Amplify Science ALABAMA

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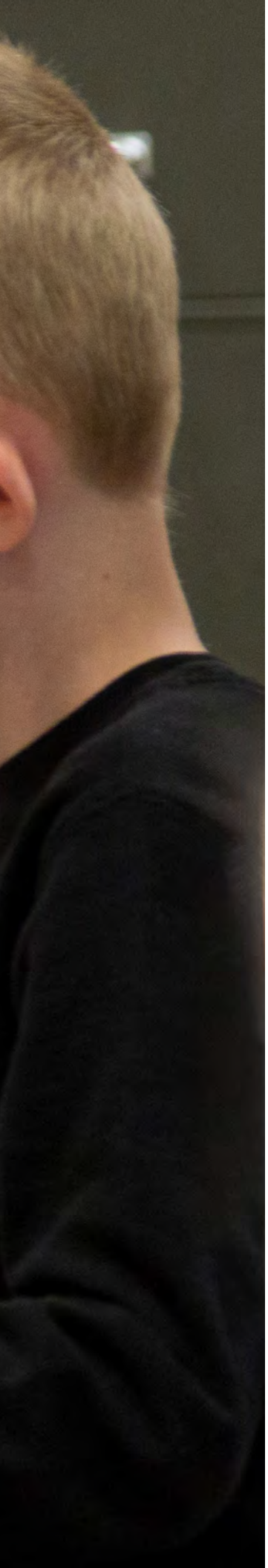
Literacy-rich science instruction in K–5

Immersing young students in reading, writing, and arguing like real scientists and engineers



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Disciplinary literacy

Literacy is an integral part of science. While practicing scientists actively investigate the natural world, large parts of their investigations involve reading, writing, listening, and speaking in order to obtain, evaluate, and communicate information about the natural world. Scientists read about and connect their work to the work of other scientists, explain their findings, and communicate ideas to a variety of audiences.

Thoughtful science instruction guides students to understanding that reading, writing, and talking are essential practices of science, and that all scientists communicate their ideas by making claims, leveraging evidence, drawing conclusions from data, and sharing their ideas through oral and written explanations and arguments.

The way scientists participate in these practices is unique within the discipline of science. Studies show[1] that a key component of success in school is to meaningfully situate literacy instruction within content areas. Situating literacy instruction in a content area like science brings with it several benefits. First, it helps students develop ways of thinking that are characteristic to the discipline. It offers opportunities to refine sense-making skills that are essential to both disciplines. Finally, science provides an authentic reason for reading—to better understand science ideas under study. Reading, like science, can be an act of inquiry when there are genuine questions to be investigated.

Science and literacy instruction that are truly integrated, as opposed to simply connected, should align to the following principles:

1. Students acquire literacy expertise through the pursuit of science knowledge and by engaging in science and engineering practices.
2. Attention to disciplinary literacy instruction should begin as soon as students enter school and should continue throughout each grade.
3. Participation in a community is key to acquiring disciplinary expertise and literacy.
4. Argumentation and explanation are the central enterprises of science and, thus, these practices should be the focus of reading, writing, and talking in science.

1 For more research on science and literacy integration, see Anderson, West, Beck, MacDonnell, & Frisbie, 1997; Guthrie, Anderson, Alao, & Rinehart, 1999; Palincsar & Magnusson, 2001; Romance & Vitale, 1992, 2001; Lee, Deaktor, Enders, & Lambert, 2008; Stoddart, Canaday, Clinton, Erai, Gasper, Latzke, Pinal, & Ponce, 1999.

Instructional approach

Beginning and young readers have unique developmental needs, and science instruction should support these students in reading more independently as they progress through sections of content, the school year, and each grade.

One way of meeting these needs is to strategically deploy three different modes of reading within lessons and units of instruction: Read-Aloud, Shared Reading, and Partner Reading.

- In the **Read-Aloud** mode, the teacher reads the book while students listen. During a Read-Aloud, the teacher models fluent and expressive reading, demonstrates strategic reading, thinks aloud about the content of the book, introduces new vocabulary, and facilitates students' comprehension as the class gathers information to figure out a science idea. The teacher may think aloud to model a focal comprehension strategy, and/or pause and discuss key content.
- In the **Shared Reading** mode, the teacher and students interact with the book together. Shared Reading provides additional opportunities for students to observe the teacher as an expert reader, to actively join in the discussion about the book, and to practice using a focal comprehension strategy. The teacher explicitly guides students to understand that science informational texts are organized in ways that help readers find and understand information, recognize new vocabulary in print, and practice reading strategies. Engaging in Shared Reading provides instruction and practice that prepares students for reading more independently.
- In **Partner Reading** mode, two students work together to read or gather information from a book. Partner Reading provides opportunities for each student in a pair to be the reader and the supporter while reading a text. Partner Reading opportunities should occur after students have had exposure to the content and vocabulary through previous reading lessons, as well as through hands-on investigations. Partner Reading books should use familiar language and science vocabulary that students have already encountered.

Readability levels for each book should be based on the mode of reading used to introduce the book. For example, a book that is designed for Read-Aloud can and should have a higher readability level than a book designed for Partner Reading because, in the Read-Aloud, the teacher takes full responsibility for recognizing and decoding the words, whereas in Partner Reading students have more responsibility for reading the text with less teacher support.

After each book is read for the first time, students should have further opportunities to interact with the words and images as they figure out the answers to questions. This builds students' familiarity with academic language as well as their facility with strategies for reading to learn from informational books.

Text design for accessibility

Kindergarteners are generally at the very beginning stages of reading development. For this reason, instruction in kindergarten should focus on two reading modes: Read-Aloud and Shared Reading. This provides opportunities for beginning readers to first hear new language and vocabulary when a book is read aloud, and then encounter similar language and vocabulary as the teacher guides their participation during Shared Reading. Students are introduced to Partner Reading through re-reading and discussing familiar books to gather information from visual representations.

Grade 1 students are generally developing the skill of learning how to read words as well as developing strategies to understand and learn from books. For this reason, grade 1 instruction should include books especially designed for Partner Reading as well as opportunities for Read Alouds and Shared Reading.

In **grades 2–5**, reading activities should build on the foundations set out in the early grades by continuing to engage students in reading informational text for a variety of authentic purposes, building towards greater independence. Students should be reading to support their investigations into various scientific phenomena; to gather evidence and information; to learn about science ideas and crosscutting concepts; to be exposed to the work of real scientists and engineers, and to connect what they are learning in science to the world around them.

Scaffolding reading in elementary school

For some activities, it may be helpful to offer support in anticipation of a reading activity such as a guide that prompts discussion about prior knowledge. In addition, following up on a reading activity with a reflection exercise can help students organize their thinking around a text and also keep fast readers or those ready for more of a challenge engaged with the material.

Ideally, all students should read the same core texts and the level of scaffolding for students should be adjusted to meet their needs. If instruction surrounding the reading activity is truly multimodal, students should be fairly prepared for the vocabulary in the text and may even exceed the instructor's expectations during paired or independent reads.

The goal should be to provide appropriately complex science texts for students that support, link to, and expand their firsthand science learning. By reading while having other multimodal experiences around a topic, more students will be able to access science texts and see their utility and purpose in finding information.

Vocabulary

To be successful in demonstrating internalization of grade-level instruction, students need to gain active control over academic science vocabulary—that is, to be able to read, write, and speak using words such as *molecule*, *environment*, *evidence*, and *data* fluently and accurately, and to have a deep and nuanced understanding of what these words mean that goes beyond merely being able to define them.

Strong instruction will incorporate vocabulary by:

1. Targeting a small but powerful set of vocabulary words.
2. Designing multiple opportunities to use vocabulary words, which are part and parcel to learning science ideas.
3. Providing explicit instruction and practice.
4. Supporting productive as well as receptive language. Students should not only hear and read the words, but be encouraged, prompted, and reminded to use them in their discussions and written work.
5. Emphasizing use in varied contexts over definitions—knowing a word is much more than knowing its dictionary definition.
6. Highlighting academic language as part of science.

Writing

Strong instructional materials should provide grade-level-appropriate introductions to and practice with making arguments from evidence. Students should be engaged in leveraging data and ideas in support of claims.

For younger students, Explanatory Language frames can help them begin to develop language to facilitate their learning of challenging concepts and support them in explaining their learning to others (both orally and through writing). This oral language build links explanation language common in science to authentic learning contexts, and helps develop children's facility with causal language across the units of study. This is an example of an Explanatory Language frame:

_____ started to move because _____ exerted a force on it.

Following a gradual release of responsibility model, the Explanation Language frame should expand in complexity through kindergarten and grade 1, scaffolding students' acquisition of scientific ways of speaking and thinking.

In grades 2–5, students should begin to explicitly focus on oral and written argumentation. Special attention should be paid to writing arguments and to highlighting how scientists make arguments in their field. While students are still engaging with the other science and engineering practices, instruction around argumentation should become more explicit, more structured, and more frequent, giving students extensive practice with claims and evidence.

Students engaging in this kind of argumentation should:

- Analyze examples of arguments about accessible topics.
- Discuss how evidence supports claims.
- Gather evidence from multiple sources.
- Leverage relevant, specific evidence to support claims.
- State general ideas to show how specific data supports a claim.
- Use data to evaluate claims and determine which claims are plausible and well-supported.
- Make and support arguments with evidence from investigations, text, and models.
- Write arguments for particular audiences.

Engineering arguments

The Alabama Course of Study: Science calls for more of a focus on engineering and design practices. Instruction centered around engineering can and should include writing engineering arguments.

Just as instruction focused on scientific argumentation should provide students with a set of guidelines for writing scientific arguments, there should be a set of guidelines for writing engineering arguments.

The following goals could be applied to instruction focused on building convincing engineering arguments across grades 2–5:

Grades 2–5 goals for engineering arguments

Grade	Describe how a proposed solution meets design goals	Argue for the best solution to a problem, based on evidence	Understand that engineers argue for solutions to problems, based on evidence from testing	Evaluate proposed solutions based on criteria	Discuss the trade-offs of different solutions to a problem
2	✓	✓	✓		
3	✓	✓	✓		
4	✓	✓	✓	✓	✓
5	✓	✓	✓	✓	✓

Visual representations

In science texts, information and data are often represented in visual form—graphs, diagrams, tables, maps, models, and even photographs. Scientists often share their conceptual thinking through these types of visual representations, so a full understanding of scientific ideas includes the ability to interpret these representations.

For students to obtain a sophisticated level of literacy in science, they need to learn how to "read" diagrams, graphs, and models—to use features such as titles, colors, labels, and keys in order to comprehend the science concept that the visual representation shows. However, explicit instruction in how to read visual representations is often overlooked. As a result, readers often skim over these in a text. To address this important area, students should be explicitly taught how to combine a reading of the words in the text with a reading of the visual representations included with the text.

By the end of grade 5, students should be able to:

- Understand that visual representations in science text convey key ideas and represent data.
- Attend to visual representations as they read science text, and use visual representations as evidence to support claims.
- Understand that there are many different types of visual representations, and that scientists use those that are the most effective for particular purposes.
- Examine, discuss, and interpret a variety of visual representations common in science and explain how the visual representation shows the information.
- See that often the most powerful understanding comes from neither the text nor the visual representation alone, but from connecting the two.

So much of what scientists do is reading, writing, listening, and speaking in order to obtain, evaluate, and communicate information about the natural world. To prepare the next generation of scientists and critical thinkers, we built Amplify Science Alabama in collaboration with literacy expert Dr. P. David Pearson to combine what we know about excellent literacy instruction with what we know about excellent science instruction.

As outlined in this guide, situating literacy instruction in a content area like science brings with it several benefits. It helps students develop ways of thinking that are characteristic to the discipline, offers opportunities to refine sense-making skills that are essential to both disciplines, and provides an authentic reason for reading—to better understand science ideas under study.

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