Science Curriculum Analysis Worksheet

Current research on science education emphasizes the importance of integrating the learning progressions from all three dimensions included in *A Framework for K-12 Science Education* in order to deepen student understanding of the big ideas connected to scientific phenomena. This Curriculum Analysis Worksheet is a tool that can be used to align your current instructional practices to a 3-dimensional model of instruction, designed to deepen student learning.

1.	Identify a science concept or concepts within the Arizona Science Standard from Strands 4, 5, or 6 that you teach at your grade level/course. Record the science concept, big idea/scientific phenomena, and the three-dimensional learning outcome(s).
2.	Identify learning progressions from each of the three dimensions that will be bundled together to build student conceptual understanding of the big idea/scientific phenomena selected in Step 1.
3.	a. Identify objectives from the Arizona Science Standard from Strands 1, 2 and 3 that align with the **Science and Engineering Practices** learning progression(s) you have identified in Step 2. b. Examine your current science curriculum to identify ways you can modify instruction to reach the vision of *A Framework for K-12 Science Education* while you currently teach grade level objectives aligned to the Arizona Science Standard.
4.	a. Identify the current objectives from the Arizona Science Standard from Strands 4, 5, and 6 that align with the **Disciplinary Core Ideas** learning progression(s) you have identified in Step 2. b. Examine your current science curriculum to identify ways you can modify instruction to reach the vision of *A Framework for K-12 Science Education* while you currently teach grade level objectives aligned to the Arizona Science Standard.
5.	a. Identify the current unifying concept(s) from page viii of the Arizona Science Standard that aligns with the **Crosscutting Concepts** learning progression(s) you have identified in Step 2. b. Examine your current science curriculum to identify ways you can modify instruction to reach the vision of *A Framework for K-12 Science Education* while you currently teach grade level objectives aligned to the Arizona Science Standard.
6.	a. Identify connections to grade level ELA/Literacy standards, as appropriate. b. Identify connections to grade level Mathematics standards and practices, as appropriate.

1.

Arizona Science Concept: Strand 5 Concept 3: Energy

Big Idea/Scientific Phenomenon: The total amount of energy in the Universe is always the same but can be transferred from one energy store to another during an event.

- Light is a form of energy that travels in a straight line until it strikes an object. The path of light can be directed and is the cause of shadows and colors that we see.

2. Science and Engineering Practices Learning Progression *(See Learning Progressions for K-5 Science)*	**Disciplinary Core Ideas Learning Progression** *(See Learning Progressions for K-5 Science)*	**Crosscutting Concepts Learning Progression** *(See Learning Progressions for K-5 Science)*
Planning and Carrying Out Investigations Planning and carrying out investigations to answer questions or test solutions to problems in K–2 builds on prior experiences and progresses to simple investigations, based on fair tests, which provide data to support explanations or design solutions. **Constructing Explanations and Designing Solutions** Constructing explanations and designing solutions in K–2 builds on prior experiences and progresses to the use of evidence and ideas in constructing evidence-based accounts of natural phenomena and designing solutions.	**PS4: Waves and Their Applications in Technologies for Information Transfer (K-2 Grade Band)** • Some materials allow light to pass through them, others allow only some light through, and others block all the light and create a dark shadow on any surface beyond them (i.e., on the other side from the light source), where the light cannot reach. Mirrors and prisms can be used to redirect a light beam. (Boundary: The idea that light travels from place to place is developed through experiences with light sources, mirrors, and shadows, but no attempt is made to discuss the speed of light.) **(3-5 Grade Band)** • An object can be seen when light reflected from its surface enters the eyes; the color people see depends on the color of the available light sources as well as the properties of the surface.	**Cause and Effect** • Simple tests can be designed to gather evidence to support or refute student ideas about causes.

Three Dimensional Learning Outcomes:

- Plan and conduct investigations to determine the effect of placing objects made with different materials in the path of a beam of light.
- Make observations to create an evidence-based explanation of how the path of light can be directed. (reflected, refracted and absorbed.)
- Plan and conduct an investigation to determine the effects of magnifying and bending light.

3. Science and Engineering Practices

Current Practice

Identify performance objectives from Strands 1-3 within the Arizona Science Standard that align to the learning progressions listed above.
(Strand 1: Inquiry; Strand 2: History and Nature of Science; Strand 3: Science and Social Perspectives)

Concept 1: Observations, Questions, and Hypotheses
Observe, ask questions, and make predictions.
PO 1. Formulate relevant questions about the properties of objects, organisms, and events of the environment using observations and prior knowledge.
PO 2. Predict the results of an investigation based on observed patterns, not random guessing.

Concept 2: Scientific Testing (Investigating and Modeling)
Participate in planning and conducting investigations, and recording data.
PO 1. Demonstrate safe behavior and appropriate procedures (e.g., use of instruments, materials, organisms) in all science inquiry.
PO 2. Plan a simple investigation (e.g., one plant receives adequate water, one receives too much water, and one receives too little water) based on the formulated questions.
PO 3. Conduct simple investigations (e.g., related to plant life cycles, changing the pitch of a sound, properties of rocks) in life, physical, and Earth and space sciences.
PO 4. Use metric and U.S. customary units to measure objects.
PO 5. Record data in an organized and appropriate format (e.g., t-chart, table, list, written log).

Concept 3: Analysis and Conclusions
Organize and analyze data; compare to predictions.
PO 1. Organize data using the following methods with appropriate labels:
• bar graphs
• pictographs
• tally charts
PO 2. Construct reasonable interpretations of the collected data based on formulated questions.
PO 3. Compare the results of the investigation to predictions made prior to the investigation.
PO 4. Generate questions for possible future investigations based on the conclusions of the investigation.
PO 5. Record questions for further inquiry based on the conclusions of the investigation.

Concept 4: Communication
Communicate results of investigations.
PO 1. Communicate investigations and explanations using evidence and appropriate terminology.
PO 2. Describe an investigation in ways that enable others to repeat it.
PO 3. Communicate with other groups to describe the results of an investigation.

Vision of A Framework for K-12 Science Education

Gap Analysis/Curriculum Examination
Refer to the Science and Engineering practice learning progressions within the Learning Progressions for K-5 Science document and your current curriculum to answer the following questions.

- What scientific phenomenon will students investigate and connect to the big idea?
- What practices are currently missing from my curriculum?
- What changes and refinements need to be made?
- What strategies/investigations can be implemented to achieve the vision?

Engage:
Have students watch a shadow puppet video.
Ask students:
How are the puppets in this video created?
Use Page Keeley's probe *Shadow Size* to pre assess students and then use again as a post assessment

Explore:
Have students investigate and explore with flashlights to determine the behavior of light.

Have students devise an experiment to determine what different types of materials do when placed in the beam of light. Have each group use one or two different materials and report out their findings to the class. Create a group data table.

Have students use mirrors to disrupt the beam of light and record observations. Have students use a prism to disrupt the beam of light and record observations.

Explain:
Use the data collected from the light experiments to provide an evidence-based explanation (C-E-R) on how altering a light source can be useful to humans.

Extend:
Have students place colored lens in front of a white light source and see what the results of this interference is on the path of light. How is it changed when a prism is used in conjunction with the colored lenses?

4. Disciplinary Core Idea			
Current Performance Objectives	Concept 3: Energy and Magnetism Investigate different forms of energy. PO 1. Demonstrate that light can be: • reflected (with mirrors) • refracted (with prisms) • absorbed (by dark surfaces) PO 2. Describe how light behaves on striking objects that are: • transparent (clear plastic) • translucent (waxed paper) • opaque (cardboard)	**Vision of *A Framework for K-12 Science Education***	**Gap Analysis** **Refer to the Content learning progressions within the Learning Progressions for K-5 Science document and your current curriculum to answer the following questions.** • What core idea(s) is/are currently targeted within my current curriculum? • What changes and refinements need to be made? (add, refine, delete concepts) • What strategies/investigations can be implemented to achieve the vision? • Have students investigate the path of light using flashlights to determine that light travels in a straight line. • Conduct a Shadow walk to see how shadows are formed and determine if all shadows are the same. • As a class, develop an experiment to test how different materials (cardboard, fabric, paper, wax paper, plastic wrap, etc.) affect a beam of light when they are placed in front of the beam of light. Have student groups each test one or two different materials and then generate a class data table. • Have students investigate how light is changed when a mirror is introduced into the path of light. Have students investigate how light changes when a prism is introduced into the path of light. • Students develop an explanation (C-E-R) of how altering the path of light can be helpful to humans. • Provide video, picture or text that shows how shadows are formed from changes in light.

5. Crosscutting Concepts			
Current Crosscutting Concepts	**Unifying Concepts and Processes (Crosscutting concepts) Listed in page viii of the front matter of the Arizona Science Standard, and explained in the National Science Education Standards (1995) pp. 115-119** Constancy, Change, and Measurement	**Vision of *A Framework for K-12 Science Education***	**Gap Analysis** **Refer to the Crosscutting Concepts learning progressions within the Learning Progressions for K-5 Science document and your current curriculum to answer the following questions.** • How is/are the crosscutting concept(s) made explicit within my current curriculum? • What changes and refinements need to be made? • What strategies/investigations can be implemented to achieve the vision? **Cause and Effect** Provide opportunities for students to determine the effect of different materials being placed in a beam of light. Provide opportunities for students to determine the effects of mirrors when used with beams of light.

6. Connections			
Other Content Area Standards	**Identify other Content Area Standards that will build student understanding of this concept or phenomenon, especially those in ELA/Literacy and Mathematics/Practices.** 3.RI.2 Determine the main idea of a text; recount the key details and explain how they support the main idea. 3.RI.3 Describe the relationship between a series of historical events, scientific ideas or concepts, or steps in technical procedures in a text, using language that pertains to time, sequence, and cause/effect. (3.RI.3) 3.RI.4 Determine the meaning of general academic and domain-specific words and phrases in a text relevant to a *grade 3 topic or subject area.* 3.W.8 Recall information from experiences or gather information from print and digital sources; take brief notes on sources and sort evidence into provided categories. 3.SL.1a Come to discussions prepared having read or studied required material; explicitly draw on that preparation and other information known about the topic to explore ideas under discussion. 3.SL.2 Determine the main ideas and supporting details of a text read aloud or information presented in diverse media and formats, including visually, quantitatively, and orally.	**Connections to Instruction**	**Gap Analysis** **Refer to the Other content standards that are being used as a connection to answer the following questions.** • How are the connected standards explicitly taught within my current curriculum? • What changes and refinements need to be made? • What strategies/investigations can be implemented to achieve the vision? **Reading:** Have students read an informational text on light (ex. Readworks.org passage on light) Have students read trade books on light such as *I See Myself* by Vicki Cobb and have students identify the steps that it takes to shine light using a mirror. **Writing:** Write a poem or short story explaining what happens when light when it is blocked by an object. Have student write an evidenced based claim (C-E-R)) on how altering a light source can be useful to humans. **Speaking and Listening:** Have students report information and experimental data to compile a class data table for the results of different materials crossing a beam of light. Discuss as a class what claims can be made based on this evidence.