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Making Sense of Student Sensemaking

How teachers can leverage the wealth of knowledge students bring to the classroom

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Students enter classrooms equipped with a rich foundation of skills and knowledge from their everyday experiences. High-quality science education builds on students' wealth of experience in making sense of the world.

In science classrooms, *sensemaking* is a collaborative practice that includes students sharing initial ideas with peers and identifying inconsistencies or gaps in their shared understandings about the cause of phenomena or solutions to problems (Odden and Russ 2019). While sensemaking, students are continually drawing on their existing knowledge and integrating it with new information. Therefore, the process of sensemaking in science classrooms includes building or revising explanations for phenomena or iteratively working to solve problems and answer questions.

Credit: FatCamera/Getty Images Plus

Students notice features of insects placed in a bug box for investigation.

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Why Should Teachers Prioritize Student Sensemaking?

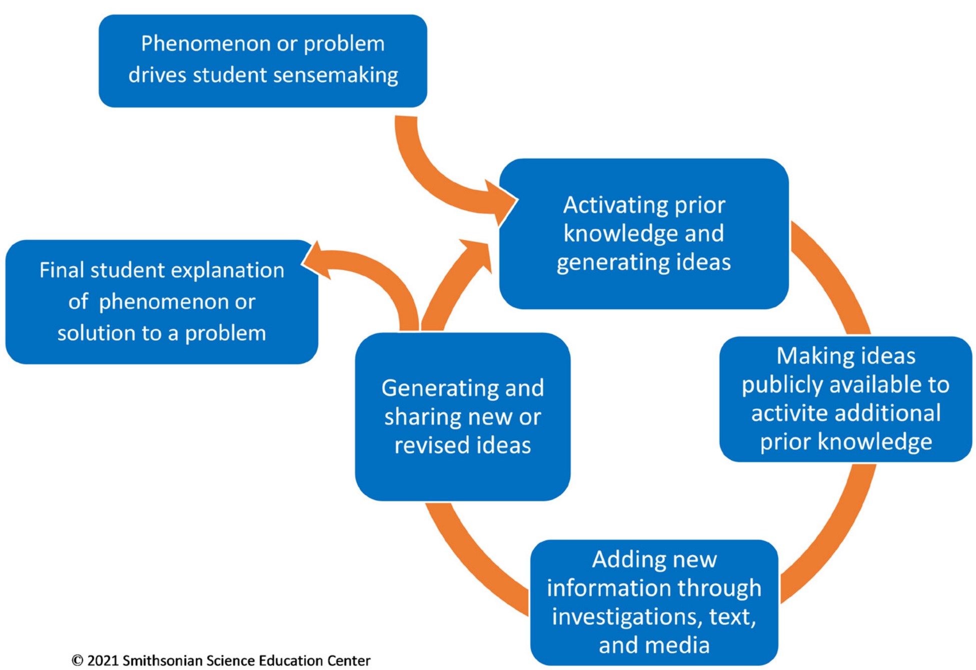
The sensemaking shift in science education is intended to transform science classrooms to create more equitable pathways to science, technology, engineering, and math (STEM) careers for all students. Central to this effort is encouraging instructional methods that help students construct scientific identities early on. Research suggests that leveraging the knowledge, languages, and ways of knowing students bring from home into their classrooms supports students' constructing science identities (NRC 2012). Therefore, a critical part of teaching for sensemaking in science education includes engaging students' initial ideas and prior knowledge as assets rather than deficits in need of repair (Campbell, Windschitl, and Schwartz 2016). Curriculum designed for student sensemaking may provide examples of possible initial student ideas along with suggestions that help teachers "take up" students' ideas and use them to progressively build more nuanced or complex explanations of concepts and mastery of skills.

Building New Knowledge from Lived Experiences

Once students have had a chance to use their existing knowledge to begin figuring out phenomena or solving problems, sensemaking includes identifying how another person's experiences or new information does not fit with initial ideas (Campbell, Windschitl, and Schwartz 2016; Phillips, Watkins, and Hammer 2018). Central to designing curriculum for sensemaking is making ideas publicly available so that, through discussion with peers, students may identify inconsistencies or gaps in their thinking about a phenomenon or problem.

As students engage with new information through investigations, text, and media about a phenomenon or problem, they discuss what they notice. This provides opportunities to generate new ideas and sift through them in what Odden and Russ refer to as the "cultivation of a variety of alternative suggestions" (Odden and Russ 2019, 75). As new ideas proliferate among students, students activate additional prior knowledge they may not have considered relevant while developing their initial explanation of the

Sensemaking in Science Instruction



phenomenon or problem. From here, students generate revised ideas using the new information; additional prior knowledge activated during discussion; or by engaging with new information surfaced through investigations, text, and media. Sensemaking, therefore, is a cyclical, collaborative process of thinking, sharing, and revising.

There are many ways curriculum can create robust sensemaking opportunities in science classrooms. Here, we focus on just a few—specifically, on how curriculum can support teachers in asking questions and using hands-on investigations, models, and digital simulations to help students make sense of phenomena and problems.

Students investigate what makes a plant healthy.

Credit: Kimberly Fitzpatrick, Abram Lansing Elementary, Cohoes, New York

How Can Curriculum Support Student Sensemaking?

Science often starts with a question (NRC 2012). Therefore, one of the most popular ways teachers and curriculum developers encourage sensemaking is by posing questions that highlight gaps or inconsistencies in students' initial explanations (Ford 2012). But what kinds of questions can teachers ask to support students' sensemaking?

According to Campbell, Windschitl, and Schwartz (2016), questions that support student sensemaking press students to actively reason about the phenomenon or problem they are trying to figure out.

Examples of Questions That Support Sensemaking

- Requests for clarification about specific aspects of proposed explanations

  "Can you say more about what you mean by _____?"

- Pressing students to use evidence to support explanations

  "What makes you think _____?"

- Highlighting inconsistencies found across multiple explanations

  "I heard Hallie say _____ caused the phenomenon, but I heard Aman say _____ caused the phenomenon. Both can't be true. How can we find out more about what happened?"

Recent research from Phillips, McLean, and Hammer (2018) highlights that while questions play a key role in science, scientific inquiry often begins without a clear question. The rest of this paper will discuss some of the other ways teachers can support student sensemaking.

Sensemaking with Investigations

Just like carefully crafted questions, hands-on investigations provide rich sensemaking opportunities. During hands-on investigations, new information is generated through data students record and analyze. After analyzing the results of their investigations, students return to their initial ideas and revise them, incorporating the information or evidence that has emerged to better account for the cause of the phenomenon or problem driving the investigation.

For example, students may observe the phenomenon of an unhealthy plant. From prior experience, they may already have an idea that plants need water and light to grow. By collaboratively planning and carrying out a hands-on investigation, students arrive at more nuanced explanations to account for differences between a plant that has been living for some time without light and a healthy plant thriving with access to both light and water.

Using Texts and Media to Support Sensemaking

Curriculum can also support sensemaking by providing additional information through texts or media. Media may include videos or digital interactive simulations. For example, students trying to explain how a tree became wet on one side may draw on their experience to suggest that it was splashed by a car. An image presented through a card set or story accompanying the curriculum may show the same phenomenon in a different context to complicate students' thinking. For example, when trying to explain how a tree became wet on one side, the same phenomenon found along a wooded trail where cars could not have driven by may surface alternative student explanations.

Showing the same phenomenon in a different context may challenge students to develop alternative explanations.

Credits: The Smithsonian Science Education Center (left) and Dawei Qiu (right)

Using Models to Support Student Sensemaking About Problems and Solutions

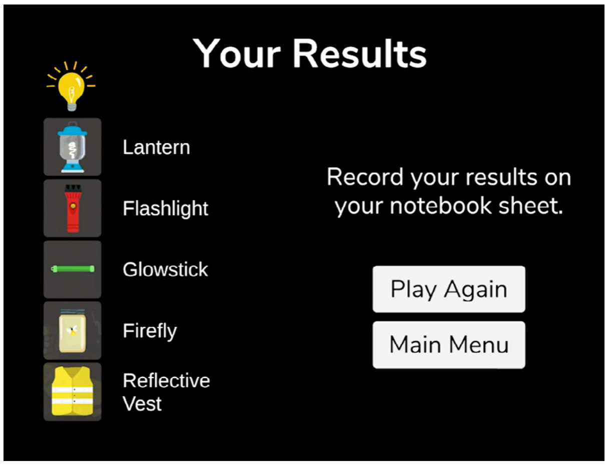
Models and digital simulations can be useful both when making sense of scientific phenomena and when designing solutions to problems. In both science and engineering, when phenomena and problems are too large, too small, too complex, or too far away to be reproduced inside a laboratory or classroom setting, modeling and digital simulations are powerful tools through which students can observe phenomena and problems as directly as possible and activate new information for use in examining possible gaps or inconsistencies in their initial ideas.

One example of a problem that is too large to re-create in a classroom space is a school play area that becomes too hot to play on. By using lamplight to represent the sun and black foam to represent schoolyard asphalt, students can figure out that sunlight caused the schoolyard's asphalt to warm up. Next, pulling together this new information and integrating it with existing knowledge, students may then refine their proposed solutions and understanding of the scientific phenomena. Ultimately, students may build and test models of their own design.

Lamplight and black foam model how sunlight can cause asphalt to warm up (top). Students can design their own model to better understand the phenomenon (bottom).

Credit: Carolina Biological Supply Company

Digital simulations are another type of model that allow students to engage as directly as possible with phenomena and problems that cannot be reproduced in a classroom setting. For example, total darkness is almost impossible to achieve in classroom settings. However, using the simulation Light Up the Cave, students can test how useful different objects are for finding things in the dark. Students record the results of their tests and use them to develop an increasingly complex solution to a problem.



The Light Up the Cave simulation lets students investigate the question "How can we light our way in the dark?"
Credit: Smithsonian Science Education Center

Three-Dimensional Sensemaking

Sensemaking is a process that treats students' existing knowledge and ways of learning about the world as assets worth sharing with peers in the interest of constructing increasingly complex explanations of phenomena or solutions to problems (Campbell, Windschitl, and Schwartz 2016; Odden and Russ 2019). As students add to their existing wealth of knowledge through sensemaking, they identify patterns occurring in the cause-and-effect relationships in the natural world and begin to recognize relationships between parts of natural and human-designed systems. In drawing on their existing knowledge, making ideas publicly available to peers, and gathering new information through investigations, texts, or media, students deepen their conceptual knowledge while simultaneously developing scientific and engineering skills.

References

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How the Smithsonian Science Education Center Supports Sensemaking

The Smithsonian Science Education Center (SSEC) is transforming K–12 education through science in collaboration with communities across the globe. One way to support this ambitious objective is by designing science curriculum for student sensemaking. Each Smithsonian Science for the Classroom® grades K–5 and Science and Technology Concepts™ Middle School (STCMS) for grades 6–8 module includes investigations into phenomena and problems and uses them to drive sensemaking beginning with the initial knowledge and ways of knowing students bring into classrooms. Modules nurture students' curiosity and guide teachers and students in asking carefully crafted questions, supporting students in planning and conducting investigations, and using models and digital simulations to continue their lifelong journeys to figure out how the world works.

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