

**PBL Unit Title:** Algae in the Aquarium

**Primary Subject Area:** Biology

**Interdisciplinary Areas also Covered:** English, Algebra I, and Computer Technology Skills

**Grade/Age Level:** 10<sup>th</sup> Grade

**Description of students' role and problem situation:** Students have been given the task of determining the cause of an algal bloom in the classroom aquariums.

**Educational Objectives: (Indicate if unit is interdisciplinary, but only list the objectives from primary subject area)**

- ◆ The learner will develop an understanding of the physical, chemical, and cellular basis of life.
- ◆ The learner will develop an understanding of the continuity of life and the changes in organisms over time.

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**School Name:** Smithfield-Selma High School

**School Location:** Smithfield, North Carolina



# From the Desk of the Principal

To: Mrs. Debevec

From: Dr. Woodard

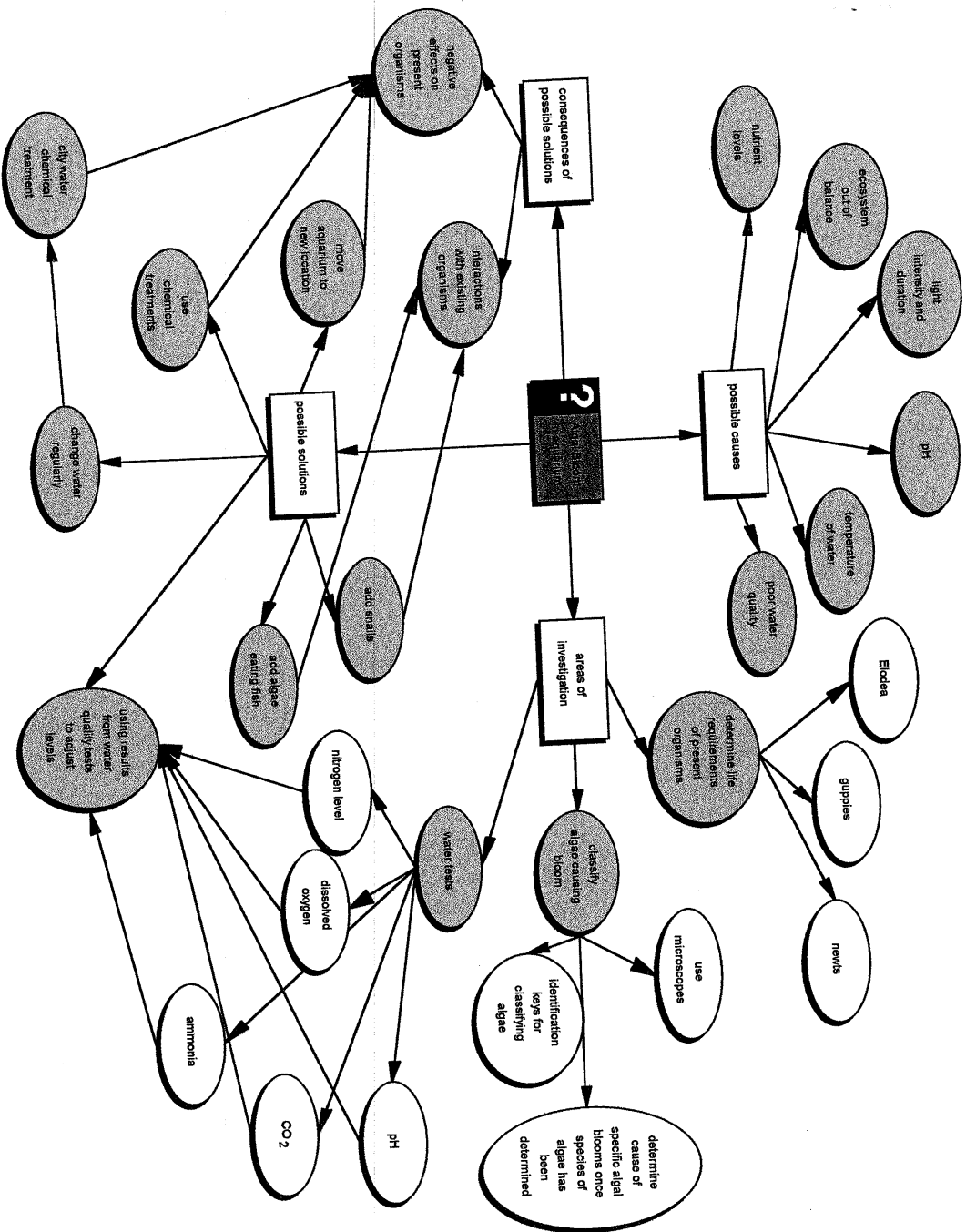
A handwritten signature in black ink, appearing to read 'D.W.' or similar initials.

Date: September 20, 2002

Re: Classroom aquariums

Recently I made a walk through inspection of all the classrooms in preparation for the October 25 visitation by the School Board and County Commissioners. I was very disturbed to note the condition of the aquariums in your classroom. I know that you are extremely busy but I do expect that your classroom materials to be maintained including these aquariums. You need to clear up the algal problems I could not help but notice in them before the visitation. Do not take down the tanks since these visitors have expressed a desire to see working science classrooms. As you know, I was once a science teacher and I believe that your Honors Biology students can benefit if this is turned into a class project to determine the cause of the algal blooms and work to remedy the situation. It will be a great learning experience for them and an opportunity for our visitors to see that our students are involved in hands on activities.

I will be checking back with you to see the progress your students have made.



### **Know**

1. There is an algae problem in the aquariums.
2. Dr. Woodard wants the problem taken care of.
3. On October 25, the School Board and County Commissioners are visiting the school.
4. There are fish (guppies) present. \*\*
5. There are live plants (Elodea) present.\*\*
6. There are 2 newts in each aquarium.\*\*
7. The water is green with algae.\*\*
8. Each aquarium has a light.\*\*
9. All the aquariums are located on the lab counter by the window.\*\*
10. Each aquarium has a filter.\*\*
11. The aquariums are not to be taken down.

\*\* from observations of aquariums

### **Need to Know**

1. The species of algae inhabiting the tank.
2. Available chemicals to kill algae.
3. The effects of chemicals on fish, newts, and live plants.
4. The temperature of the water.
5. The pH of the water.
6. How long the lights are left on for each aquarium.
7. Species of organisms that eat algae.
8. How these algae eating organisms interact with present fish, newts, and live plants.
9. What caused the algal blooms.
10. Possible methods of preventing and controlling algae growth.
11. What substances, i.e. fish food, and amounts are added to aquarium on a daily basis

## **Biology Standard Course of Study**

Competency Goal 1: The learner will develop an understanding of the physical, chemical and cellular basis of life.

1.01 Analyze the matter-energy relationships of living and non-living things including:

- Chemical processes and regulatory mechanisms of cells.
- Bonding patterns.
- Energy use and release in biochemical reactions.

1.02 Describe the structure and function of cell organelles.

1.04 Assess and explain the importance of water to cells, as well as transport into and out of cells.

1.06 Analyze the bioenergetic reactions:

- Aerobic respiration.
- Anaerobic respiration.
- Photosynthesis.
- Chemosynthesis.

Competency Goal 2: The learner will develop an understanding of the continuity of life and the changes of organisms over time

2.02 Compare and contrast the characteristics of asexual and sexual reproduction.

Competency Goal 3: The learner will develop an understanding of the unity and diversity of life.

3.02 Classify organisms according to currently accepted systems.

3.03 Determine the form and function of organisms including:

- Organ systems of animals.
- Functional systems of plants including: transport, reproduction, and regulation.

3.04 Compare and contrast the processes of reproduction, growth, development, and regulation of major phyla of organisms.

3.05 Determine the internal and external factors that influence the growth and development of organisms.

Competency Goal 4: The learner will develop an understanding of ecological relationships among organisms.

4.02 Identify the interrelationships among organisms, populations, communities, ecosystems, and biomes.

4.02 Analyze the cycling of matter: water, carbon, and nitrogen in systems.

4.05 Assess and explain human activities that influence and modify the environment:

- Global warming.
- Human population growth.
- Pesticide use.

Competency Goal 5: Students will develop an understanding of the behavior of organisms, resulting from a combination of heredity and environment.

5.01 Evaluate the survival of organisms and suitable adaptive responses to environmental pressures.

## **Algebra I Standard Course of Study**

Competency Goal 3: Patterns, Relationships, and Functions - The learner will graph and use relations and functions to solve problems.

3.02 Identify properties and relationships of data in tables, graphs, and equations.

3.03 Define and distinguish between relations and functions, dependent and independent variables, domain and range.

Competency Goal 4: Data, Probability, and Statistics - The learner will collect and interpret data to solve problems.

### **English Language Arts Standard Course of Study 10<sup>th</sup> grade**

Competency Goal 1: The learner will react to and reflect upon print and non-print text and personal experiences by examining situations from both subjective and objective perspectives.

Competency Goal 2: The learner will evaluate problems, examine cause/effect relationships, and answer research questions to inform an audience.

### **Computer Technology Skills Standard Course of Study**

Competency Goal 3- Science: The learner will use a variety of technologies to access, analyze, interpret, synthesize, apply, and communicate information.

Objective 1: Use scientific instruments to perform experiments.

Objective 2: Use appropriate technology tools to efficiently collect, analyze, and display data.

Objective 3: Use electronic resources for research.

Objective 4: Use spreadsheets and/or data bases to collect, record, analyze, and present data.

Objective 5: Select and use technology tools for class presentations.

Significant learner characteristics of Honors Biology students:

1. extremely grade conscious
2. competitive
3. materialistic
4. proficient in using technology
5. social
6. out of touch with current events
7. creative at times
8. dependent on each other for motivation and academic support

How can we as Biology students determine the cause of the algal bloom in our classroom aquarium and implement a solution in such a way that we

1. produce noticeable improvement in the aquarium
2. do not detrimentally affect existing organisms-plant and animal-in the aquarium
3. prevent a future algal bloom, and
4. do so in the time allowed.

## Reference List

- Algae in a planted tank. [http://www.csd.net/~cgadd/aqua/art\\_plant\\_algae.htm](http://www.csd.net/~cgadd/aqua/art_plant_algae.htm)
- Brody, Michael J. & Patterson, B. Patricia. (1992). All about Aquaculture. Science Teacher, 59(2), 36-41.
- City Water Plant Supervisor, Town Utilities.
- DeFilippo, Shirley. (1975). Aquarium problems: How to solve them. Science Teacher, 42(5), 56-57.
- Everything about algae. <http://dupla.com/e025.htm>
- Hargrove, Maddy. (1999). Aquariums for Dummies. New York, New York: IDG Books Worldwide, Inc.
- Jones, Barry. (1986). A Fishkeeper's Guide to Aquarium Plants. Morris Plains, New Jersey: Tetra Press.
- Wickham, Mike. (1998). The Complete Idiot's Guide to Freshwater Aquariums. New York, New York: Howell Book House.

### Capstone Performance

The students in each group are required to prepare an oral presentation for their classmates, Dr. Woodard, and the visiting School Board members and County Commissioners to demonstrate the research and experimentation they have accomplished in controlling the algae growth in their aquarium. The oral presentation is to be 8-10 minutes in length with an additional 5 minutes for questions from the audience. Each group is to prepare a PowerPoint slide show to accompany their oral presentation. The oral presentation and PowerPoint slide show must show the areas of research the group covered in order to reach their proposed solution, any tests done and the data from them, the proposed solution path, and the outcome(s) of implementing their solution. Photos of their progress taken with the digital camera are to be included in the PowerPoint slide show. Each member of the group must have a speaking part in the oral presentation. In completing the PBL problem and preparing the presentation, the students will demonstrate that they have met the objectives included on the attached Curriculum Alignment. The students will be assessed by the teacher, Dr. Woodard, and selected members of the visiting team on the oral presentation and PowerPoint slide show. Members of each group will assess themselves and the other group members on their individual contribution to the overall performance of the group.

## Capstone Performance Assessment Rubric

<u>Vocal Quality</u>	Rate of speech, volume, articulation, and enthusiasm good in all members (as demonstrated by teacher previously) <b>5 points</b>	Rate of speech, volume, articulation, and enthusiasm good in most members <b>3 points</b>
<u>Attire</u>	All group members appropriately dressed- no jeans or T-shirts <b>5 points</b>	Most group members appropriately dressed <b>3 points</b>
<u>Body Language</u>	Eye contact, posture, and body movements used effectively by all group members (as demonstrated by teacher previously) <b>5 points</b>	Eye contact, posture, and body movements used effectively by most group members <b>3 points</b>
<b>Response to questions</b>	All group members respond well to questions <b>5 points</b>	Most group members respond well to questions <b>3 points</b>
<u>Participation</u>	All group members have an equal speaking part, teamwork evident in presentation <b>5 points</b>	Some group members dominate speaking part, teamwork not evident <b>3 points</b>
<u>Time</u>	Presentation stays within time restriction (8-10 minutes) <b>5 points</b>	Presentation either too short (less than 8 minutes) or too long (over 10 minutes) <b>3 points</b>
<u>Slide Show</u>	Well organized, used effectively to illustrate logical progress of investigation <b>20 points</b>	Lacks organization, not used effectively to illustrate logical progress of investigation <b>10 points</b>
<u>Solution Path</u>	Evident, well thought out, supported by specific research details <b>25 points</b>	Not as evident, lacks specific research details <b>15 points</b>
<u>Content/Concepts</u>	group demonstrates thorough understanding of scientific concepts <b>25 points</b>	group does not demonstrate thorough understanding of scientific concepts <b>15 points</b>

**Grading rubric for Individual Work**  
 Name of Student being Assessed \_\_\_\_\_  
 Name of Student Assessing the student \_\_\_\_\_

	possible points	points assessed
Came to the group each day prepared to work	5	
Completed all individual tasks for the group with high quality.	5	
Completed all individual tasks for the group on time.	5	
Participated in a constructive manner.	5	
Encouraged others to participate in a constructive manner.	5	
Was a good listener.	5	
Shared the responsibility in helping the group get the job done on time.	5	
Promoted positive relationships between group members.	5	

*How to determine the number of points to give*  
 5 points= This statement is 100 % true, student did an outstanding job  
 4 points= the statement is generally true, student did a good job  
 3 points = Ok job, but the statement does not accurately reflect the contributions of the student  
 2 points= fair job, much more could have been done by the student to match the statement  
 1point = the statement is basically untrue for this student, poor job  
 0 points= the statement is 100 % false, the student did not contribute to the groups

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## Coaching Questions

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### Meeting the Problem

- C 1. Define algal bloom.
- M 2. What you are asked to do?
- EC 3. How is this problem like one you or someone outside this classroom may face at some time?

### Know/Need to Know Board

- C 1. What living organisms are in the aquarium?
- M 2. Where can you look to find out what causes algal blooms in an aquarium?
- EC 3. Why is it important to know if chemicals that kill algae will affect the live plants in the aquarium?

### Writing Problem Statement

- C 1. How much time do we have before the visitation by the School Board and County Commissioners?
- M 2. What do we need to do after we clear up the algae problem?
- EC 3. Have you considered the needs of the fish and newts in this situation?

### Information Gathering & Sharing

- C 1. Which water tests are available?
- M 2. Now that you know the amount of dissolved oxygen in the water is important, what is the next step?
- EC 3. How can we verify that the location of the aquarium is the cause of the algae problem?

### Generating Possible Solutions

- C 1. How many water tests have you conducted?
- M 2. Can more than one factor be causing the algae problem?
- EC 3. Does this solution address the cause of the algae problem? How?

## Alternative Solutions

	<b>Pros</b>	<b>Cons</b>	<b>Consequences</b>
<b>Strategy A:</b> Use of chemicals (algaecides) to clear up aquarium	1. convenient, easy to use 2. quick results 3. will kill algae suspended in the water 4. no other variable to consider in determining if solution worked or not	1. does not address the underlying cause of the algae problem 2. can get expensive 3. may harm live plants 4. one must be careful not to overdose the aquarium	1. The use of algaecides can cause the death of live plants whose remains will settle to bottom of aquarium. The decay of this material can lead to oxygen depletion and result in a fish kill. 2. Use of the algaecides can result in a clear tank but in a few weeks, the algae problem can reoccur.
<b>Strategy B:</b> move the aquarium away from window, add snails and algae eating fish, change water regularly, and test water regularly	1. no algaecides used 2. focus on the cause of the algae growth 3. less stressful to fish and newts 4. no worry about long range consequences of using chemicals	1. one must be careful of the chemicals added to the city tap water used for the water changes 2. snails will also feed on live plants 3. slower visible results 4. can get a population explosion of snails	1. Eventually the aquarium will have a balanced ecosystem within the aquarium, resulting in a controlled algae growth. 2. The aquarium may not be clear of visible algae by the time the School Board and City Council visit.

**Preferred Solution:** Strategy B is my preferred solution because it causes the students to be more actively involved in the aquarium problem. The students go beyond the task of clearing up the aquarium and have to focus on determining the cause of the algae growth. Strategy A will work in clearing up the problem but I want the students to realize that chemical treatments can have unknown and unpredictable consequences down the road.

## Debriefing Session

All students will be present for the oral presentations. Any absent students can view the PowerPoint presentations prepared by each group. During the presentations, all students will complete a pro/con worksheet for each group presentation. The students will be instructed prior to the presentations that they are judging the quality of the solutions proposed by each group not the quality of the presentation. In the class period following the oral presentation, a group discussion will be held to evaluate each group's solution. Students will be asked to share the information they wrote down on their worksheet while listening to the presentations. A student scribe will be chosen to write the pros and cons for each solution on the board. After all the pros and cons have been listed on the board, I will use coaching questions to help the students determine the advantages and disadvantages of each solution. Then the students will be asked if one solution alone is the "best" solution to the algae problem or if a combination from several groups would be best. Students will be asked to orally defend their opinions. As the discussion proceeds, I will use more coaching questions to have the students look for important issues that were or were not addressed by the groups. Together, the students and I will generate one "best" solution that covers all the important issues. After this discussion, I will address any concepts that were overlooked by the students.

Possible coaching questions to be used during the debriefing session:

1. What did this group determine was the cause of the algae growth?
2. Did this group's solution address this cause? How?
3. What are the strengths of this solution?
4. What are the weaknesses of this solution?
5. How did your group determine this was the best solution?
6. What were the observed consequences of this solution?
7. What were unanticipated negative consequences of this solution? What could have been done to foresee and prevent these consequences?
8. What issues did your solutions overlook?
9. What would you have done differently? Why?
10. What experimental procedures for gathering data did you use? What ones could you have used that you did not?
11. How does this solution address the needs of the live plants?
12. How will the additional animals impact the aquarium ecosystem?
13. How will the additional animals interact with the existing populations of animals and plants?
14. How can we combine the strengths of each solution into one "best" solution?
15. Is it possible to create one "best" solution? Why or why not?

Pro/Con Worksheet

**Solution**

**Pros**

**Cons**
