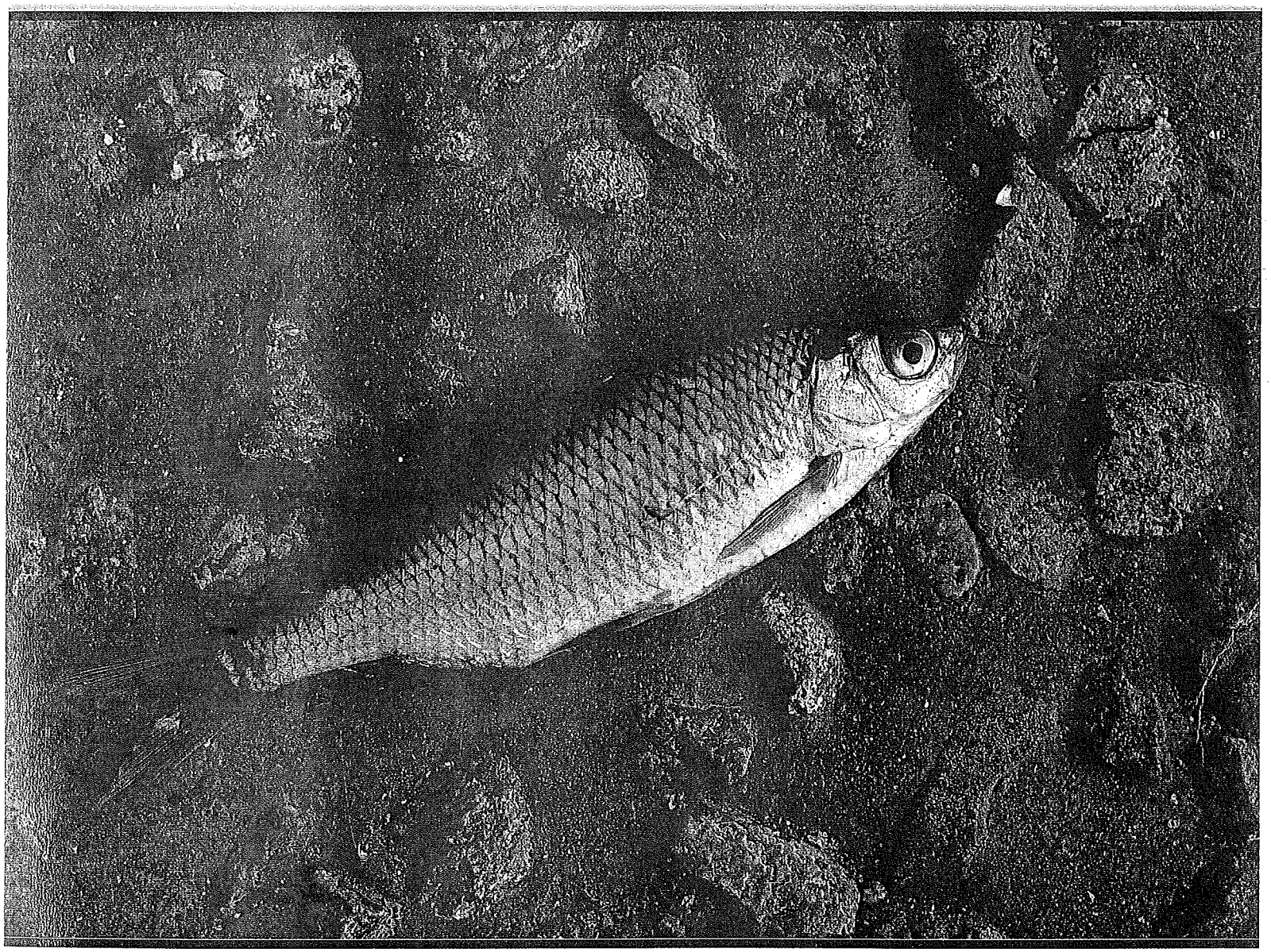
Something Fishy

Exploring an Aquatic Ecosystem



Second Edition

CENTER FOR GIFTED EDUCATION
The College of William & Mary

Unit Introduction

Something Fishy is a problem-based science unit designed for high-ability learners that has been successfully used with all learners in a wide variety of settings, from pullout programs for high-ability learners to traditional heterogeneously grouped classrooms. It allows middle school students to explore an aquatic ecosystem in a novel way, namely through the process of grappling with an ill-structured, real-world problem.

Because the unit is problem-based, the way in which a teacher implements the unit will necessarily differ from the way in which most traditional science units are used. Preparing for and implementing problem-based learning requires time, flexibility, and a willingness to experiment with teaching strategies.

Rationale

This unit has been designed to introduce high-ability students in sixth through eighth grade to ecology and the impact of pollution on ecosystems by means of an examination of an aquatic ecosystem. The problem-based learning format was chosen to allow students to acquire significant science content knowledge in the course of solving an interdisciplinary, real-world problem. This format requires students to analyze the problem situation, to discover and select information that applies to the problem solution, and to obtain that information in a variety of ways. In addition to research, students, with teacher facilitation, will conduct experiments of their own design to generate useful data and to formulate possible solutions. This problem-based method allows students to model the scientific process and to examine multiple interconnections. Finally, the overarching scientific concept of systems provides students with a framework for the analysis of both their experiments and the problem as a whole.

Implementation Time

The total time required for completion of *Something Fishy* is a minimum of 45 hours, with more time required for additional activities and lessons.

Assessment

Something Fishy contains many assessment opportunities that can be used to monitor student progress and assess student learning. Opportunities for formative assessment include:

- The student's Problem Log is a written compilation of the student's thoughts about the problem. Most lessons contain suggested questions for students to answer in their Problem Logs. Students should also use their Problem Logs to record and store data and new information they have obtained during the course of the unit.

- Other metacognitive forms are used to help the student explain his/her solutions to particular parts of the problem.
- Teacher observation of student participation in large- and small-group activities is another opportunity for ongoing assessment.

Opportunities for summative assessment include:

- The final resolution activity involves a small-group presentation of a solution for the unit's ill-structured problem. The quality of the solution will reflect the group's understanding of the science involved as well as the societal and ethical considerations needed to form an acceptable solution.
- Final post-assessments allow the teacher to determine whether individual students have met the objectives related to systems, science content, and science process skills listed in the Curriculum Framework at the beginning of the unit.

Appendix E, Suggested Rubrics, includes suggestions for assessing experimental design process skills, connections to the systems concept, oral presentations, and persuasive writing.

Books

Student books are available for purchase to provide students an opportunity to record information about the problems as they progress through the units.

Included in the student books are the Problem Log Questions, Student Brainstorming Guides, Experimental Design Diagrams, Student Experiment Protocols, and Student Laboratory Reports, along with the Glossary and Laboratory Safety Precautions.

The books are designed to be consumable.

Words to the Wise Teacher:

The unit you are about to begin, *Something Fishy,* consists of 18 lessons; the unit requires a minimum of 45 hours of instruction. A letter for parents is included that you may wish to send home with your students or use as a template for your own letter to be distributed before beginning the unit. The letter describes the goals of the curriculum as well as ways parents can supplement the unit at home.

The unit includes many opportunities for students to participate actively in solving a real-world problem. Some of these activities involve homework that supplements class work; others involve research conducted in a library/media center or online. Please read the unit before beginning to teach so that you have a sense of when you might need materials and assistance from your media specialist.

Handouts for the unit are included, as well as some background information on various topics. A separate notebook or Problem Log is required for each student. A materials list at the beginning of each lesson notes specific items for that lesson; however, you may wish to procure additional items depending upon the outcomes of sessions with your students.

Several methods for assessing student progress are indicated in the unit. Assessments ask students to demonstrate understanding of the unit concept within the relevant context. Writing activities include essays, a research project, and Problem Log responses throughout the unit. Finally, post-assessments are included that may be used to compare student achievement at the conclusion of the unit to their knowledge at the beginning.

A section providing some implementation guidelines and the key teaching models of the unit follows the lesson plans. Teachers are encouraged to read this section and, if possible, to attend an implementation workshop about the units. Contact the Center for Gifted Education for more information.

The Center for Gifted Education thanks you for your interest in our materials!

Alignment to National Science Education Standards and Benchmarks for Science Literacy

Category of Standard	*Something Fishy*	National Science Education Standards	Benchmarks for Science Literacy
Concept	Students will be able to: 1. Analyze systems, 2. Use systems language; 3. Analyze systems interactions; 4. Make predictions based on systems thinking; 5. Transfer system concept to new systems.	A system is an organized group of related objects or components that form a whole. Systems have boundaries, components, resource flow (input and output), and feedback. The goal of this standard is to think and analyze in terms of systems. Prediction is the use of knowledge to identify and explain observations, or changes in advance.	Systems: 1. Consist of many parts; the parts usually influence one another. 2. May not work as well if a part is missing, broken, worn out, mismatched, or misconnected.
Content/ Topics	Students will be able to: 1. Explore the scientific topic of aquatic ecosystems; 2. Understand the importance of oxygen content to aquatic systems; 3. Determine the level of oxygen present in an aquatic system; 4. Investigate factors that maximize algal growth; 5. Determine the nature and source of pollutants; 6. Suggest solutions to the given problem from various stakeholders' perspectives.	Physical Science: 1. Students will develop the understanding of properties of objects and materials. Life Science: 2. Students will develop understanding of organisms and environment. Science in Personal and Social Perspectives: 3. Students will develop an understanding of science and technology in local challenges.	Nature of Mathematics: 1. Mathematical ideas can be expressed graphically. Technology & Science: 2. Measuring instruments can be used to gather accurate scientific comparisons. Structure of Matter: 3. When a new material is made by combining two or more materials, it has different properties. Interdependence of Life: 4. Changes in an organism's habitat are sometimes beneficial and sometimes harmful.

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Alignment to National Science Education Standards and Benchmarks for Science Literacy *continued*

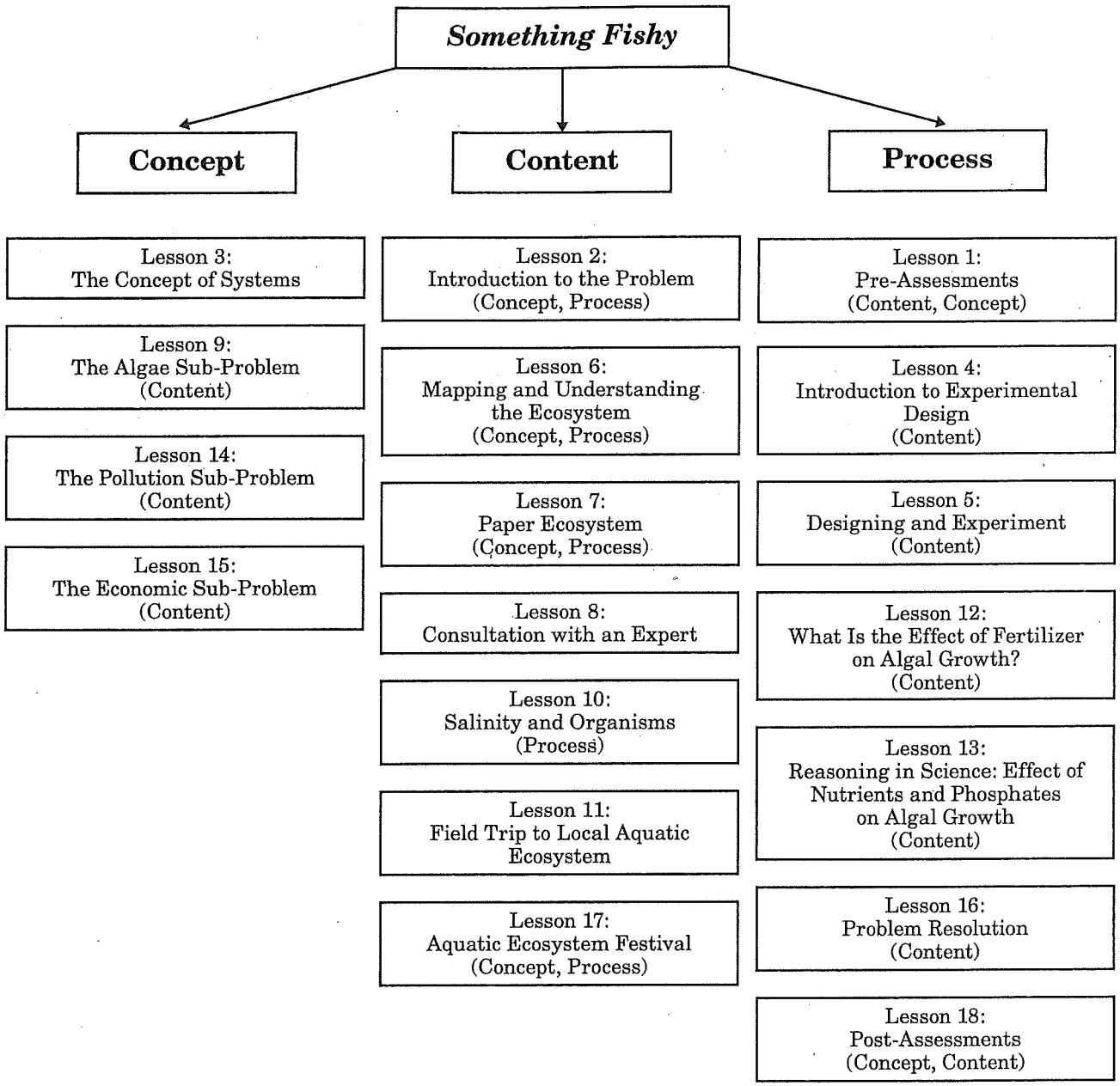
Category of Standard	*Something Fishy*	National Science Education Standards	Benchmarks for Science Literacy
Scientific Processes	Students will be able to: 1. Design, perform, and report on the results of experiments; 2. Demonstrate good data handling skills; 3. Analyze experimental data as appropriate; 4. Transfer knowledge to make predictions about similar problems; 5. Communicate understanding to others; 6. Identify meaningful scientific problems for investigation.	Students will be able to: 1. Ask a question about objects, organisms, and events in the environment; 2. Plan and conduct a simple investigation; 3. Employ simple equipment and tools to gather data and extend the senses; 4. Use data to construct a reasonable explanation; 5. Communicate investigations and explanations.	Students should know that: 1. Scientific investigations may take many different forms; 2. Results of similar investigations seldom turn out the same; 3. Scientists' explanations come from observation and thinking; 4. Claims must be backed up with evidence; 5. Clear communication is an essential part of doing science.

Something Fishy Curriculum Goals

1. Concept	2. Content
Goal 1: To understand the concept of systems	**Goal 2:** To understand the nature and properties of aquatic ecosystems
Curriculum Outcomes	
Students will be able to 1. Analyze the problem system and a local aquatic system; 2. Articulate in oral and written form how and why systems work, using appropriate systems language such as boundaries, elements, input, and output; 3. Demonstrate how given systems interact with each other (e.g., real-world and experimental); 4. Predict the impact of multiple solutions to the given problem within each system; 5. Generalize systems knowledge across problems; 6. Assess how human systems change over time based on needs, resources, and circumstances.	**Students will be able to** 1. Explore the scientific topic of aquatic ecosystems; 2. Understand the importance of oxygen content to aquatic systems; 3. Determine the level of oxygen present in an aquatic system; 4. Investigate factors that maximize algal growth; 5. Determine the nature and source of pollutants; 6. Suggest solutions to the given problem from various stakeholders' perspectives.
3. Process/Experimental Design	**4. Process/Reasoning**
Goal 3: To understand and apply the principles of basic experimental design	**Goal 4:** To develop reasoning skills with application to science
Curriculum Outcomes	
Students will be able to 1. Design, perform, and report on the results of experiments related to a given problem; 2. Demonstrate good data handling skills; 3. Analyze experimental data as appropriate; 4. Evaluate experimental results; 5. Transfer knowledge to make predictions about similar problems; 6. Articulate enhanced understanding of the scientific area to others.	**Students will be able to** 1. Infer the benefits or detriments of aquatic ecosystem management to the local community; 2. Discover and appreciate the problems inherent in aquatic ecosystem protection and management; 3. Reason about situations or events that require attention; 4. Recognize stakeholders and the varying points of view they represent.

Lesson Organizational Chart

This chart is a graphic depiction of the curriculum framework as it is incorporated within the lesson plans. Each lesson is listed under the heading of the primary type of goal that is covered (concept, content, or process).



Introduction to the Problem

2

Instructional Purpose

- To introduce students to the initial problem statement
- To begin using problem-based learning

Curriculum Alignment

- ● Goal 1 — Concept
- ● Goal 2 — Content
- ● Goal 3 — Process/ Experimental Design
- ○ Goal 4 — Process/ Reasoning

Vocabulary

Assumption Conclusions based on one's own beliefs and presuppositions

Materials/Resources

- Chart paper
- Markers
- Initial Problem Statement (Handout 2.1)
- Need to Know Board (Handout 2.2)
- Problem Log Questions (Handout 2.3)

Lesson Length

Two 60-minute sessions

Activities Session 1

1. Read the **Initial Problem Statement** (Handout 2.1) to students. Have students identify key words and phrases as they organize the elements of the problem. Use the **Need to Know Board** (Handout 2.2) to help students identify what they know and what they need to know.
2. Make a large copy of the **Need to Know Board** on chart paper. Organize the problem statement into three categories on the **Need to Know Board:** What Do We Know, What Do We Need To Know, and How Can We Find Out. Prioritize the Need to Know list from most to least critical.

3. Debate reasons for prioritizing choices. Ask students to identify resources that will help them answer or further investigate the elements of the Need to Know list. Divide the learning issues among students so that each student (or a different group of students) will bring different information to the class in the following session.
4. **Ask:**
   - What's going on?
   - What are we supposed to do?
   - What seems to be the main problem?
   - Is this a problem specific to the restaurant?
   - Why might sea trout be unavailable at the restaurant?
   - Where else might they go to find sea trout?
   - Are there other problems?
   - Where can we find the answers to these questions?

Activities Session 2

1. Have students report the information that they found. Look back over the Need to Know list and identify: (1) what questions they have answered and (2) what new questions arise out of their new information. Next, ask students what they are going to need to know in order to solve the problem. Prioritize the list based on negotiations with students.
2. **Ask:**
   - What questions are answered by the new information?
   - What questions do we still need to answer?
   - What new questions do you have?
   - What are the things we may have to learn about to solve the problem?
   - Is the problem different today than it was yesterday?
   - How are we going to solve this problem?
3. Have students answer the **Problem Log Questions** (Handout 2.3) in their Problem Logs.

Assessment

- Completed **Need to Know Board**
- Active and appropriate participation in group and class discussions
- **Problem Log Questions:** Students should use information from the class discussion to frame their answers.

Technology Integration

Often these **Need to Know Boards** are originally done on large chart paper and placed throughout the room. One way to incorporate technology into this activity is to use a computer. Students can serve as the "computer recorders" to improve their skills in word processing. A word processing format that incorporates a table works well for this activity. Using a computer to capture the information is a viable way to record and distribute it to students. In other sessions, when information is added to or subtracted from the board, changes can be captured in the computer version as well. A projection system can make the computer pages visible to all. Be sure to save the older versions of the **Need to Know Board** each time changes are made; it may at some time be helpful to go back to earlier versions to review information.

Handout 2.1

Name Date

Initial Problem Statement

Julie and Josh Miller's grandfather has come back to Virginia for one of his periodic visits. While eating with the family in Sam's Restaurant in the Phoebus section of Hampton, Grandfather Miller is very upset to find that sea trout is no longer on the menu.

"I came here to eat sea trout because Sam is the only one who can prepare it the way it should be cooked! Let me talk to Sam about this!" exclaims Grandfather Miller. When informed that Sam is on vacation in Florida, Grandfather becomes more angry and it is with great effort that the Millers convince him to settle for flounder stuffed with crab meat instead of sea trout.

Julie and Josh are understandably upset by these events. Wondering why sea trout is not available for their grandfather, they decide to investigate.

You are Julie and Josh's science teacher; they are your favorite students. They've come to ask for your help in their investigation. How can you help Julie and Josh?

Handout 2.2

Name _____ Date _____

Need to Know Board

What we know . . .	What we need to know . . .	How we can find out . . .

Handout 2.3

Name Date

Problem Log Questions

1. After our initial discussions, what do you think the problem really is?

2. Why do you think this is the main problem?

3. Is it the same problem you thought it was when we first started talking?

continued

4. How has it changed?

5. What are the issues you are most interested in researching?