Disciplinary Literacy in Grades 6-8 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 in grades 6-8, 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information provided by reading scientific tools and instruments; published documents in print or electronic format; unpublished documents written by students, peers, or teachers; or other sources of information.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

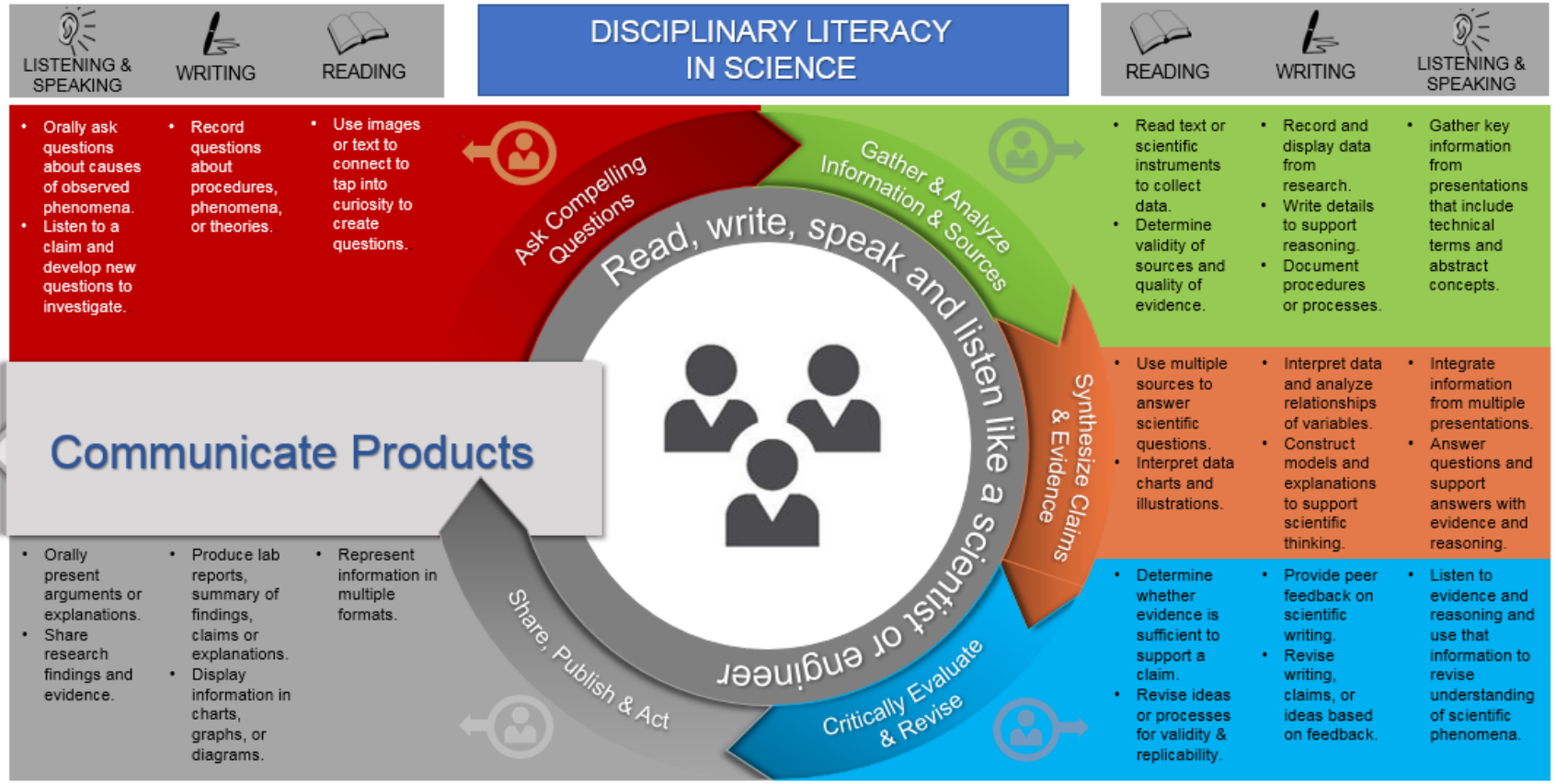
A fundamental goal of science education is to help students figure out how the world works and make sense of scientific phenomena or compelling questions. A scientific phenomenon is an event or situation that is observed to exist or happen, especially one whose cause or explanation is in question. Sense-making 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 6-8) These ELA standards help students gather and analyze sources and information (evidence from text) that can be used to support their reasoning as they develop conceptual 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: • Find answers to relevant science questions or problems. • Understand and follow a written lab protocol, scientific process or procedure. • Connect new understandings with background knowledge. • Determine which information is important to answering scientific questions. • Pay attention to details, accuracy, and precision when reading/collecting data from scientific instruments. • Interpret diagrams, pictures, charts, graphs, and data to gather information. • Interpret and evaluate quality and quantity of data, evidence, and scientific reasoning. • Determine the credibility of information, including research design, sample size, and visual representations of data and findings.

Craft and Structure	Using **Craft and Structure** to Build Disciplinary Literacy in Science
(Link to RI.4, RI.5, RI.6 for grades 6-8) These ELA standards help students navigate the norms and conventions of complex science text. Scientific and technical text often contains a variety of text structures, visual representations, and vocabulary that has a very specific meaning across science disciplines (theory) or within a single discipline (precipitation in weather vs. precipitation in chemical reactions).	Craft and Structure standards can be applied to help students: • Use strategies (context clues, linguistic roots and affixes, restatement, examples, contrast, glossary, etc.) to determine the meaning of words and phrases in the text. • Use context to determine meanings of words and differentiate how vocabulary may be used differently in a science context compared to non-science contexts. • Identify structures within a text (headings, sub-headings, bold words, pictures, graphs, data tables, and paragraphs) and explain how they support or supplement information in the paragraph text. • Explain how key terms relate to each other or to broader science concepts and general understanding. • Use information to answer questions and support reasoning and conclusions. • Make meaning out of mathematical symbols and equations; diagrams, flow charts and other visual representations; and abstract ideas.

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 6-8) These ELA standards help students integrate and synthesize scientific knowledge and ideas when obtaining, evaluating, and communicating information. Students integrate information to evaluate the merit, 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: • Extract information from multiple sources and text types; synthesize information to create an understanding that aligns to current scientific explanations and understanding. • Compare multiple representations of information (quantitative data, video, multimedia, articles, books, photographs, infographics, diagrams, etc.) related to the same phenomenon or science concept and explain whether the representations convey similar levels of detail or whether the information supports or contradicts each other. • Interpret data and analyze relationships of variables, using words and visual information. • Accurately depict written or spoken words through a visual representation (graph, chart, picture, etc.); or vice versa. • Synthesize multiple sources of information to support an evaluation of scientific research or reports, their experimental design, data collection methods, analysis, or conclusions. • Identify an argument or claim by distinguishing among facts, research findings, inferences, speculation, and reasoning; determine whether the evidence is relevant and sufficient to support the claim.

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 6-8) 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 6-8) 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. 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. • Write a claim, evidence-based argument, or explanation that includes logical reasoning, accurate science content, and relevant and sufficient evidence to support the claim. Claims are created with effective word choice, appropriate use of science vocabulary, and writing style. • Write formal or informal texts. The product may include field notes, mind maps, research papers, laboratory reports, functional text, or visual displays of data. • Produce science writing in a voice appropriate for the type of writing and the audience. Objective or academic voice in science is used when a writer wants to deliver information in a neutral, factual, and unbiased way. • Write step-by-step procedures for experiments that are detailed enough that others would be able to replicate their experiments exactly and achieve the same results. • Produce texts that include charts, graphs, timelines, photographs, videos, maps, flowcharts, diagrams, models, or tables to supplement or support the text.

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 6-8) 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 (Internet, keyboarding skills, formatting, storing) to create a published piece where information and ideas are connected and presented clearly and efficiently. • Use technology (blogs, wikis, smartboards, apps) to support collaborative brainstorming and writing. • Integrate graphs, data tables, drawings or illustrations, 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, W.9 for grades 6-8) 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: • Conduct research projects or experimental investigations of differing lengths to provide enough information to construct claims, evidence, and explanations that answer scientific questions or solve a problem. • Integrate information from a variety of credible print and digital sources, taking care to use a consistent voice, avoid plagiarism, and appropriately cite resources in a standard recognized format in both the text and the bibliography. (APA style is most commonly used by scientists) • Use evidence from informational texts (e.g., data sets, credible web sites, news articles, textbooks) to support claims, analyses, reflections, and/or research. • Convert informal writing in drafts while still synthesizing information and developing claims, to a formal academic voice when publishing formal writing of claims.

Range of Writing	Using **Range of Writing** to Build Disciplinary Literacy in Science
(Link to W.10 for grades 6-8) This ELA standard requires that students produce informal, formal, and persuasive scientific writing across multiple delivery formats and topics, for different purposes and audiences.	Implementation strategies for this standard are embedded in the previous writing examples. • Writing assignments should be of varying lengths (field or research notes, one paragraph responses, multiple paragraph essays, lab reports or presentations, extended research). • Scientific writing often includes pictures, diagrams, charts, thinking maps, data, or statistics; these can be integrated with text or presented with minimal text.

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 6-8) These ELA standards help students engage in scientific discourse 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. • Integrate multiple sources of information presented in diverse media or formats (e.g., visually, quantitatively, orally), evaluating the credibility and accuracy of each source. • Collaboratively plan an investigation or test a design solution, controlling variables and ensuring the data is collected with appropriate tools and in a safe and ethical manner, including considerations of environmental, social, and personal impacts. • Collaboratively conduct investigations; evaluate the types, amounts, and accuracy of data needed to produce reliable measurements; consider limitations on the precision of the data (number of trials, cost, risk, time); and refine the design to meet the goals of the investigation..

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 6-8) These ELA standards help students engage in scientific discourse 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: • Engage in science discourse with a partner or small group by discussing questions, information, findings, and supporting evidence clearly, concisely, and logically such that listeners can follow the line of thinking and reasoning; organization, substance, and style are appropriate to purpose, audience, and task. • Engage in formal presentations to small or large groups of students to share findings and supporting evidence. Presentation should be clear, concise, and logical organized, so listeners can follow the line of reasoning; organization, development, substance, and style are appropriate to purpose, audience, and task. • Use digital media (e.g., textual, graphical, audio, visual, video conferencing, or interactive elements) when presenting findings to support claims, evidence, reasoning, and to add interest.

Annotated Vignette – 6th Grade Science

In a 6th grade science class, students have learned that cells are the basic unit of life and all life has certain requirements to survive and reproduce. They are now being introduced to the structures and functions of cells, and how to differentiate between plant and animal cells. This lesson focuses on students learning how to classify plant and animal cells, and then applying what they know to classify an unknown cell. (Strand 4 Concept 1).

<table>
<tr><th>Disciplinary Literacy Skills</th><th>Vignette of Student Activities During a Science Lesson</th></tr>
<tr><td>• RI=Gather information using key ideas and details.
• W=Gather and analyze information using research to build and present knowledge.
• W=Record observations and ideas using text types and purposes.
• SL=Synthesize claims and evidence using comprehension and collaboration.</td><td rowspan="3">Small groups of students explore eight different plant and animal cells (numbered 1 - 8) by viewing them under the microscope, microslide viewer, or through photographs. Students draw sketches or other visual representations of observed cells and their structures in their science notebooks. Students look for patterns of any similar structures among different cell types that they viewed, and attempt to classify into two categories - Category 1 and Category 2 - based on similarities of structures. Groups discuss common structures to determine which cells belong in Category 1 and which belong in Category 2. Students reference evidence from their drawings to support their classification.

The teacher asks, What is the difference in structure and function between plant and animal cells?

Students are provided idealized models (print or 3D models) of both plant and animal cells, with each type of cell and internal structures labeled. Students work in small groups to determine whether the cells they grouped into Category 1 (and then Category 2) are plant or animal cells. Students use information from text, labeled drawings, Internet searches, and the models to justify their classification. As students develop common understandings of the differentiating characteristics between plant and animal cells, they revise how they sorted the cells, as needed.

Each student labels 8 sticky notes with numbers 1-8. The teacher then writes two headings on the board: Plant Cells and Animals Cells. Each student then places their 8 post-it notes corresponding to the numbered cells they observed under the heading they think is correct. The teacher facilitates a whole class discussion, going through each cell at a time. Students justify the placement based on structural evidence (presence or absence of particular cell structures).

For each disagreement in the class (for example, sticky notes labeled with Cell 5 are placed under both plant and animal cell headings), students provide evidence of which structures they saw (or failed to see) referencing their drawings, observations, or research. Students are provided opportunities to look at those cells again.</td></tr>
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• SL= Critically evaluate and revise using comprehension and collaboration.</td></tr>
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</table>

• SL=Communicate/share claims and evidence using presentation of knowledge and ideas. • SL= Critically evaluate and revise using comprehension and collaboration.	Once the class has agreement on how to classify the 8 cells, the teacher reveals the sources/types of cells that were observed. If any cells were misclassified, the class observes the cells again, concentrating on the characteristics that were missed or incorrectly interpreted.
• RI=Gather and analyze information on new cell using integration of knowledge and ideas. • W= Synthesize claims and evidence using production and distribution of writing. • SL=Communicate claim and evidence using presentation of knowledge and ideas.	The teacher provides each group with a different, unknown plant or animal cell. Based on what students know about the structures of plant and animal cells, they write a claim as to whether their cell is a plant or animal cell, and support their claim with evidence.
• SL=Communicate/share claims and evidence using presentation of knowledge and ideas • SL= Critically evaluate and revise using comprehension and collaboration. • W=Critically evaluate and revised using production and distribution of writing.	Students present their claim and evidence to the whole class. The other groups view the cells, listen to the claim and evidence, and can ask questions of the presenting group. The non-presenting groups can also offer counterclaims and evidence if they believe the presenting group incorrectly classified their cell. Following class discussion, each group revises their claim or their supporting evidence, based on the whole class discussion.

Annotated Vignette – 7th Grade Science

In a 7th Grade science class, students have learned about various geologic processes, such as erosion, deposition, plate tectonics and volcanism. In this lesson, students apply what they know about Earth's geologic features to the changing geologic features of Arizona over time and the processes involved in creating this change. (Strand 6, Concept 1)

Disciplinary Literacy Skills	Vignette of Student Activities During a Science Lesson
• RI= Gather information using key ideas and details from images to generate compelling questions. • W=Record thoughts, ideas, sketches, or collected data based on different text types and purposes. • SL= Communicate information using comprehension and collaboration to share observations and generate compelling questions.	Students work in small groups to look at a series of images printed from the Paleogeography Timeline on the Arizona Experience web page showing changes to the topography of ancient Arizona; images show changes from the Proterozoic through the Tertiary Cenozoic time periods. For the first observation, only the name of the period and the image with the Arizona map is provided to students. All other information on the page is not provided. Students observe the images of Arizona and use their science notebooks to record geologic elements (bodies of water, mountains, vegetation, sand, etc.) visible in each picture, and record any questions they have about the pictures.
• SL = Gather and analyze information using comprehension and collaboration. • RI=Gather and analyze information using key ideas and details. • W=Synthesize information using research to build and present knowledge.	The teacher facilitates a class discussion about geologic features observed in each picture. The main geologic features from each period are recorded. Students explain their thinking in how they identified each geologic feature ("I could tell there was vegetation because the map was colored green.", "I could tell there were mountains because…."). For unresolved disagreements about how to identify a geologic feature ("As a class, we can't decide if this area of the map is showing a river or a canyon"), those disagreements or questions are recorded for students to further investigate. The students share other questions their group raised. The teacher helps organize the questions into categories, and asks the class to further investigate the questions related to **What caused the geology of Arizona to change over time?**
• RI=Gather information using key ideas and details. • RI=Synthesize information using integration of knowledge and ideas. • W= Synthesize information using research to build and present knowledge. • SL=Communicate/publish using presentation of knowledge and ideas.	Students use the full pages the Paleogeography Timeline to supplement the initial pictures and make new observations. They use the information to confirm prior observations about the geology changes, answer the unresolved class disagreements about geographic features, and indicate which geological processes contributed to these changes. Each group constructs a timeline that identifies the time period, the major geologic changes between each time period, the geologic processes responsible for the major changes, and evidence to support their thinking. Students use a whiteboard or poster paper to display their timelines.

• RI=Critically evaluate using integration of knowledge and ideas. • W= Critically evaluate using text types and purposes.	Students use a gallery walk to view each of the timelines, noting where the processes responsible for the changes were similarly identified, and where there were different processes identified. On the board or a large sheet of chart paper, students record the discrepancies – including the geologic time period, the geological feature that changed, and which processes were identified as responsible for changing those features.
• RI= Gather and analyze new information from multiple sources using integration of knowledge and ideas. • W= Synthesize information using research to build and present knowledge. W=Critically evaluate and revise using production and distribution of writing. • SL=Critically evaluate and revise using comprehension and collaboration.	The teacher offers additional resources from the text book, trade books, and geologic web sites to provide additional information the students to help resolve these discrepancies. Different groups are provided different resources and different discrepancies to research. Each group then shares the additional research with the class to resolve the discrepancies and each group revises their timelines, accounting for the new information.
• W=Communicate/publish using text types and purposes • W=Communicate/publish using production and distribution of writing.	Students individually create a data table of their revised timeline, to answer the question **What caused the geology of Arizona to change over time**? For each geological time period, they include the name and dates of the time period, the geological processes that occurred, and the evidence of the changes to the geology.

Annotated Vignette – 8th Grade Science

In an 8th grade science class, students have been learning about Newton's laws. Students have investigated Newton's first law and how a force is needed to produce a change in motion. In this lesson, students investigate Newton's second law so they can describe how the acceleration of a body is dependent on its mass and the net applied force (Strand 5 Concept 2).

Disciplinary Literacy Skills	Vignette of Student Activities During a Science Lesson
• RI= Gather information using key ideas and details to generate compelling questions • SL= Communicate information using comprehension and collaboration to share observations and generate compelling questions	Students watch several video clips showing different types of vehicles (large trucks, trains, race cars, etc.) going from a stopped or parked position to accelerating to full speed. Students discuss their observations. After a brief class discussion about their observations and any questions it generates for them, the class is asked **Why do different vehicles have different rates of acceleration?**
• RI= Gather information using key ideas and details to generate compelling questions • SL= Communicate information using comprehension and collaboration to share observations and generate compelling questions • W= Gather and analyze evidence by recording thoughts, ideas, or collected data using research to build and present knowledge	Students work in small groups to using articles and websites to research the rates of acceleration of different vehicles (standard car, race car, train) and collect any additional information (mass of the vehicle, power of the engine) that they think will help them answer the question. They record key information from their research in their science notebooks.
• RI= Gather information using key ideas and details from experiments or simulations • W= Gather and record data using text types and purposes • RI= Synthesize claims and evidence using craft and structure • W= Synthesize claims and evidence using research to build and present knowledge • SL= Synthesize claims and evidence using comprehension and collaboration	Students use hands-on materials and computer simulations to manipulate the variables of mass and force to determine the relationship between these variables on an object's acceleration. Students record all observations and data in science notebooks and organize their data in tables and/or charts. Students write a claim that supports or refutes the statement "An object is accelerating if it is changing its velocity." The students provide evidence to support their claim with the experimentally collected data. While completing the simulations and hands on experiments, students determine the meaning of variables in the mathematical equations f=ma, v=d/t, and a=v/t.
• SL= Synthesize claims and evidence using comprehension and collaboration • SL= Critically evaluate and revise using comprehension and collaboration	The teacher facilitates a class discussion, where each group of students presents their claims and supporting evidence and reasoning. Students ask each other clarifying questions and challenge the evidence or reasoning, as needed. The teacher guides the conversation to then focus on determining which variables have a large impact on the acceleration of an object.

• RI= Gather information using key ideas and details. • RI= Synthesize information using integration of knowledge and ideas. • W= Gather and analyze evidence by recording thoughts, ideas, sketches or collected data based on different text types and purposes • W= Synthesize information using research to build and present knowledge • SL= Synthesize claims and evidence using comprehension and collaboration.	After student discussion shows that the class understands the variables that impact acceleration, the teacher challenges students to "design a vehicle that has more acceleration than anyone else in class". Over several class periods, students research and design a car to have maximum acceleration. The research and design process is recorded in science notebooks including citations of sources, diagrams of their model car, and any data they record as they test their designs. Students note other possible variables that might influence the acceleration of their car besides mass and applied force.
• W= Gather and analyze evidence by recording thoughts, ideas, sketches or collected data based on different text types and purposes • W= Synthesize information using research to build and present knowledge • SL= Communicate/publish using presentation of knowledge and ideas • SL= Critically evaluate and revise using comprehension and collaboration	As students design their vehicles, they use digital photographs, sketches, and show measured or calculated data on how they designed and redesigned their car for maximum acceleration. Students present their designs to the class, explaining what they did and why, and then the class tests each design by determining the acceleration of each car. Students synthesize the class experimental results and designs of their peers to write and support a claim as to why the faster car in the class was the fastest car. They support their claim with evidence – including mathematical data, diagrams, and pictures - that was collected experimentally and during research.
• RI= Critically evaluate and revise the claim using integration of knowledge and ideas • W= Critically evaluate and revise the claim using text types and purposes • SL= Critically evaluate the claim using presentation of knowledge and ideas • SL= Communicate oral feedback using comprehension and collaboration.	Each student peer reviews another student's claim, analyzing the text to identify whether the evidence is appropriate and sufficient to support the claim. Students provide written and oral feedback explaining what the author can do to strengthen their claim. Students revise their claim based on peer feedback.