Disciplinary Literacy in Grades K-2 Science

Purpose of this Document

This document is intended to illustrate how disciplinary literacy skills develop in science and possible strategies that teachers can use while helping their students deepen their understanding of science content and practices. It is important to note that the 2016 ELA Standards are meant to complement the specific content demands of the Arizona High School Science Standards, not replace them.

In this document, **text** is broadly defined as any communication, spoken, written, or visual, involving language. This include written words, numbers, and symbols; visual representations in graphs, pictures, flowcharts, videos, and computer simulations; information provided by reading scientific tools and instruments; published documents in print or electronic format; unpublished documents written by students, peers, or teachers; or other sources of information.

Science Sense-Making

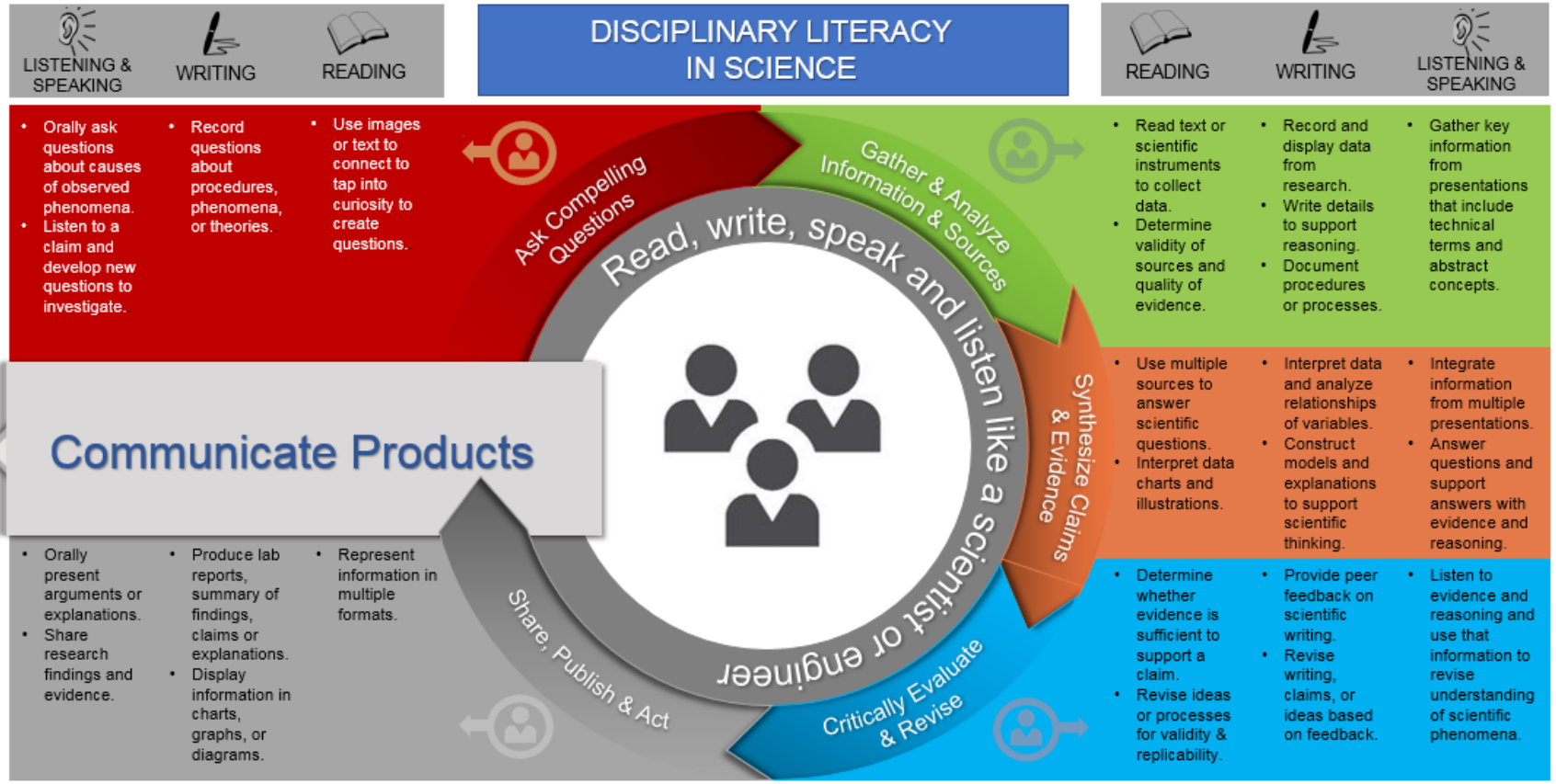
A fundamental goal of science education is to help students figure out how the world works and make sense of scientific phenomena or compelling questions. A scientific phenomenon is an event or situation that is observed to exist or happen, especially one whose cause or explanation is in question. Sense-making is a conceptual process in which a learner actively engages with scientific phenomena to construct logical and coherent explanations that incorporate their current understanding of science and are consistent with the available evidence. To develop a scientific understanding of the natural and designed worlds, and to answer compelling questions in science, students must be able to:

- **Gather and analyze** information and sources
- **Synthesize claims and evidence** to support reasoning
- **Critically evaluate and revise** ideas and connect them to scientific principles and theories
- **Communicate** understanding and reasoning through a variety of methods or products

Disciplinary Literacy in Science

Disciplinary literacy in science focuses on how reading, writing, speaking, and listening are used to develop sense-making in science. It emphasizes the content knowledge, experiences and skills, and ability to acquire new knowledge that experts within science disciplines use to apply and generate new knowledge.

As students begin to develop disciplinary literacy in science, they use strategies to build background knowledge and experiences specific to science content and practices, learn specialized vocabulary, deconstruct complex text structures, map graphic and mathematical representations against explanations in text, pose discipline-specific questions, and provide evidence to support, evaluate, and communicate claims. As students develop disciplinary literacy in science, they strengthen their ability to think critically in a way that is meaningful to developing scientific understanding of the world and scientific habits of mind.



Reading Informational Text

Reading and interpreting scientific and technical text is critical to building knowledge in science and engineering. The 2016 ELA Standards provide the skills for students to do this. This section of the document illustrates ways science teachers can help students apply reading standards as they develop disciplinary literacy in science.

Key Ideas and Details	Using **Key Ideas and Details** to Build Disciplinary Literacy in Science
(Link to RI.1, RI.2, RI.3 for grades K-2) These ELA standards help students gather and combine more than 1 source of information (evidence from text) that can be used to support their reasoning as they develop basic understanding of science phenomena. Being able to read and interpret scientific and technical text is a fundamental practice of science and engineering.	Key Ideas and Details standards can be applied to help students: • Use text to find answers to relevant science questions or problems. • Follow a written lab protocol or sequence of steps. • Connect formation from text to background knowledge. • Determine which information is important to answering scientific questions. • Pay attention to details in text and when reading/collecting data from scientific instruments. • Describe how specific images (e.g., a diagram showing how a machine works) support a scientific or engineering idea. • Interpret and evaluate data, evidence, and scientific reasoning. • Provide an accurate and objective summary or conclusion.

Craft and Structure	Using **Craft and Structure** to Build Disciplinary Literacy in Science
(Link to RI.4, RI.5, RI.6 for grades K-2) These ELA standards help students use scientific language during investigations, observations of science phenomena, reading texts, and classroom discussions. Scientific and technical text often contains a variety of text structures, visual representations, and vocabulary that has a very specific meaning. Reading text structures that embed bullets, data, images, captions, and non-linguistic representations is a fundamental practice of science and engineering.	Craft and Structure standards can be applied to help students: • Use strategies (context clues, restatement, examples) to determine the meaning of words and phrases in the text. • Use context to determine meanings of words and compare how vocabulary may be used differently in a science context compared to non-science contexts. • Identify different structures within a text (headings, tables of contents, glossaries, electronic menus, icons) to locate key facts or information in a text. • Identify information in pictures, diagrams and other visual representations; explain why the author used them instead of paragraph text. • Identify when an author is making a scientific claim, and the evidence and reasoning used to support their claim. • Use the information in text to answer questions, and support reasoning and conclusions.

Integration of Knowledge and Ideas	Using **Integration of Knowledge and Ideas** to Build Disciplinary Literacy in Science
(Link to RI.7, RI.8, RI.9 for grades K-2) These ELA standards help students integrate scientific knowledge and ideas when obtaining, evaluating, and communicating information. Students integrate information to evaluate the validity and reliability of ideas, methods, claims, and designs. They use this knowledge to generate their own questions about scientific phenomena or to identify solutions to design problems.	Integration of Knowledge and Ideas standards can be applied to help students: • Use information from multiple sources, including lab investigations, to answer a scientific question. • Use multiple sources or formats of information related to the same science concept and explain whether these representations provide similar levels of detail. • Locate the claim, evidence, and reasoning in scientific explanations and arguments. • Identify explanations and arguments that are supported by evidence and determine why some evidence is relevant to a scientific question and some is not. • Distinguish between explanations that account for all gathered evidence and those that do not. • Explain how specific images (e.g., a diagram showing how a machine works or a labeled drawing of animal parts) contribute to and clarify a text.

Range of Reading and Level of Complexity	Using **Range of Reading and Level of Complexity** to Build Disciplinary Literacy in Science
(Link to RI.10 for grades K-2) This ELA standard requires that students engage with different lengths, structures, types, and complexities of science text, appropriate for their grade level. Reading science texts requires a set of discipline-specific skills and strategies. Science texts use scientific vocabulary and present information in multiple formats.	Implementation strategies for this standard are embedded in the previous reading examples. Students in science classrooms often read at different levels of proficiency, and even the same student may read at different levels based on text structures or format. Teachers should understand the complexity of the text provided to students and implement appropriate strategies to support student conceptual understanding of science phenomena.

Writing

Writing is a key means of engaging in argument from evidence and requires students to construct a convincing argument that supports or refutes claims for explanations about the natural world. Students use appropriate and sufficient evidence and scientific reasoning to defend and critique the validity and reliability of claims and explanations about the natural world, or methods for collecting data and evidence.

The 2016 ELA Standards provide the skills for students to assert and defend claims, show what they know about a subject, and convey what they have experienced, thought, and designed. This section of the document illustrates ways science teachers can help students apply writing standards as they develop disciplinary literacy in science. Scientific writing may include:

- informal writing (notes based on observations, summarizations of technical texts, making thinking visible by tracking how understanding of phenomena changes over time)
- formal writing (lab reports, documenting procedures, investigation designs, explanations of models, and research)
- persuasive writing (calls for action, letters to editors/policy makers, position statements)

Text Types and Purposes	Using **Text Types and Purposes** to Build Disciplinary Literacy in Science
(Link to W.1, W.2, W.3 for grades K-2) These ELA standards help students write in formats that are typically found in science contexts or may be specific for their content area. Typically, only formal science writing is written in passive/third person voice. In science, focus is shifted from stating personal opinions to using evidence to support an explanation or scientific argument. Students use evidence and reasoning to defend scientific claims and explanations, or methods for collecting data and evidence. It is critical that students know how to incorporate appropriate visual representations to support the scientific explanations and arguments they write.	Text Types and Purposes standards can be applied to help students: • Record thoughts, ideas, sketches, or collected data in science notebooks to be used as evidence or to support reasoning. • Identify arguments that are supported by evidence and determine why some evidence is relevant to a scientific question and some is not. • Distinguish between explanations that account for all gathered evidence and those that do not. • Construct an explanation with evidence to support a claim and distinguish between opinions and evidence in one's own explanations. • Write formal or informal texts. The product may include notebook entries, observations, functional text, or visual displays of data. • Produce science writing in a voice appropriate for the type of writing and the audience. • Write step-by-step procedures for experiments that are detailed enough that others would be able to repeat the procedure and achieve the same results. • Communicate information, solutions, or design ideas with others using models, drawings, writing, or numbers that provide detail about scientific ideas, practices, or design ideas

Production and Distribution of Writing	Using **Production and Distribution of Writing** to Build Disciplinary Literacy in Science
(Link to W.4, W.5, W.6 for grades K-2) These ELA standards help students develop scientific writing appropriate for task, purpose and audience.	Production and Distribution of Writing standards can be applied to help students: • Develop and strengthen writing; focus on purpose and audience. • Incorporate peer or adult feedback of drafts into writing; the writing process and review of drafts can be used for any writing assignments within the science classroom. • Use technology (keyboarding skills) to interact and collaborate with others as a way of sharing ideas. • Integrate drawings or other visual representations of information to support text.

Research to Build and Present Knowledge	Using **Research to Build and Present Knowledge** to Build Disciplinary Literacy in Science
(Link to W.7, W.8, for grades K-2) These ELA standards help students synthesize multiple texts, observations, or experiments to answer questions, gather information, reason about the evidence, and communicate findings or conclusions. Final communication products typically follow a formal writing style (documenting or publishing procedures, investigation designs, explanations of models, and research) and are written in academic or passive/third person voice.	Research to Build and Present Knowledge standards can be applied to help students: • Participate in shared research and writing projects (e.g., read books on a single topic to produce a report; record science observations). • Use and combine information from multiple sources to construct claims, evidence, and explanations. • Gather relevant information from a variety of credible print and digital sources to answer a question. • Recall information from experiences or gather information from provided sources to answer a question. • Use evidence from informational texts (e.g., encyclopedias, credible web sites, experts, news articles, textbooks, trade books) to support claims, analyses, reflections, and/or research.

Speaking and Listening

Students must have ample opportunities to engage in science discourse across a variety of rich, conversations—as part of a whole class, in small groups, and with a partner. Being productive members of these conversations requires that students contribute accurate, relevant information; respond to and extend what others have said; make comparisons and contrasts; and analyze and synthesize a multitude of ideas in various domains. The 2016 ELA Standards provide the skills for students to do this. This section of the document illustrates ways science teachers can help students apply speaking and listening standards as they develop disciplinary literacy in science.

Comprehension and Collaboration	Using **Comprehension and Collaboration** to Build Disciplinary Literacy in Science
(Link to SL.1, SL.2, SL.3 for grades K-2) These ELA standards help students engage in scientific conversations to gather and evaluate information. Engaging in scientific discourse communities to collaborate and build comprehension is a fundamental practice of science and engineering.	Comprehension and Collaboration standards can be applied to help students: • Initiate and participate effectively in a range of collaborative discussions (one-on-one, small groups, teacher-led, digitally) to express their own ideas clearly and building on others' ideas. • Listen actively to others' explanations or arguments to indicate agreement or disagreement based on evidence, and/or to retell the main points. • Distinguish between opinions and evidence in the speaker's explanations or arguments. • Recount or describe key ideas or details from a text read aloud or information presented orally or through other media. • Ask and answer questions about what a speaker says to clarify comprehension, gather additional information, or deepen understanding of a science topic or issue.

Presentation of Knowledge and Ideas	Using **Presentation of Knowledge and Ideas** to Build Disciplinary Literacy in Science
(Link to SL.4, SL.5, SL.6 for grades K-2) These ELA standards help students engage in scientific conversations to informally share ideas and develop understanding of scientific phenomena and provide a formal way to present information appropriate to the audience and task. Engaging in scientific discourse communities to communicate understanding and findings is a fundamental practice of science and engineering.	Presentation of Knowledge and Ideas standards can be applied to help students: • Discuss science questions, information, results, and supporting evidence with a partner or small group; speak clearly and in a sequence so listeners can follow the line of thinking and reasoning. • Make a claim about the effectiveness of an object, tool, or solution that is supported by relevant evidence and listen actively to others' comments that indicate agreement or disagreement based on evidence. • Engage in formal presentations to small or large groups of students to share findings and supporting evidence. Presentation should be clear, concise, and logically organized; content and presentation style should be appropriate to purpose, audience, and task. • Communicate scientific information orally, using various forms of print or digital media, pictures, and charts.

Annotated Vignette – Kindergarten

In a kindergarten science lesson, students learned about observable properties of materials, including the type of material(s) used to make an object (Strand 5 Concept 1). Students are now connecting that knowledge to magnetic properties of objects. In this lesson, students are learning about magnetic properties by sorting objects and materials based on whether they are attracted by a magnet. (Strand 5 Concept 3).

Disciplinary Literacy Skills	Vignette of Student Activities During a Science Lesson
• SL= Gather and share information and ideas.	The teacher holds a large magnet and asks students if they know what it is. Students talk to their shoulder partners to share what they think the object is. The teacher then asks several students what it is. Students identify it as a magnet. The teacher tells students there is a property some materials have – they can be magnetic, and explains that you can't always observe by just looking at the material; sometimes you need to test it. The teacher places a metal paper clip against the magnet and lets go. The paper clip sticks to the magnet. The teacher then writes the definition of **magnetic** on the board, explaining that if an object can stick to a magnet, it has magnetic properties. The teacher picks up a plastic paper clip and places it against the magnet. It doesn't stick. The teacher then explains that only some materials have magnetic properties and that the class' job today is to figure out what materials are magnetic.
• SL= Communicate to express ideas clearly and build on other's ideas using comprehension and collaboration.	The teacher directs students into small groups to discuss how they can test whether the materials making up an object are magnetic (will stick to a magnet). Small groups of students share their ideas for testing this. Each group of students shares their ideas with the class. The class agrees that everyone will test whether materials are magnetic by placing magnets against the objects to see if the magnets will stick. Each group spends 5 minutes testing the objects placed on a materials table, plus other objects in the classroom (except electronic equipment).

• SL= Communicate to express ideas clearly and build on other's ideas using comprehension and collaboration. • SL= Communicate to express ideas clearly and build on other's ideas using presentation of knowledge and ideas. • RI= Gather and analyze information suing craft and structure.	The teacher brings the entire class together and asks the class to name of an object they tested and whether it was magnetic. Students start listing objects (file cabinet, paper clip, paper, textbook, crayon, screw, eraser, etc.) For each object, the teacher records the object name and whether it was magnetic on the board. If groups disagree, the teacher selects a volunteer to test it for the class. If an object is made of multiple materials the teacher asked the students to be specific about the part of the object (the rings on a three ring binder were magnetic, but the front and back cover were not magnetic).
• RI= Gather and analyze information using craft and structure. • SL= Communicate to express ideas clearly and build on other's ideas using comprehension and collaboration. • SL= Communicate to express ideas clearly and build on other's ideas using presentation of knowledge and ideas.	The teacher makes a t-chart on the board, labeling one column magnetic materials and the other column not magnetic materials. The teacher then starts with each object that was labeled as not magnetic. The teacher asks students to name the type of material it is made of (paper, plastic, metal, rock, wood). The students identify the materials of each non-magnetic object and the teacher records them on the t-chart. The teacher then repeats this process for the magnetic objects, asking students to identify their materials (metal). The teacher then asks each group to make a claim about whether you can tell if an object is magnetic based on the material it is made of. Each group works on their claim and identifying supporting evidence. Students are allowed to further test items in the classroom as they develop their claim.
• SL= Critically evaluate information by linking claims to evidence, using presentation of knowledge and ideas. • W= Synthesize claims and evidence using text types and purposes.	The class ends with each group sharing their claim and other groups asking questions about their evidence. Each group agrees that if an object is made of paper, plastic, wood, wax, food, or rocks, that it isn't magnetic and supports those claims with evidence. The class is still confused about metal, because sometimes it is magnetic and sometimes it isn't. Students draw and label pictures of non-magnetic materials in their science notebooks. The teacher ends the class by telling the students that tomorrow they will further test metals to see if they can make a claim about the magnetic properties of metals.

Annotated Vignette – Grade 1 Science

In a first-grade science lesson, students are being introduced to the characteristics of living things (Strand 4, Concept 1). The purpose of this lesson is to elicit student understandings and prior knowledge about characteristics of living things so future lessons can build on and develop this understanding.

Disciplinary Literacy Skills	Vignette of Student Activities During a Science Lesson
• RI= Gather information by interpreting drawings using key ideas and details. • W= Gather and analyze information by recording drawings using text types and purposes. • SL= Gather and analyze information using comprehension and collaboration.	At the start of the class, each student is given a handout with 12 pictures (human, duck, snail, beetle, cow, tree, car, shovel, paper, watch, rock, balloon). Students are instructed to circle the pictures that represent living things and then come up with a reason why they think each picture they circled is living. The students are then organized into small groups. Each group is given a set of cards with the same 12 pictures as their handout. Each group is asked to sort their cards into two groups: living and nonliving. Students share their original thoughts with the group and negotiate with the rest of their group where to place each card. Each student in the group is responsible for being able to explain why the group made each card placement. The teacher circulates around the room, asking each group questions about the placement of specific cards.
• RI= Gather information by interpreting drawings using key ideas and details. • SL= Gather and analyze information using comprehension and collaboration.	With the whole class, the teacher separates the board into 3 sections: class agrees that it is living, class agrees that it is non-living, and class does not agree. Selecting one card at a time, the teacher asks the class to say whether it is living or not. Students stand up if they think the picture represents a living thing, and remain seated if they think the card represents something nonliving. If the class is unanimous (human, duck, cow, shovel, paper) the card is placed in the corresponding category on the board. If the class is not unanimous (snail, beetle, tree, car, watch, rock, balloon), the card is placed in the "class does not agree" section on the board.

• RI= Gather information by interpreting drawings using key ideas and details. • SL= Gather and analyze information using comprehension and collaboration. • SL= Critically evaluate and revise information using comprehension and collaboration.	The teacher asks students to work with a partner to brainstorm all the ways the living things are different from the nonliving things. Each pair comes up with ideas. One pair shares to the whole class that they think that all living things grow and nonliving things do not grow. The teacher asks the class of they agree with that statement. Students who agree stand up, and those that don't agree remain seated. The teacher then reviews the list of items from the cards that the class decided were living (human, duck, cow) and asks if all of these objects grow. The class agrees that they do. The teacher then reviews the list of items that the class decided were not living (shovel, paper). The class agrees that these items do not grow and are not living. The teacher then selects "tree" from the can't agree section of the board. The teacher asks the class if a tree can grow. The class agrees that a tree can grow so they think it should be living. The teacher then asks the class if a balloon can grow. The class does not agree. Students are asked to explain their thinking and what the word "grow" means to them. After much discussion, the class agrees that stretching something out or filling it can make an object bigger, but that isn't the same thing as growing. They conclude that a balloon can be stretched or filled to make it bigger, but it didn't grow. The teacher writes "grows" and "doesn't grow" on slips of paper, and places "grow" in the living section of the board and "doesn't grow" on the nonliving section of the board.
• RI= Gather information by interpreting drawings using key ideas and details. • SL= Gather and analyze information using comprehension and collaboration. • SL= Critically evaluate and revise information using comprehension and collaboration.	The teacher asks students for another way that living things are different from the nonliving things. One pair shares that they think that all living things move and nonliving things do not move. The teacher asks the class if they agree with that statement. Students who agree stand up, and those that don't agree remain seated. The teacher then reviews the list of items from the cards that the class decided were living (human, duck, cow) and asks if all of these objects move. The class agrees that they do. The teacher then reviews the list of items that the class decided were not living (shovel, paper). The class agrees that these items do not move and are not living.

• RI= Gather information by interpreting drawings using key ideas and details. • SL= Gather and analyze information using comprehension and collaboration. • SL= Critically evaluate and revise information using comprehension and collaboration.	The teacher then selects “car” from the can’t agree list and asks the class if a car can move. The class does not agree. Students are asked to explain their thinking and what the word “move” means to them. The class works to refine their definition of what move means for living things. The teacher then selects “tree”. The teacher asks the class if a tree can move. The class doesn’t think that a tree can move. They struggle because they decided a tree is living because it can grow but now it doesn’t move. The teacher writes the word ‘move’ on a card, and places it in the can’t agree section of the board.
• RI= Gather information by interpreting drawings using key ideas and details. • SL= Gather and analyze information using comprehension and collaboration. • SL= Critically evaluate and revise information using comprehension and collaboration.	The class repeats this process for other characteristics they brainstormed, including: eat, drink, breathe, and sleep. Each time the students work to refine their understanding of these terms as they relate to living things, and the teacher places the characteristic in the appropriate section of the board, based on student understanding.
	The teacher ends the lesson by explaining that it is ok to have some things that are still confusing or unclear, and tells the class that they will be spending time in future lessons learning more about the characteristics of different living things. As they learn more, they will be able to come back to this chart and their definitions and add to it or revise it when needed. The teacher then explains that a big part of science is starting with an idea, and gathering more information to help make that idea stronger, or using the new information to change their thinking to better match the evidence.

Annotated Vignette – Grade 2 Science

In a second-grade science lesson, students are learning about changes in the Earth and sky by understanding the characteristics of weather conditions and climate. Students have examined and compared the different objects in the sky and are now focusing on the weather conditions (Strand 6 Concept 3). Students will measure and record different weather conditions and cloud types. They will examine the relationship between clouds, temperature, and weather patterns.

Disciplinary Literacy Skills	Vignette of Student Activities During a Science Lesson
• SL= Gather information about clouds and weather using comprehension and collaboration. • RI= Gather information using key ideas and details. • W= Gather information using text types and purposes. • W= Gather information using research to build and present knowledge.	A teacher reads a trade book with photographs and diagrams that shows different clouds and the weather conditions that are associated with them (rainy, sunny, windy). As the teacher reads, students listen to the information and view the photographs and diagrams. The teacher pauses between reading each condition, and small group of students discuss their understanding of the weather condition and factors associated with it. After each group discussion, students draw a diagram or visual representation in their science notebooks to summarize their understanding of each weather condition.
• RI= Gather information about current clouds and weather using key ideas and details. • RI= Gather and analyze information using craft and structure. • W= Gather information using research to build and present knowledge. • W= Gather information using text types and purposes.	Students go outside to observe the clouds, and record the temperature, and other observations or measurements of weather conditions (precipitation, wind). They draw pictures of the clouds in their science notebooks, use a picture of a thermometer to record temperature, and record any other observations or measurements.
• SL= Synthesize information using comprehension and collaboration. • SL= Critically evaluate and revise ideas using comprehension and collaboration. • RI= Synthesize information using integration of knowledge and ideas. • RI= Critically evaluate and revise ideas using integration of knowledge and ideas.	Students work in small groups to determine the type of clouds they observed, using their earlier drawings in their notebooks and pictures from the book the teacher read as evidence to support their identification. The teacher facilitates a class discussion, where students make a claim about how to label the cloud and support it with evidence, until the entire class has correctly labeled the cloud type. The class repeats this process of collecting data about the weather each day for a week. After collecting daily weather data for a week, the teacher asks students to review their information for the week and make a claim about how clouds and temperature can be used to predict the weather.

• RI= Gather information from multiple resources using craft and structure. • RI= Synthesize information using integration of knowledge and ideas. • RI= Critically evaluate and revise ideas using integration of knowledge and ideas. • W= Synthesize information from observations and measurements collected using research to build and present knowledge. • W= Synthesize information using production and distribution of writing. • SL= Synthesize information using comprehension and collaboration. • SL= Critically evaluate and revise ideas using comprehension and collaboration.	Students work in small groups to develop their claim and support it with evidence from their science notebooks, website resources, pictures, or trade books. Students use visuals, headings, bold words, and captions in informational text to look up key weather words and cloud types to compare to their own observations. After each group of students reaches agreement on their claim and supporting evidence, they record their claim and evidence - including any data charts, graphs, or pictures - on a whiteboard or poster to share with the whole class.
• W= Communicate/publish using production and distribution of writing. • SL= Communicate/publish using presentation of knowledge and ideas. • SL= Critically evaluate using comprehension and collaboration. • SL= Critically evaluate and revise using comprehension and collaboration. • W= Critically evaluate and revise using production and distribution of writing.	Each group presents their claim, evidence, and reasoning to other groups. While students are presenting other students are actively listening and asking questions to clarify their own understanding of the presented information and to provide feedback to the presenting students. Following presentations, each group revises their claim and presentation as needed, based on the feedback they received.