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 6 Concept 2: Energy in the Earth System

Big Idea/Scientific Phenomenon: The composition of the Earth and its atmosphere and the processes occurring within them shape the Earth's surface and its climate.

- Changes in the Earth's surface including weather and variations in the flow of energy cause changes in climate.

2. Science and Engineering Practices Learning Progression *(See Learning Progressions for 6-12 Science)*	**Disciplinary Core Ideas Learning Progression** *(See Learning Progressions for 6-12 Science)*	**Crosscutting Concepts Learning Progression** *(See Learning Progressions for 6-12 Science)*
Developing and Using Models • Use a model to provide mechanistic accounts of phenomena. **Planning and Carrying Out Investigations** • Plan and conduct an investigation individually and collaboratively to produce data to serve as the basis for evidence, and in the design: decide on types, how much, and accuracy of data needed to produce reliable measurements and consider limitations on the precision of the data (e.g., number of trials, cost, risk, time), and refine the design accordingly. **Analyzing and Interpreting Data** • Analyze data using tools, technologies, and/or models (e.g., computational, mathematical) in order to make valid and reliable scientific claims or determine an optimal design solution. **Engaging in Argument from Evidence** • Construct an oral and written argument or counter-arguments based on data and evidence.	**ESS2: Earth's Systems** • Earth's systems, being dynamic and interacting, cause feedback effects that can increase or decrease the original changes. • The geological record shows that changes to global and regional climate can be caused by interactions among changes in the sun's energy output or Earth's orbit, tectonic events, ocean circulation, volcanic activity, glaciers, vegetation, and human activities. These changes can occur on a variety of time scales from sudden (e.g., volcanic ash clouds) to intermediate (ice ages) to very long-term tectonic cycles. • The foundation for Earth's global climate systems is the electromagnetic radiation from the sun, as well as its reflection, absorption, storage, and redistribution among the atmosphere, ocean, and land systems, and this energy's re-radiation into space.	**Cause and Effect** • Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects. **Energy and Matter** • Energy drives the cycling of matter within and between systems. **Stability and Change** • Much of science deals with constructing explanations of how things change and how they remain stable. Feedback (negative or positive) can stabilize or destabilize a system.

Three Dimensional Learning Outcomes:

- Use data to support a claim about whether one change to Earth's surface can create feedbacks that cause changes to other Earth systems.
- Use a model to describe how variations in the flow of energy into and out of Earth's systems result in changes in climate.

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
Formulate predictions, questions, or hypotheses based on observations. Evaluate appropriate resources.
PO 1. Evaluate scientific information for relevance to a given problem.
PO 2. Develop questions from observations that transition into testable hypotheses.
PO 3. Formulate a testable hypothesis.
PO 4. Predict the outcome of an investigation based on prior evidence, probability, and/or modeling (not guessing or inferring).

Concept 2: Scientific Testing (Investigating and Modeling)
Design and conduct controlled investigations.
PO 1. Demonstrate safe and ethical procedures (e.g., use and care of technology, materials, organisms) and behavior in all science inquiry.
PO 2. Identify the resources needed to conduct an investigation.
PO 3. Design an appropriate protocol (written plan of action) for testing a hypothesis:
- Identify dependent and independent variables in a controlled investigation.
- Determine an appropriate method for data collection (e.g., using balances, thermometers, microscopes, spectrophotometer, using qualitative changes).
- Determine an appropriate method for recording data (e.g., notes, sketches, photographs, videos, journals (logs), charts, computers/calculators).

PO 4. Conduct a scientific investigation that is based on a research design.
PO 5. Record observations, notes, sketches, questions, and ideas using tools such as journals, charts, graphs, and computers.

Concept 3: Analysis, Conclusions, and Refinements
Evaluate experimental design, analyze data to explain results and propose further investigations. Design models.
PO 1. Interpret data that show a variety of possible relationships between variables, including: positive relationship, negative relationship or no relationship
PO 2. Evaluate whether investigational data support or do not support the proposed hypothesis.
PO 4. Evaluate the design of an investigation to identify possible sources of procedural error, including: sample size, trials, controls, analyses

Concept 4: Communication
Communicate results of investigations.
PO 1. For a specific investigation, choose an appropriate method for communicating the results.
PO 2. Produce graphs that communicate data.
PO 3. Communicate results clearly and logically.
PO 4. Support conclusions with logical scientific arguments.

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 6-12 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:
"There is a greater than 90% chance that El Niño will continue through Northern Hemisphere winter 2015-16, and around an 85% chance it will last into early spring 2016". Report Issued by Climate Prediction Center 2015
Ask students "What does this claim mean for the winter of 2015-16 in Arizona?"

Have students create a model of the El Nino climate pattern based on their current experiences and knowledge of this phenomenon.

Explore:
Have students evaluate the 1950 – 2015 data from the Oceanic Nino Index (ONI) to predict what years were El Nino and La Nina seasons.
http://www.cpc.ncep.noaa.gov/products/analysis_monitoring/ensostuff/ensoyears.shtml
Have student research the weather including precipitation in Arizona during the years they have found to be el Nino years.

Explain:
Use the data collected and models created to provide an evidence-based explanation (Claim – Evidence - Reasoning) the prediction for this year's weather pattern as a result of El Nino.

4. Disciplinary Core Ideas

Current Performance Objectives

Strand 6, Concept 2: Energy in the Earth System (Both Internal and External)

Understand the relationships between the Earth's land masses, oceans, and atmosphere.

PO 9. Explain the effect of heat transfer on climate and weather.

PO 10. Demonstrate the effect of the Earth's rotation (i.e., Coriolis effect) on the movement of water and air.

PO 11. Describe the origin, life cycle, and behavior of weather systems (i.e., air mass, front, high and low systems, pressure gradients).

PO 12. Describe the conditions that cause severe weather (e.g., hurricanes, tornadoes, thunderstorms).

PO 13. Propose appropriate safety measures that can be taken in preparation for severe weather.

PO 14. Analyze how weather is influenced by both natural and artificial Earth features (e.g., mountain ranges, bodies of water, cities, air pollution).

PO 15. List the factors that determine climate (e.g., altitude, latitude, water bodies, precipitation, prevailing winds, topography).

Vision of *A Framework for K-12 Science Education*

Gap Analysis

Refer to the Content learning progressions within the Learning Progressions for 6-12 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?

1. Have student use local maps to determine longitudinal and latitudinal readings for Arizona locations such as bodies of water, mountain ranges, landmarks, etc.
2. Have students collect weather data including temperature, wind speed, wind direction, relative humidity, barometric pressure and precipitation in for a period of 7-10 days.
3. Using the weather data collected, have students write an evidence based explanation regarding the movement of air masses over the 7-10 day period.
4. Have students read an article on El Nino and discuss the significance of changes in climate and how that can affect the prediction of weather patterns.
5. Have students conduct research on significant weather events that have occurred in the United States in the past year including hurricanes, tornadoes, etc.
6. Have students present to the class the weather event they researched and the resulting impact of the weather event on the affected communities.
7. Chart the similarities and difference between the weather events presented in class. Discuss the community response and changes to notification systems or prevention of possible issues.

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

Evolution and Equilibrium

Vision of *A Framework for K-12 Science Education*

Gap Analysis
Refer to the Crosscutting Concepts learning progressions within the Learning Progressions for 6-12 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 investigate data on precipitation and El Nino patterns to determine if El Nino patterns are the cause of greater precipitation for Arizona.

Energy and Matter
Provide opportunities for students to evaluate satellite images to determine the effects of changes in water temperature that result in El Nino cycles.

Stability and Change
Provide opportunities for students to understand the change in water temperatures and how they affect the patterns that are reflected in El Nino.

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.

RST.11-12.1
Cite specific textual evidence to support analysis of science and technical texts, attending to important distinctions the author makes and to any gaps or inconsistencies in the account.

RST.11-12.2
Determine the central ideas or conclusions of a text; summarize complex concepts, processes, or information presented in a text by paraphrasing them in simpler but still accurate terms.

WHST.9-12.1
Write arguments focused on discipline-specific content.

WHST.9-12.7
Conduct short as well as more sustained research projects to answer a question (including a self-generated question) or solve a problem; narrow or broaden the inquiry when appropriate; synthesize multiple sources on the subject, demonstrating understanding of the subject under investigation.

SL.11-12.5
Make strategic use of digital media (e.g., textual, graphical, audio, visual, and interactive elements) in presentations to enhance understanding of findings, reasoning, and evidence and to add interest.

HSN.Q.A.1
Use units as a way to understand problems and to guide the solution of multi-step problems; choose and interpret units consistently in formulas; choose and interpret the scale and the origin in graphs and data displays.

HSN.Q.A.2
Define appropriate quantities for the purpose of descriptive modeling.

HSN.Q.A.3
Choose a level of accuracy appropriate to limitations on measurement when reporting quantities.

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
Cite textual evidence from the El Nino reading to determine the important factors the author is communicating and what gaps in information are present in the article.

Writing
Students display weather data collected in appropriate ways, and explain how the information provides evidence to support a claim.

Students write explanations to explain the prediction for this year's weather pattern as a result of El Nino.

Speaking and Listening
Students participate in small group discussions to review the El Nino data.

Students present weather events to the class.

Mathematics
Using the data from the Oceanic Nino Index (ONI), interpret the units in the data accurately to be able to correctly discuss the information.