

**Aquaponics**  
**9/10<sup>th</sup> Grade**  
**Quarter Project**

|   |  |  |
|---|--|--|
| <p><b>Unit Description:</b><br/> This unit will provide students the opportunity to utilize science, engineering, and math practices in an authentic problem solving activity. Students will design and construct an operational aquaponics system that produces food and optimizes the nutrient cycling.</p> <p>The lessons, sequence and time frame in the unit plan are possibilities for teachers. The actual lessons will be determined by teachers and schools based on equipment, interest, and personnel. An entire curriculum could be taught using aquaponics or the system could be used to a specific topic such as nutrient cycling or photosynthesis.</p> <p><b>Note:</b> For specific lessons that can be modified for high school, see Aquaponics Unit (grade 4).</p> |  |  |
| <p><b>Big Ideas:</b></p> <ul style="list-style-type: none"> <li>● Develop an understanding of sustainability and explain how aquaponics systems contribute to local sustainability.</li> <li>● Life cycles of plant, animals and microorganisms in an aquatic system and the importance of interdependence and nutrient cycling within an ecosystem.</li> </ul>   |  | <p><b>Essential Questions:</b></p> <ul style="list-style-type: none"> <li>● What is sustainability?</li> <li>● What is an aquaponics system?</li> <li>● What organisms make up the community in the system?</li> <li>● What role do plants animals and microbes play?</li> <li>● How do the organisms depend on each other?</li> </ul> |
| <p><b>Performance Task:</b><br/> Design, construct and maintain an aquaponics system that optimizes nutrient cycling and produces fish and vegetables.</p>  |  |  |
|   | <b>Benchmarks and Processes</b>  | <b>Concepts</b>  |
| <b>Science</b>  | <p><b>Practices:</b></p> <ul style="list-style-type: none"> <li>● Ask</li> <li>● Develop and use models</li> <li>● Planning and carrying out investigations</li> <li>● Analyzing and interpreting data</li> <li>● Constructing explanations</li> <li>● Engaging in argument from evidence</li> <li>● Obtaining, evaluating, and communicating information</li> </ul> | <ul style="list-style-type: none"> <li>● Interdependence</li> <li>● Photosynthesis</li> <li>● Respiration</li> <li>● Nutrient Cycling</li> <li>● Producers</li> <li>● Consumers</li> <li>● Symbiosis</li> <li>● Food Chains</li> <li>● Scientific Inquiry</li> </ul>   |

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|------------|---|---|
|            | <p><b>Benchmarks:</b><br/><b>Science Standards:</b></p> <ul style="list-style-type: none"> <li>● <b>Standard 1: The Scientific Process: SCIENTIFIC INVESTIGATION: Discover, invent, and investigate using the skills nS.IC.5</b> Use data from a randomized experiment to compare two treatments; use simulations to decide if differences between parameters are significant.</li> <li>● <b>necessary to engage in the scientific process</b> <ul style="list-style-type: none"> <li>○ <b>SC.BS.1.1-1.9</b> – Scientific Inquiry</li> </ul> </li> <li>● <b>Standard 2: The Scientific Process: NATURE OF SCIENCE: Understand that science, technology, and society are interrelated</b> <ul style="list-style-type: none"> <li>○ <b>SC.BS.2.1-</b> Explain how scientific advancements and emerging technology have influenced society</li> <li>○ <b>SC.BS.2.2-</b> The student: Compares risks and benefits (e.g., in terms of the impact on populations, resources, health, disease, environment) of alternative solutions to a specific current technological issue (e.g., biotechnology).</li> </ul> </li> <li>● <b>Standard 3: Life and Environmental Sciences: ORGANISMS AND THE ENVIRONMENT: Understand the unity, diversity, and interrelationships of organisms, including their relationship to cycles of matter and energy in the environment</b> <ul style="list-style-type: none"> <li>○ <b>SC.BS.3.1-</b> Describe biogeochemical cycles within ecosystems</li> <li>○ <b>SC.BS.3.2-</b> Explain the chemical reactions that occur in photosynthesis and cellular respiration that result in cycling of energy</li> <li>○ <b>SC.BS.3.3-</b> Explain how matter and energy flow through living systems and the physical environment</li> <li>○ <b>SC.BS.3.4-</b> Explain dynamic equilibrium in organisms, populations, and ecosystems; explain the effect of equilibrium shifts.</li> </ul> </li> </ul> |   |
| Technology | <ul style="list-style-type: none"> <li>● <b>Research and information fluency</b> <ul style="list-style-type: none"> <li>○ Students apply digital tools to gather, evaluate, and use information.</li> </ul> </li> <li>● <b>Critical thinking, problem solving and decision making</b> <ul style="list-style-type: none"> <li>○ Students use critical thinking skills to plan and conduct research, manage projects, solve problems, and make informed decisions using appropriate digital tools and resources</li> </ul> </li> <li>● <b>Creativity and innovation</b> <ul style="list-style-type: none"> <li>○ apply existing knowledge to generate new ideas, products, or processes</li> </ul> </li> </ul>  | <ul style="list-style-type: none"> <li>● Probeware</li> <li>● Design</li> <li>● Analysis</li> </ul> |



|                           |  |   |
|---------------------------|--|---|
| <p><b>E</b>ngineering</p> | <p><b>The Engineering Design Process:</b></p> <ul style="list-style-type: none"> <li>● Ask</li> <li>● Imagine</li> <li>● Plan</li> <li>● Create</li> <li>● Experiment</li> <li>● Improve</li> </ul> <p><b>CTE Standards:</b></p> <ul style="list-style-type: none"> <li>● <b>Standard 1: TECHNOLOGICAL DESIGN:</b> Design, modify, and apply technology to effectively and efficiently solve problems</li> </ul>   | <ul style="list-style-type: none"> <li>● Design</li> <li>● Optimize</li> <li>● Research</li> <li>● Plan</li> <li>● Construct</li> <li>● Experiment</li> <li>● Modify</li> </ul>                 |
| <p><b>M</b>athematics</p> | <p><b>Math Process Standards:</b></p> <ul style="list-style-type: none"> <li>● Communication</li> <li>● Connections</li> <li>● Representation</li> <li>● Reasoning and Proof</li> <li>● Problem Solving</li> </ul> <p><b>Math Standards:</b></p> <ul style="list-style-type: none"> <li>● <a href="#">G.GMD.3</a> Use volume formulas for cylinders, pyramids, cones, and spheres to solve problems.</li> <li>● <a href="#">S.ID.2</a> Use statistics appropriate to the shape of the data distribution to compare center (median, mean) and spread (interquartile range, standard deviation) of two or more different data sets.</li> <li>● <a href="#">S.IC.1</a> Understand statistics as a process for making inferences about population parameters based on a random sample from that population.</li> <li>● <a href="#">S.IC.6</a> Evaluate reports based on data.</li> </ul> | <ul style="list-style-type: none"> <li>● Measurements</li> <li>● Graphing</li> <li>● Calculating rates (e.g. water flow rates, nitrification, growth rates)</li> <li>● Data Analysis</li> </ul> |

**GLOs:**

- **Self-directed Learner:** The ability to be responsible for one's own learning
- **Community Contributor:** The understanding that it is essential for human beings to work together
- **Complex Thinker:** The ability to demonstrate critical thinking and problem solving
- **Quality Producer:** The ability to recognize and produce quality performance and quality products
- **Effective Communicator:** The ability to communicate effectively
- **Effective and Ethical User of Technology:** The ability to use a variety of technologies effectively and ethically

**STEM Competencies:****Students will:**

- collaborate and make positive contributions to the group toward identifying and achieving task goals
- consistently assess the group's progress and encourage others to use scientific investigation, a mathematical approach, appropriate technology, and engineering principles towards achieving their goal
- clearly describe and/or create the learning goal(s) for the performance or product
- engage in scientific inquiry and engineering design processes to produce clear and coherent ideas, creative solutions, and defensible arguments
- gather relevant information from multiple sources and media, determine their reliability, and draw evidence from information
- persist in optimization of a performance or product until the desired outcome is achieved with maximum efficiency
- explain and justify design choices and the trade-offs inherent in those choices
- reflect upon their product or performance
- apply content knowledge and skills to solve real life problems and be able to explain or demonstrate and evaluate how their product or performance meets or exceeds HCPS
- use technical drawings, graphic images, models, symbols, and/or language to gather and organize (synthesizes and analyzes) data/information; convey ideas/ innovations to an audience; and interact with others
- incorporate new technologies, understands how new technologies are developed, and possesses skills to analyze how new technologies affect Hawai'i, our nation, and the world

Aquaponics is a large-scale project that can be used to stimulate inquiry and develop problem-solving skills. There are many standards across content areas that can be integrated into the curriculum. The suggested Lesson Sequence below is a sample with actual time frame and lessons to be determined by individual teachers.

**Lesson Sequence**

| Lesson Title/Description  | Time Frame     |
|---|----------------|
| <p>Sustainability</p> <p>Students conduct internet research on: What is sustainability? How does Hawaii get most of its food? How does Hawaii fulfill its energy needs?</p>   | 1 wk           |
| <p>Photosynthesis &amp; Respiration</p> <p>Students learn reactions through classroom lectures and laboratory investigations.</p>   | 3 wk           |
| <p>Interdependence and Nutrient Cycling (Nitrogen)</p> <p>Students use results from photosynthesis/respiration lab to infer interdependence in nature. Internet research on nutrient cycling.</p>   | 1 wk           |
| <p>Design Aquaponics System</p> <p>Students conduct internet research into aquaponics systems already used. Then use a drafting program (sketchup or 3D CAD) to design a system, including initial plans for energy supply, fish density, plant density, water volume and flow rates.</p> | 2 wk           |
| <p>Construct Aquaponics System</p>  | 3 wk           |
| <p>Digital “How To Set Up Aquaponics System”</p>  | 1 – 2 wk       |
| <p>SIP and EDP process used to :Optimizing Fish Density, Plant Density, Water Volume and Flow Rates, etc.</p>   | 2 wk – ongoing |

**Aquaponics**  
**Seven-Step Standards-Based Instructional Plan**  
**Grade 9-10**

**1. CONTENT AREA STANDARDS AND BENCHMARKS**

**Science Standards:**

- **Standard 1: The Scientific Process: SCIENTIFIC INVESTIGATION: Discover, invent, and investigate using the skills necessary to engage in the scientific process**
  - **SC.BS.1.1-1.9** – Scientific Inquiry
- **Standard 2: The Scientific Process: NATURE OF SCIENCE: Understand that science, technology, and society are interrelated**
  - **SC.BS.2.1-** Explain how scientific advancements and emerging technology have influenced society
  - **SC.BS.2.2-** The student: Compares risks and benefits (e.g., in terms of the impact on populations, resources, health, disease, environment) of alternative solutions to a specific current technological issue (e.g., biotechnology).
- **Standard 3: Life and Environmental Sciences: ORGANISMS AND THE ENVIRONMENT: Understand the unity, diversity, and interrelationships of organisms, including their relationship to cycles of matter and energy in the environment**
  - **SC.BS.3.1-** Describe biogeochemical cycles within ecosystems
  - **SC.BS.3.2-** Explain the chemical reactions that occur in photosynthesis and cellular respiration that result in cycling of energy
  - **SC.BS.3.3-** Explain how matter and energy flow through living systems and the physical environment
  - **SC.BS.3.4-** Explain dynamic equilibrium in organisms, populations, and ecosystems; explain the effect of equilibrium shifts.

**Math Standards:**

- [G.GMD.3](#) Use volume formulas for cylinders, pyramids, cones, and spheres to solve problems.
- [S.ID.2](#) Use statistics appropriate to the shape of the data distribution to compare center (median, mean) and spread (interquartile range, standard deviation) of two or more different data sets.
- [S.IC.1](#) Understand statistics as a process for making inferences about population parameters based on a random sample from that population.
- [S.IC.5](#) Use data from a randomized experiment to compare two treatments; use simulations to decide if differences between parameters are significant.
- [S.IC.6](#) Evaluate reports based on data.

**CTE Standards:**

- **Standard 1: TECHNOLOGICAL DESIGN:** Design, modify, and apply technology to effectively and efficiently solve problems

**Language Arts Standards:**

- [9-10.W.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.
- [9-10.SL.4](#) Present information, findings, and supporting evidence clearly, concisely, and logically such that listeners can follow the line of reasoning and the organization, development, substance, and style are appropriate to purpose, audience, and task.
- [9-10.SL.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.
- [9-10.RH.7](#) Integrate quantitative or technical analysis (e.g., charts, research data) with qualitative analysis in print or digital text.
- [9-10.RST.9](#) Compare and contrast findings presented in a text to those from other sources (including their own experiments), noting when the findings support or contradict previous explanations or accounts.
- [9-10.WHST.4](#) Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience.

**Engineering:**

- Engineering Design Process

**GLOs:****What will this add to the students' experiences in addition to the science benchmarks?**

- **Self-directed Learner:** The ability to be responsible for one's own learning
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**STEM Competencies:**



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**BIG IDEA(S)**

- Develop an understanding of sustainability and explain how aquaponics systems contribute to local sustainability.
- Life cycles of plant, animals and microorganisms in an aquatic system and the importance of nutrient cycling within an ecosystem.

**Essential Questions:**

- What is sustainability?
- What is an aquaponic system?
- What organisms make up the community in the system?
- What role do plants, animals and microbes play in the aquaponic system and are those the same roles from natural ecosystems?
- How do organisms in the aquaponic system as well as in natural ecosystems depend on each other?

**2. CRITERIA**

- Explain how scientific concepts apply to an aquaponic system, including:

- Interdependence
- Photosynthesis
- Respiration
- Nutrient Cycling
- Producers/Consumers
- Food Chains
- Design experiments to improve nutrient cycling.
- Illustrate the N-cycle and identify the role plants, animals and bacteria have in the Nitrogen Cycle.
- Use appropriate probes to make measurements of variables important for aquaponics systems. Including: NH<sub>3</sub>, NO<sub>2</sub>, Dissolved O<sub>2</sub>, Temperature, pH.
- Use appropriate technology to analyze, present and communicate results.
- Research Designs of operational aquaponics systems.
- Design an operational aquaponics system using sketchup or 3D CAD that incorporates pumps, hoses and tanks and optimizes nutrient cycling.
- Plan- list all the materials required to construct the aquaponics system.
- Construct an operational aquaponic system that has fish, plant, and microbial communities.
- Communicate learning by creating a digital presentation on “How To Set Up an Aquaponic System.”
- Experiment on aquaponics variables to maximize plant and/or fish growth. For example, water volume, flow rate, plant density, fish density and types of plants.
- Modify aquaponic system to improve nutrient cycling based on experimental results.
- Students will use a variety of math problem solving skills during design, implementation and improvement stages. Including: making and interpreting graphs, calculating tank volumes, flow and cycling rates exchange, calculating the rate of nitrification, and data analysis.

## **2. EVIDENCE**

### **Observations:**

- Effective Group Contributor

### **Products:**

- Research on aquaponics and sustainability
- Computer-generated design of Aquaponics System
- Functioning Aquaponic System
- A completed lab report on nutrient cycling investigation

- A short essay identifying and explaining the roles of the organisms in the aquaponic system and describing the interdependence of the aquaponics community

### **ASSESSMENTS (FORMATIVE)**

- A short essay describing how Hawaii fulfills its energy and food needs. The essay will also include a section about what aquaponics is and how it could help Hawaii be self sustainable. Students will also conduct research on aquaponics systems that are found locally and write an opinion piece for or against the use of aquaponics using at least two resources to support their opinion.
- A short assignment where students list the animal(s), the plants, and the microbial communities present in the aquaponic system. Followed by a short description of the interdependent nature of the organisms in aquaponic system as well as in natural ecosystems.
- Check computer design of system and plan of required parts.
- Review/Monitor aquaponics system construction.
- Proper use of probes along with an understanding of what is being measured and why will be demonstrated by students.
- Inquiry into nutrient cycling will be monitored in stages of completion checking question to be answered, how to answer (experimental design) and conclusions.

### **EVALUATION (SUMMATIVE)**

- Experimental Results presented in written and oral formats
- Functioning aquaponic system
- The completed video
- The system has been redesigned and modified based on experimental results
- An exam testing the students understanding of sustainability, photosynthesis, respiration, interdependence and nutrient cycling

### **3. LEARNING EXPERIENCES** (Lesson Plan)

**What evidenced-based learning experiences will address student needs, interests, and learning styles? What sequence of strategies and activities will support students in meeting the selected goal(s)?**

- Students conduct Internet research focused on answering the questions: What is sustainability? How does Hawaii get most of its food? How does Hawaii fulfill its energy needs?
  - Students use the information gathered to write a short paper regarding sustainability in Hawaii.
- Photosynthesis & Respiration

- Students learn about the biochemical reactions through classroom lectures and laboratory investigations.
- One lab focuses on cellular respiration of yeast.
- Another studies photosynthesis and respiration by aquatic plants and snails.
  
- Interdependence and Nutrient Cycling (Nitrogen).
  - Students use results from photosynthesis/respiration lab to infer interdependence in nature.
  - Students conduct Internet search on nutrient cycling. Can use [http://www.windows2universe.org/earth/Life/nitrogen\\_cycle.html](http://www.windows2universe.org/earth/Life/nitrogen_cycle.html) as a resource for Nitrogen Cycle.
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### **3. Learning Experiences (Lesson Plan)**

#### **Materials:**

- PowerPoint presentation: Aquaponics Introduction

#### **Handouts/Other Resources:**

- Interdependence Worksheet

#### **Teacher Background Information:**

##### *1. What is aquaponics?*

- In an aquaponics system, one of the components is a hydroponic bed wherein crops are grown with the use of nutrient enriched solution. The other component is a tank or aquarium wherein fish are grown. These two systems coexist and depend on each other for growth.
- As the fish grow, they excrete ammonium and other waste matter. This water needs to be changed frequently so that the fish can survive and flourish in clean water. In a conventional aquaculture setting, the dirty water is generally disposed of, which is a great waste of a precious natural resource and invaluable plant nutrient.
- An aquaponics system uses the waste matter from the fish. Bacteria convert the toxic ammonium to nitrite and then to nitrate. Nitrate is the primary source of nitrogen for plant growth.
- Over time, this water must be replaced with new nutrient-rich water, so that the plant growth can be continued at a normal pace. This is where the nutrient-rich water from the fish tank comes in.

● After being treated with bacteria, this water is passed on to the hydroponic section, where it replaces the water that is depleted of nutrients. The nutrient-free water from the hydroponics section is not usable by the plants, but it is safe for the fish because it is free of waste matter and other nutrients that become toxic to the fish. This water is sent to the fish tank, where it stays until it becomes riddled with fish waste again. The same process is then repeated, wherein the fish waste is converted to plant nutrients and supplied to the plants and the tank water is replaced by wastewater from the hydroponic area.

● Aquaponics has several advantages over independent hydroponics and aquaculture systems. It provides a harvest of plants as well as fish, all without the need for soil. There is no waste involved because of the continuous recycling that goes on. Aquaponics systems function on less water as well, because additional water is only required when sizable amounts of moisture are lost to evaporation.

## 2. *What is the difference between hydroponics and aquaponics?*

● **Hydroponics** and **aquaponics** are both soil-free methods of cultivating crops. The major difference between the two methods is that aquaponics integrates a hydroponic environment with aquaculture, the process of cultivating fish. Aquaponics combines hydroponics and aquaculture in a controlled environment, to create a balanced ecosystem that benefits crops as well as the fish. Hydroponic systems must add large amounts of fertilizers to the water. Aquaponics does not since the fish provide the fertilizer and the bacteria convert it to a form that plants can use.

● Read more:

<http://www.doityourself.com/stry/the-difference-between-hydroponics-and-aquaponics#b#ixzz2HhXmgiuQ>

### **Procedure:**

1. T-Chart: Ask students, "What are the elements of an Aquaponics system? Record answers on T-chart.
2. Show students the Aquaponics Introduction PowerPoint and go through the slides.
3. Pass out student worksheet to students and project on Elmo (or create a chart paper of same material), going through all of the elements together.
4. Refer back to the original t-chart and have students clear up initial misconceptions of the elements of an aquaponics system. On the right side of the t-chart, fill in correct elements.

5. Have students reflect on what they learned about aquaponics in their Science Notebook. Students need to title their work, Aquaponics Overview, and include a diagram (with labels) of what an aquaponics system looks like. Students will also write about the necessary elements of an aquaponics system. Students will also glue in their Interdependence Worksheet.
6. Students will create a food chain and food web that includes plants, fish and bacteria living in the system as well as others (e.g. humans, slugs, rats).
7. Reflections: Science Journaling in Science Notebook - see Lesson for Science Notebook Rubric

Suggested Entries for Science Journal:



- Explain how food chains and food webs can be traced back to plants.
- Describe how an organism's behavior is determined by its environment.
- Choose one organism in an aquaponics system and describe how its behavior is determined by its environment.
- Describe the cycle of energy among producers, consumers and decomposers in an aquaponics system and how they are interdependent.


Name \_\_\_\_\_

Date: \_\_\_\_\_

### Interdependence Worksheet

1. How do the different organisms (living things) in your aquaponic system depend on each other? Fill in the table to assist you in answering this.

| Organism  | What's the role?<br>Producer, consumer or<br>decomposer? | What do they need<br>from others to live? | How do they get it? | What do they do for<br>the others? | Where do they get<br>their energy? |
|---|--|---|---------------------|------------------------------------|------------------------------------|
| Fish<br>    |  |   |                     |                                    |                                    |
| Plants<br> |  |   |                     |                                    |                                    |

|   |  |  |  |  |  |
|---|--|--|--|--|--|
| Bacteria<br> |  |  |  |  |  |
|---|--|--|--|--|--|

2. Pick at least 3 living organisms near your home and describe how they are interdependent with each other and other living things.

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**Interdependence Worksheet (with possible answers)**

1. How do the different organisms (living things) in your aquaponic system depend on each other? Fill in the table to assist you in answering this.

| Organism | What role do they play?<br>Producer, consumer or decomposer? | What do they need from others to live?                                     | How do they get it?                            | What do they do for the others?                                    | Where do they get their energy?   |
|----------|--|--|--|--|---|
| Fish     | <i>Consumer</i>  | <i>O<sub>2</sub><br/>Food<br/>Remove Wastes<br/>Ammonium &amp; Nitrate</i> | <i>Air Pumps/algae<br/>People<br/>Bacteria</i> | <i>Supply Ammonium</i>   | <i>Food that is given by us, that originally came from plants using the sun's energy and animals eating those plants.</i> |
| Plants   | <i>Producer</i>  | <i>CO<sub>2</sub><br/>Light<br/>Nitrate</i>                                | <i>Air<br/>Sun<br/>Fish and Bacteria</i>       | <i>Remove Nitrate<br/>Give O<sub>2</sub> &amp; food for humans</i> | <i>Sun through photosynthesis</i>   |
| Bacteria | <i>Decomposer</i>  | <i>Need Ammonium</i>   | <i>Fish Waste</i>                              | <i>Convert Ammonium to Nitrate</i>                                 | <i>From waste product of fish, ammonium and organics in solid wastes</i>  |

2. Pick at least 3 organisms living near your home and describe how they are interdependent with each other and other living things.

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- Design Aquaponic System.
  - Students conduct Internet research into aquaponic systems already in use.
  - Then use a drafting program (sketchup or 3D CAD) to design a system, including initial plans for fish density, plant density, water volume and flow rates.
  
- Construct Aquaponic System.
  - Build system collaboratively with CTE partner.
  
- Students record and edit setup to create a digital “How To Set Up Aquaponic System” guide.
  
- Students design experiments to improve nutrient cycling to optimizing fish and plant yields.

#### **4. TEACH AND COLLECT EVIDENCE OF STUDENT LEARNING**

**Does instruction connect with students’ prior knowledge? What does the evidence (formative) indicate about the student’s progress?**

Note: Analysis of summative assessments implemented in the Evaluate phase of this learning.

Points for teacher to notate:

- What did the students understand?
- What did the students not grasp? How do I know?
- What needs to be done for next time or after this lesson?

Notes for my own reflection:



## **5. ANALYZE STUDENT WORK TO INFORM INSTRUCTION OR USE DATA TO PROVIDE FEEDBACK**

**Is there enough work to make a judgment about the student's level of proficiency? What further support is needed?**

Points for teacher to notate:

- In terms of instruction, what worked? What needs to be changed?
- What additional idea could I use next time?
- Were the materials sufficient for the investigation, for the amount of student? What changes would I make for next time?
- Did each part of the instruction provide adequate learning opportunities for the students?

Notes for my own reflection:

## **6. EVALUATE STUDENT WORK AND MAKE JUDGMENT ON LEARNING RESULTS AND COMMUNICATE FINDINGS**

**What is the level of proficiency most recently demonstrated by the student?**

Points for teacher to notate:

- Does the level of proficiency match or go beyond the expectations of the benchmarks?
- Does this work represent a culmination of the student's learning?
- Will this work be a major consideration for the chapter, unit, and/or quarter?

Notes for my reflection:

## **7. RE-PLAN, RE-TEACH, OR REPEAT THE PROCESS**

Points for teacher to notate:

- What does the student data say about their understanding of the learning targets?
- What do students still need to learn, or what misconceptions do they have?
- What instructional strategies do I now need to implement to address the students' needs?
- How do I revise my instructional plans for future implementation?

Notes for my reflection: