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 4 Concept 4: Biological Evolution
Big Idea/Scientific Phenomenon: Explain how genetic variations result in adaptations in populations that influence the success of an organism in a specific environment**.**
Three Dimensional Learning Outcomes:

- Construct an explanation based on evidence for how natural selection leads to adaptation of populations.

2. Science and Engineering Practices Learning Progression *(See Learning Progressions for 6-12 Science)* **Constructing Explanations and Designing Solutions** Construct an explanation based on valid and reliable evidence obtained from a variety of sources (including students' own investigations, models, theories, simulations, peer review) and the assumption that theories and laws that describe the natural world operate today as they did in the past and will continue to do so in the future. **Engaging in Argument from Evidence** Evaluate the evidence behind currently accepted explanations or solutions to determine the merits of arguments **Using Mathematics and Computational Thinking** Create or revise a simulation of a phenomenon, designed device, process, or system.	**Disciplinary Core Ideas Learning Progression** *(See Learning Progressions for 6-12 Science)* **AZ Strand 4 Concept 4: Biological Evolution** Natural selection leads to adaptation, that is, to a population dominated by organisms that are anatomically, behaviorally, and physiologically well suited to survive and reproduce in a specific environment. That is, the differential survival and reproduction of organisms in a population that have an advantageous heritable trait leads to an increase in the proportion of individuals in future generations that have the trait and to a decrease in the proportion of individuals that do not.	**Crosscutting Concepts Learning Progression** *(See Learning Progressions for 6-12 Science)* **Cause and Effect** Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects. - ***Connections to Nature of Science*** **Scientific Knowledge Assumes an Order and Consistency in Natural Systems** Scientific knowledge is based on the assumption that natural laws operate today as they did in the past and they will continue to do so in the future.

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:
Watch a video of a Venus fly trap plant. Ask students to think about these questions:
What adaptation does this plant exhibit?
Why has it adapted/evolved in this way?
Are there other plants that have similar adaptations?

Explore:
Set up an opportunity for students to research different adaptations of plants. In teams, students will explain the adaptation they researched and how it benefits the species' survival.

As a class, students devise a method of classification to compare and contrast types of adaptations in plants.

Students will create an experiment to investigate the use of chemical inhibitors produced by plants.

Explain:
Use the research and data collected by the class to create an evidence-based explanation (Claim-Evidence-Reasoning) of the adaptations of plants. Use evidence and reasoning to explain the phenomena of the Venus Fly Trap plant.

4. Disciplinary Core Ideas

Current Performance Objectives

Strand 4 Concept 4: Biological Evolution
Understand the scientific principles and processes involved in biological evolution.

PO 1. Identify the following components of natural selection, which can lead to speciation:

- potential for a species to increase its numbers
- genetic variability and inheritance of offspring due to mutation and recombination of genes
- finite supply of resources required for life
- selection by the environment of those offspring better able to survive and produce offspring

PO 2. Explain how genotypic and phenotypic variation can result in adaptations that influence an organism's success in an environment.

PO 3. Describe how the continuing operation of natural selection underlies a population's ability to adapt to changes in the environment and leads to biodiversity and the origin of new species.

PO 4. Predict how a change in an environmental factor (e.g., rainfall, habitat loss, non-native species) can affect the number and diversity of species in an ecosystem.

PO 5. Analyze how patterns in the fossil record, nuclear chemistry, geology, molecular biology, and geographical distribution give support to the theory of organic evolution through natural selection over billions of years and the resulting present day biodiversity.

Strand 2 Concept 2: Nature of Scientific Knowledge
Understand how science is a process for generating knowledge.

PO 2. Explain the process by which accepted ideas are challenged or extended by scientific innovation.

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. Provide an opportunity for students to discuss the Venus Fly Trap example and how the adaptations benefit the plant.
2. Have students conduct research on plant adaptations and create a model of a plant adaptation to be shared with the class.
3. Develop a classification chart for the adaptations that are discussed during class presentations.
4. Using video, pictures or text, show students additional examples of plant and their adaptations that were not presented in the model presentations.
5. Read informational text on plant adaptations.
   Examples:
   - Plant adaptations
   - *How Plants Cope with the Desert Climate*
   - Allelopathy
   - Talking Plants
6. Discuss the safety and organization of lab materials.
7. Conduct Inhibitor Responses in Plants experiment. http://c.ymcdn.com/sites/my.aspb.org/resource/group/a9372bf4-9ae4-4d0b-ad0c-595c9dfc3543/12labs/09_defense.pdf
8. Have students redesign the inhibitor experiment to test for a different variable. Ask students: What variables could be changed? How would the procedures change in order to test the new variable in the experiment?

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 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 see what conditions occur that result in adaptation to alter the biodiversity of plants and animals. Provide opportunities to test the causal relationship and use these relationships to explain how inhibitors have developed as a positive adaptation.

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-11.12.8 Evaluate the hypotheses, data, analysis, and conclusions in a science or technical text, verifying the data when possible and corroborating or challenging conclusions with other sources of information. WHST.9-12.2 Write informative/explanatory texts, including the narration of historical events, scientific procedures/ experiments, or technical processes. WHST.9-12.9 Draw evidence from informational texts to support analysis, reflection, and research. 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.11-12.4 Present claims and findings, emphasizing salient points in a focused, coherent manner with relevant evidence, sound valid reasoning, and well-chosen details; use appropriate eye contact, adequate volume, and clear pronunciation.	**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** Provide informational text for students to build understanding of plant adaptations. **Writing** Provide opportunities for research of evidence to support understanding of plant adaptations. Students write explanations (C-E-R) about adaptations in the Venus Fly Trap plant. **Speaking and Listening** Students present research information to the class for the development of adaptation classification for plants.