relationship they can infer from the observations.
	• Describe an investigation, the phenomenon, and one or more recorded observations. Ask students to:
	  ○ organize, represent, and analyze the data,
	  ○ use grade-level appropriate mathematics/statistics to analyze patterns in the data,
	  ○ draw conclusions supported by their analyses, and/or
	  ○ compare how the representations and analyses help them identify patterns in the data.
	• Describe an investigation, the phenomenon, a claim that the investigation was intended to test, and multiple recorded observations. Ask students to:
	  ○ organize the data and describe how this organization helps to evaluate if the evidence supports the claim, and
	  ○ draw a conclusion about whether the data are consistent with the claim.
	• Describe an investigation, the phenomenon, one or more recorded observations, the results of analyses, and an interpretation of the data. Ask students to:
	  ○ assess if the interpretation is consistent with the data and analysis or
	  ○ evaluate how the interpretation is affected by variation or uncertainty in the data.
		• Patterns
		• Scale, Proportion, and Quantity
		• Systems and System Models

Science and Engineering Practice	Sample strategies to engage students in practices	Crosscutting Concepts that often align to the practice

Developing and Using Models
 	
Students develop and use models to represent systems, processes, and relationships in science and engineering. These models (for example: diagrams, physical replicas, mathematical formulae, simulations, etc.) support them in explaining phenomena, testing ideas, and predicting outcomes based on evidence.
	• When discussing the "scientifically accepted model," critique it as a class together rather than presenting it as the "right answer." Facilitate student understanding toward the scientifically accepted model throughout the learning experience.
	• Invite the co-construction of models that make sense to the class, including opportunities to create rival models.
	• Facilitate discussions of the benefits and drawbacks of a variety of models, including student-generated models. Use a variety of representations of model components. Emphasize that all models have benefits and drawbacks.
	• Present a textual description of a phenomenon and ask students to develop a model explaining it by applying their understanding of a disciplinary core idea.
	• Present students with a model of a scientific process or system. Ask students to:
	  ○ label the components, interactions, and mechanisms,
	  ○ write a description of what is shown, and/or
	  ○ revise the model to better fit available evidence.
	• Present a textual description of a phenomenon. Ask students to:
	  ○ develop a model that helps explain how this phenomenon occurs by applying their understanding of a disciplinary core idea and
	  ○ write a prediction about a future event that could be explained by the model.
		• Structure and Function
		• Scale, Proportion, and Quantity
		• Stability and Change
		• Energy and Matter
		• Systems and System Models

Science and Engineering Practice	Sample strategies to engage students in practices	Crosscutting Concepts that often align to the practice

Constructing Explanations and Designing Solutions
 	
Students use evidence and scientific reasoning to explain how and why phenomena occur. They construct explanations that connect data to scientific ideas and revise them as new evidence emerges. When solving problems, students design, test, and refine solutions based on criteria and constraints.
	• Describe a phenomenon and related qualitative/quantitative data/observations. Ask students to develop an explanation about the mechanisms for the phenomenon using the data as evidence.
	• Describe a phenomenon and present the qualitative/quantitative data for independent and dependent variables. Ask students to explain the relationship between the variables.
	• Describe a phenomenon and present an explanation of it. Ask students to identify gaps or weaknesses in how it scientifically explains the phenomenon based on their own scientific understanding.
	• Describe a phenomenon and present a range of evidence from a variety of sources (for example: empirical investigations, models, theories, simulations, etc.). Ask student to:
	  ○ construct an explanation and
	  ○ describe how the evidence relates to the mechanism or principles they have included.
		• Structure and Function
		• Stability and Change
		• Energy and Matter
		• Systems and System Models

Critiquing Practices

Science and Engineering Practice	Sample strategies to engage students in practices	Crosscutting Concepts that often align to the practice

Engaging in Argument from Evidence
 	
Students use evidence to support or challenge explanations and solutions. They construct logical arguments, evaluate competing ideas, and communicate their reasoning clearly. Through respectful discussion and critique, they refine their thinking and deepen their understanding of scientific concepts.
	• Describe a phenomenon. Ask student to:
	  ○ articulate a claim about the phenomenon,
	  ○ identify evidence that supports the claim, and
	  ○ articulate the scientific principle(s) that connects each piece of evidence to the claim.
	• Present a claim about a phenomenon. Ask students to:
	  ○ identify the evidence that supports the claim and
	  ○ articulate the scientific principle(s) that connect each piece of evidence to the claim.
	• Present a claim and evidence about the phenomenon. Ask students to assess how well the evidence supports the claim.
	• Describe two or more explanations that are offered for a phenomenon. Ask students to identify the different claims and the evidence with each claim.
	• Present a claim and list of data sources that are relevant to the claim (but not an interpretation of the data). Ask students to
	  ○ select a pattern of evidence from the data that would support the claim or
	  ○ identify a pattern of evidence from the data that would refute the claim.
	• Present a claim and a pattern of evidence relevant to the claim. Ask students to:
	  ○ assess if the evidence is logically consistent with the claim or
	  ○ assess if the evidence is consistent with a scientific theory or model they have studied or
	  ○ generate ideas about additional needed evidence.
		• Cause and Effect
		• Energy and Matter

Science and Engineering Practice	Sample strategies to engage students in practices	Crosscutting Concepts that often align to the practice
Obtaining, Evaluating, and Communicating Information Students gather information from reliable sources to build their understanding of science and engineering concepts. They evaluate the quality and relevance of information and use it to support explanations, arguments, or solutions. Through writing, speaking, and visual displays, they communicate their ideas clearly and effectively.	• In small groups, students read text that includes evidence and science ideas about a phenomenon. Ask students to annotate the text (for example: underline evidence and star science ideas). • Provide two or more texts on the same topic. Ask students to compare the texts, focusing on how well the author defends their claim. Students decide which is the most persuasive text. • Present a grade-appropriate text set related to a phenomenon. Ask students to: ○ synthesize information from across texts and/or ○ compare information from across texts to determine which are the most relevant to explaining the phenomenon and/or ○ ask questions about the phenomenon based on combined information from relevant texts and/or ○ construct and explanation of the phenomenon based on combined information from the relevant texts. • Present a textual description of a phenomenon or of an investigation of a phenomenon. Ask students to use multiple scientific texts to communicate about the phenomenon to a given or student selected audience. • Present grade-appropriate sets of scientific literature and/or media reports related to a phenomenon. For each text, ask students to analyze and describe the validity and reliability of the information presented.	• Patterns • Structure and Function

Tips for Using Science and Engineering Practices

SEPs are essential tools that engage students in the practices of science and engineering, helping them actively build and apply knowledge. However, their power lies in not just naming them, but in how they are used to support student thinking. When SEPs are embedded meaningfully into instruction, they become cognitive tools that guide students through investigating, sensemaking, and critiquing ideas about the world around them. This requires intentional planning and consistent opportunities for students to engage with SEPs in varied and authentic contexts.

Teachers can support this process by modeling SEPs as thinking tools, encouraging their use in discourse, and providing time for reflection on how SEPs shape understanding. When students are given repeated authentic opportunities to use SEPs, they begin to see the practices not as isolated skills, but as powerful processes through which to explore and make sense of science.

To support this instructional shift, the following four approaches—**exploration, comprehension, evaluation, and foundation**—offer practical and flexible ways to incorporate SEPs into teaching, learning, and assessment. Each approach highlights a different function SEPs can serve in the classroom and provides a pathway for deepening student engagement and sensemaking.

- **Exploration:** Using SEPs to examine and investigate phenomena or problems, helping students develop a deeper understanding.
- **Comprehension:** Using SEPs to clarify scientific concepts and processes, enabling students to build on existing knowledge and create new explanations.
- **Evaluation:** Using a SEP to assess and refine scientific ideas and methods.
- **Foundation:** Using a SEP to establish common practices, language, purposes, or meaning. Students learn when and why to apply SEPs.

Exploration: How can SEPs help us see new things about this phenomenon or problem?	Comprehension: How can SEPs help us to make sense of a phenomenon or problem?	Evaluation: How can SEPs help us to evaluate and refine our understanding of a phenomenon or problem?	Foundation: Do we know when, why, and how to use the SEPs?
Supporting sensemaking: Focuses student thinking to support productive learning.	**Supporting sensemaking:** Serves as a frame for "putting the pieces together" to explain phenomena/problems.	**Supporting sensemaking:** Strengthens the knowledge structures students build around science concepts.	**Supporting sensemaking:** Deepens student understanding of why SEPs are useful tools used by scientists to understand, interpret, and communicate.
Within instruction, look for: • Students observe phenomena closely and pose their own questions or ideas about what they notice, leading to further investigation. • Students engage directly with materials, systems, or representations to explore how or why something happens, using evidence from their exploration to build understanding.	**Within instruction, look for:** • Students engage with diverse examples and contexts for SEPs. • Students use SEPs to support deeper understanding of Disciplinary Core Ideas.	**Within instruction, look for:** • Students use SEPs in the beginning of a unit when encountering an anchor phenomenon and use SEPs throughout the unit to evaluate their understanding of science concepts. • Students engage in SEPs to evaluate and critique their own and peers' scientific understanding.	**Within instruction, look for:** • Students co-construct the procedures for SEPs and how they are used to understand, interpret, and communicate. • Students have opportunities to discuss and/or reflect on which SEP(s) they used to make sense of something and why that particular SEP was useful.

Exploration: How can SEPs help us see new things about this phenomenon or problem?	Comprehension: How can SEPs help us to make sense of a phenomenon or problem?	Evaluation: How can SEPs help us to evaluate and refine our understanding of a phenomenon or problem?	Foundation: Do we know when, why, and how to use the SEPs?
Within a task, look for: • The task driving question explicitly uses a SEP. • Explicit use of SEPs in prompts.	**Within a task, look for:** • Prompts use SEPs to scaffold sensemaking – either by requiring use of multiple SEPs and/or using one SEP at multiple levels of complexity.	**Within a task, look for:** • Tasks ask students to revisit their initial explanations or models and revise them based on new data or peer feedback. • Tasks prompt students to evaluate the strengths and limitations of an investigation, model, or explanation and suggest improvements.	**Within a task, look for:** • Students have opportunities to explain and/or reflect on which SEP(s) they used to make sense of something and why that SEP was useful.

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