

Water Quality

Adapted from: This is an original activity from Environmental Science 250: Environmental Education.

Grade Level: Intermediate

Duration: No limit

Setting: Classroom

Summary: Students will be able to evaluate the water quality parameters necessary for tilapia to thrive.

Objectives: Students will draw on knowledge of how waste is recycled within the aquaponics system, and conduct tests for proper conditions within their tank, including temperature, pH, dissolved oxygen, ammonia, nitrite and nitrate.

Vocabulary: Temperature, pH, ammonia, dissolved oxygen

Additional Materials (Included in Module):

- Nitrification Cycle Worksheet
- Crossword Puzzle
- Aquaponics Quiz
- Ammonia Test Kit
- Testing Procedure Handout
- Scenario Worksheet

Additional Materials (NOT Included in Module):

- pH Test Kit
- Dissolved oxygen Test Kit
- Waste Water Container
- Deionized water
- 1 cup

ACADEMIC STANDARDS

Mathematics Pre K – High School

- 2.1 Numbers and Operations
 - A Counting and Cardinality
 - D Ratios and Proportional Relationships
 - E The Number System
 - F Number and Quantity
- 2.4 Measurement, Data, and Probability
 - A Measurement and Data

English Language Arts Pre K – 5

- 1.1 Foundational Skills
 - Print Concepts
 - Phonological Awareness
 - Phonics and Word Recognition
 - Fluency
- 1.2 Reading Informational Text
 - Key Ideas and Details
 - Craft and Structure
 - Integration of Knowledge and Ideas
 - Vocabulary Acquisition and Use
 - Range of Reading
- 1.5 Speaking and Listening
 - Comprehension and Collaboration
 - Presentation of Knowledge and Ideas
 - Integration of Knowledge and Ideas
 - Conventions of Standard English

English Language Arts 6 – 12

- 1.2 Reading Informational Text
 - Key Ideas and Details
 - Craft and Structure
 - Integration of Knowledge and Ideas
 - Vocabulary Acquisition and Use
 - Validity of Sources
 - Range of Writing
- 1.5 Speaking and Listening
 - Comprehension and Collaboration
 - Presentation of Knowledge and Ideas
 - Integration of Knowledge and Ideas
 - Conventions of Standard English

Reading in Science and Technical Subjects 6 – 12

- 3.5 Reading
 - Key Ideas and Details
 - Craft and Structure
 - Integration of Knowledge and Ideas
 - Range and Level of Complex Texts

Background

Students will be informed that they are going to learn about how the aquaponics system works, how to create conditions tolerable for tilapia, and participate in water quality testing. Students will be asked what they know about aquaponics and how the class system will recycle waste. Teachers will clarify or strengthen answers and hand out a diagram illustrating how fish waste in the form of ammonia is converted to substances beneficial for plant growth. Students will be guided through the diagram using an illustration on the board, filling in information in the blanks provided.

Students will be informally assessed for prior knowledge about proper conditions for raising fish: what kinds of conditions should we monitor in order to maintain a healthy tank? Through scaffolding, teachers will “fill in the blanks,” informing students of conditions they may not have come up with on their own. They will then be informed that they will be measuring temperature, pH, dissolved oxygen, and ammonia for their aquaponics system.

Students will then be asked to hypothesize about tolerable **temperature** for tilapia. They will then be told the actual range and learn why it is important to monitor the temperature of the system. They will learn that tilapia can survive in water temperatures between 75 and 94 °F, but at higher temperatures they start to reproduce. We want to keep temperatures on the lower end of this range in order to prevent reproduction.

Students will be asked if they can explain **pH**. After answers are clarified, they will then be informed that pH is how acidic or basic your water is, on a scale from 0 (extremely acidic) to 14 (extremely basic). Fish will be happiest somewhere in the middle of the spectrum. Students will be asked to brainstorm a short list of items they're familiar with that are acidic or basic.

The class will then be informed that fish, like us, need oxygen to breathe, so it is important to measure the amount of **dissolved oxygen** within the tank.

Students will be asked to reflect on sources of waste in the system. They will then be informed that one component of waste is in the form of **ammonia** (NH₃), which is excreted through the gills and urine. They will be informed that ammonia is toxic in high quantities, so it is important to make sure there is not too much in the system.

Day 2:

The students will be introduced to the bacteria that converts ammonia into nitrites and the bacteria that converts nitrites into nitrates, which are then used to help plants grow. They will fill in the remaining blanks on their worksheet and on the board, and review how the nitrogen cycle as a whole functions. They will be asked to speculate on why we would test for these substances, and what the optimal range might be. They will be reminded of previous handouts for guidance

Overview

Students will be able to evaluate the water quality parameters necessary for tilapia to thrive. To complete this evaluation, they will draw on knowledge of how waste is recycled within the aquaponics system, and conduct tests for proper conditions within their tank, including temperature, pH, dissolved oxygen, and ammonia.

Procedure

The class will learn that they will be measuring these parameters every-other week and recording them on a class data sheet to be referred to when teachers are fixing and caring for the system. Teachers will then select a class volunteer to record the data collected during this period on the class data sheet.

One student sitting near the tank will then be asked to read the temperature and the class recorder will record this measurement on the data sheet. Students will then be asked to reflect on whether or not the temperature is within the tolerable parameters of 75 and 94 °F.

As a class, students will observe a demonstration on pH testing. For this demonstration, two students will be selected to assist. Each student observing will receive a direction sheet and be required to guide the assistants through the testing process. When the test is complete, the comparator will be passed around so everyone can agree upon the results. The result will then be recorded onto the class data sheet and students will be asked if the result is within the tolerable parameters (6 – 8).

The class will then be divided into two groups, allowing half of the class to become experts on dissolved oxygen testing and half to become experts on ammonia testing. They will then be asked to teach each other when they test these parameters in the future.

Within each group, two to three volunteers will assist in the testing demonstration while the remaining students read the step-by-step procedures. One teacher will be stationed in each group to help guide students through the process. The third teacher will walk around, helping students and making sure students are focused. Once each group has completed their test, results will be recorded on the class data sheet and students will compare results to the tolerable parameters (D.O. 3 – 10 mg/L; Ammonia 0 - .03). If there is time, two students from each group will switch places and tell the other group what they did, explaining the process and answering any questions.

During the time that students are waiting for the results of the test, they will be introduced to various scenarios they could encounter with the aquaponics system. They will be given different scenarios that could indicate undesirable/unhealthy water parameters. They will brainstorm possible explanations for given situations and complete a worksheet once they come to the proper solution.

Day 2:

Students will complete the protocols for nitrate and nitrite testing, guided by the teacher. Volunteers will be chosen at random to participate in the testing, while the rest of the class will be required to read off the directions from their worksheets, checking each step as they instruct the volunteers.

In one of the periods of waiting during the testing process, students will complete a crossword puzzle that reviews some of the key concepts from the two lessons on water quality. This will review some of the important terms and ideas without making it repetitive. Students will do the worksheet independently.

During the second waiting period the students will complete a short quiz individually, in order for the teacher to easily gauge their understanding of the details regarding how the aquaponics system works, and information from the food miles and sustainability lessons. After each student is done with the quiz, the class will discuss the answers and teacher will guide them

towards corrections, if necessary. They will learn that it is necessary that they know these things, because it will be their responsibility to test for temperature, pH, dissolved oxygen, ammonia, nitrates and nitrites without the assistance of the teachers.

After the nitrite and nitrate tests are complete and students have finished the crossword puzzle and quiz, the teacher will clarify any other questions that the students may have about any activity from this lesson.

Discussion

As a class, students will be asked if they have any clarifying questions about the tests they performed. Teachers will stress that it is important for them to understand the processes, for they will be required to test these conditions every-other week for the rest of the year. They will be informed that next week they will learn how ammonia is converted into beneficial compounds to feed plants and learn to test for these parameters.

Evaluation

Students will complete multiple worksheets, as well as a short quiz.

Extensions and Modifications

The activity functions as a stand-alone introduction to water quality testing.

Notes (Please write any suggestions you have for teachers using this activity in the future)