What

is the

Water

like in our

River ?

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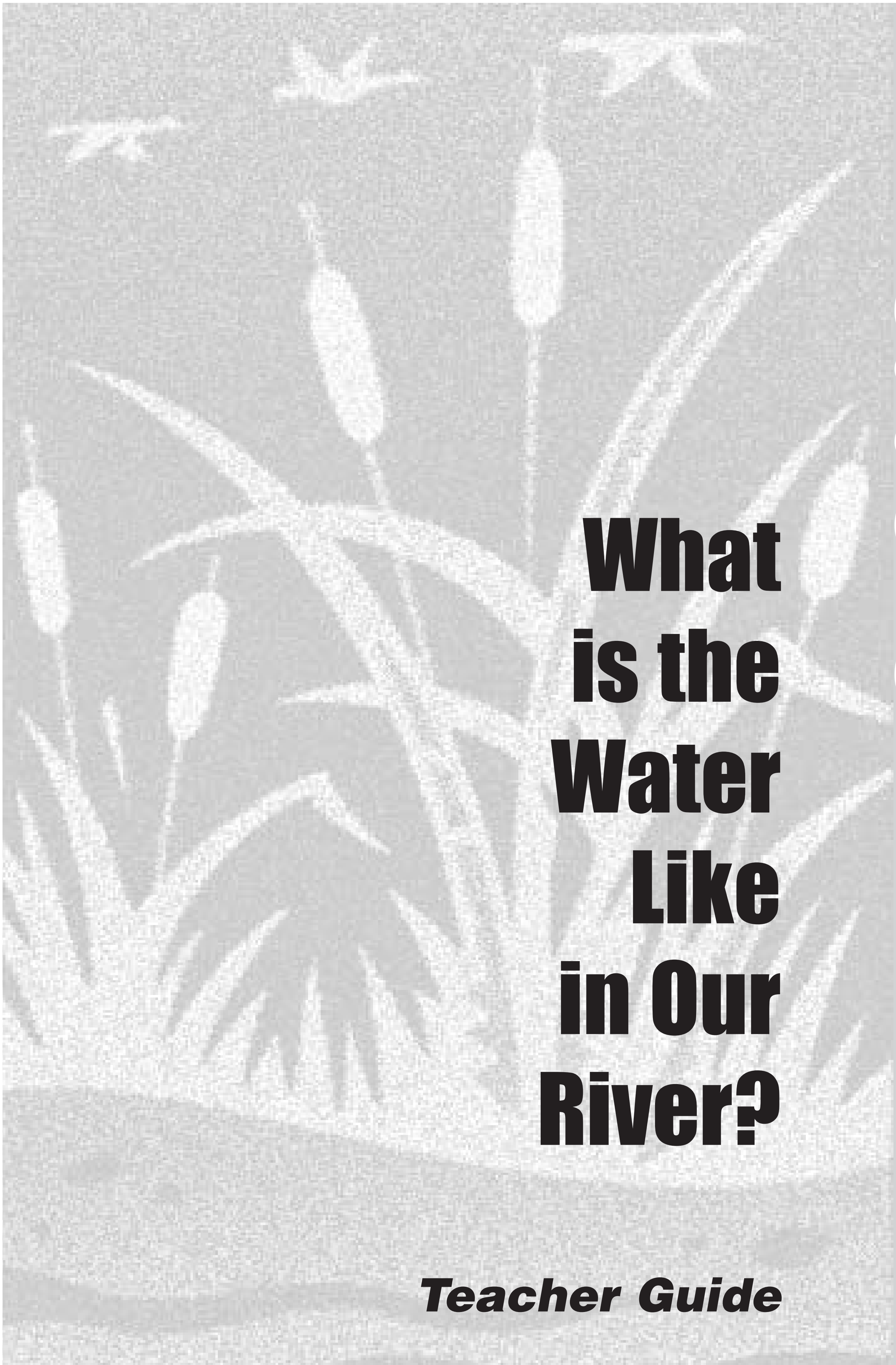

What is the Water Like in Our River?

Teacher Guide

Content

ntroduction

What is the Water Like in Our River?

Project Overview

What is the water like in our river? This question drives student inquiry through out this project. As students investigate water quality a model of their river system they construct and develop an understanding of an aquatic ecosystem. Because students are investigating a river situated in their community, they are naturally led to question what action they can take as an individual and as a community to preserve or improve water quality.

The driving question of this project leads students to investigate watersheds, the movement of water, and relationships among the surrounding landscape and an aquatic ecosystem. When students look more closely at the quality of the water in their river they investigate chemical and physical factors that affect water quality, and the relationship between water quality and biodiversity.

Student understanding is facilitated by students actively engaging with phenomena. During the project, students ask questions, conduct experiments and draw conclusions. Learning is also supported through the construction of physical and dynamic models. Constructing models of their river helps learners integrate each concept into their understanding of aquatic ecosystems. Learning technologies are an integral part of this inquiry process. Specifically, learners use Model-It, a dynamic modeling tool, to construct a model of their aquatic ecosystem. As student understanding grows so does their model. Students continually plan, build, test and evaluate their model based on the inquiry activities they engage in. The use of Model-It is supported through the construction of classroom riverboards. Probes provide an opportunity for the students to collect and visualize real-time data in the field direct from the aquatic ecosystem under study.

The community component of this project is maintained through the involvement of community members, both parents and experts, and the use of articles from local newspapers. The community promotes students' feelings of agency as they begin developing action plans to maintain or improve water quality.

At the conclusion of the project students construct a final artifact. Students choose the format and the focus of their artifact. Using multimedia displays or Model-It, students present their model of how land use or physical or chemical variables affect water quality in their river or how water quality can impact the biodiversity of their river.

Project Calendar

Learning Set One/A Closer Look At Our River

1 class period	Lesson 1/What is Water Quality?
2 class periods	Lesson 2/What Can We Finat at Our River?
3 class periods	Lesson 3/Student Questioning

Learning Set Two/Where is Our River Located?

2 class periods	Lesson 1/Exploring Watersheds
2 class periods	Lesson 2/Analyzing Maps
1 class period`	Lesson 3/Bluilding Computer Models
1 class period	Lesson 4/Planning and Building Relationships
1 class period	Lesson 5/Testing and Evaluation
3 class periods	Lesson 6/Exploring Sream Tables
2 class periods	Lesson 7/Land Cover/Use and Our River
1 class period	Lesson 8/Building and Testing Models
2 class periods	Lesson 9/Fertilizer Investigation
1 class period	Lesson 10/pH Investigations

Calendar continued on next page

Project Calendar/*Cont.*

Learning Set Three/What Iimpacts Water Quality

2 class periods	*Lesson 1/Variables Affecting Water Quality*
1 class period	*Lesson 2/Concluding the pH and Fertilizer Investigation*
1 class period	*Lesson 3/Expanding the Computer Model*
2 class periods	*Lesson 4/Water Testing*
1 class period	*Lesson 5/Analyzing Test Results/Making Conclusions*
1 class period	*Lesson 6/New Relationships With Computer Models*
2 class periods	*Lesson 7/Bioindicators*
1 class period	*Lesson 8/What Do the Organisms Tell Us?*

Learning Set Three/What is the Quality of Water in Our River?

2-4 class periods	*Lesson 1/Final Presentations*

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Pedagogical Statement

Project-based science can be used to answer students' and teachers' questions about the world around them. Benefits from investigating real-world questions have long been touted as a viable educational structure; the roots of the idea go back to John Dewey who is often described as the father of progressive education. Project-based instruction is one example of such learning, where the focus is on students investigating real-world problems that are important and meaningful to them. Because of this focus, project-based science is sensitive to the needs of a diverse group of students with respect culture, race, or gender (Haberman, 1991; Atwater, 1994). The fourth scenario described above is a brief introduction to some of the features of this approach.

Project-based science has several fundamental features, and we discuss these more thoroughly throughout this book. However, to provide you with a brief framework, let's examine some of these features. First, driving questions or problems serve to organize and drive instructional tasks and activities. Second, students engage in investigations to answer their questions. Third, it involves communities of students, teachers, and members of society who collaborate in discourse about the question or problem. Fourth, technology is used by students to investigate, develop artifacts or products, collaborate, and access information. Finally, the result is a series of artifacts or products, that addresses the question or problem. Now, let's briefly discuss each point.

Driving Questions

Science classes should have children explore solutions to questions (NRC, 1996). Project-based science calls for a question or problem that is meaningful and important to learners (Blumenfeld, et. al, 1991; Krajcik, et. al. 1993). We refer to questions that have these characteristics as driving questions. A question such as "What is the pH of rain water in our city?" is an example of what we call a driving question. Such a question serves the purpose of organizing and driving activities that take place in a science class. The driving question is the first step in meeting all of the other key features of project-based science. The question sets the stage for planning and carrying-out investigations to measure the acidity of rain water and testing the impact acid rain has on living and non-living things. Next, technology can be used to investigate this question, because students can use electronic pH meters, and they can find out information about acids and bases on the World Wide Web. As students collaboratively pursue solutions to this question, they develop meaningful understanding of key scientific concepts such as acids and bases, pH, and concentration. Hence, instruction is anchored in real-world situations that students find meaningful and from which questions emerge and students develop deep understandings. Finally, students can develop products, such as posters, to show what they have learned about acid rain in their city.

Students Engage in Investigations

One of the hallmarks of science is that of sustained investigation based on important and meaningful questions. In project-based science, students investigate a question over a longer length of time rather than engage in short term activities or investigations that are out of context from real life situations. Questions such as "What do pets need to stay healthy?" and "Where did the black stuff come from in the bottom of the aquarium?" can provide the basis for long term investigation. These investigations are meaningful to students and therefore keep the students' attention for longer periods of time - - sometimes over the course of the entire school year.

In project-based science classrooms, students find solutions to questions by messing about with ideas, asking and refining questions, finding information, planning and designing, building apparatus, collecting data, analyzing data, making conclusions, and communicating findings.

Communities of Learners Collaborating Together

Project-based science involves students, teachers, and members of society collaborating together to investigate questions. In this manner, the classroom in which project-based learning occurs becomes a community of learners. The use of telecommunication also helps create a collaborative environment by allowing students access to a wider community in which they can communicate with knowledgeable individuals, take advantage of resources others have to offer, communicate with other students in different parts of the world, and share data with other student scientists and professional scientists.

Use of Technology

Technology can help transform the science classroom into an environment in which learners actively construct knowledge (Tinker & Papert, 1989; Linn, 1997; White & Fredrickson, 1995). Using technology in project-based science makes the environment more authentic to students, because students can use the computer to access real data on the Internet, expand interaction and collaboration with others via networks (such as e-mail), use tools to gather data (such as light and heat probes that are plugged into computer ports to conduct experiments), employ graphing and visualization tools to analyze data, and produce multi-media artifacts. Finally, the multimodal and multimedia capabilities of technology not only enhance the physical accessibility of the information, they facilitate its intellectual accessibility as well (Blumenfeld, et. al., 1991).

Artifacts

Because artifacts show what students have learned, they can be used as forms of assessment that show students' deep understanding of science (Marx, Blumenfeld, Krajcik, & Soloway, 1997). Project-based science results in a series of artifacts, or products, that address the driving question and show what children have learned. Often times, teachers have students share their artifacts with other class members, teachers, parents, and members of the community.

The creation and sharing of artifacts serves several purposes. First, artifacts are real and motivating. For example, making a display of appropriate habitats for classroom pets is more realistic and fun than taking a test about animal habitats. The creation and sharing of artifacts also makes science class more like doing real science. Scientists frequently expose their ideas to public scrutiny through the process of publishing and presenting their work at conferences. Presenting an artifact to an audience of peers, professionals, and community members provides a purpose for the investigation and lets students talk with others about their work.

Second, artifacts help students develop and represent understanding. Therefore the development of artifacts is central to a project environment. Because artifacts are concrete and explicit (e.g., a physical model, report, videotape, or computer program) they are shareable and critique-able. Feedback permits learners to reflect upon, extend their understanding, and revise their artifacts.

Third, artifacts allow students to show what they have learned throughout an investigation, and they document broad learning - - sometimes over an entire school year. Because artifacts show learning over time, they show how student understanding develops. For these reasons, artifacts are excellent forms of assessment.

Assessment Statement

We view assessment as "the process of collecting, synthesizing, and interpreting information to aid classroom decision making (Airasian, 1996). Assessments must match the content taught in order for the students to demonstrate what they have learned. The assessments need to consider the learning objectives and the instructional emphasis when they are designed and implemented. Assessments should never include topics or objectives not taught to the students. Assessments can never appraise everything that students learn in class; they can only estimate what students have learned by sampling tasks from a much larger possible range of tasks. We try to address this limitation by giving students several opportunities to show what they have learned through different media (e.g., answering tests and quiz items, completing student sheets, collaborating in groups, presenting projects).

Assessment can include formal and informal assessments. Formal assessments examine products such as written or oral responses (Pellegrino, 2001). According to Pellegrino informal assessments are "intuitive, often subconscious, reasoning teachers carry out everyday in classrooms."

We strive to make all of the assessments formative in nature. According to Black and Wiliam (1998) formative assessments encompass all those activities undertaken by teachers, and/or by their students, which provide information to be used as feedback to modify the teaching and learning activities in which they are engaged. The feedback component of assessments is critical. However, many assessment have to be summative in nature in order to measure what student have learned at the end of some set of learning activities and to assign a grade.

In the LeTUS projects, there are many opportunities for assessment. These include formal assessments like tests, quizzes, artifacts, student sheets, and presentations. These assessments can also be informal and include checks for student understanding like classroom questioning and assessment conversations.

Many assessments require students to select answers to questions, others require them to construct new responses. Because students can respond to constructed response assessments in many different ways, teachers need to present guidance about how they will score answers. We provide this guidance through rubrics. In the LeTUS projects, we have provided rubrics to help students understand how they will be assessed and to provide a tool for teachers to do their assessments. The rubrics in different projects will follow a common set of guidelines, but they will be customized to the specific learning objectives and science content that the project addresses.

Organization of Unit

Driving Questions

This unit is structured around a "Driving Question" -- What is the water like in our river? A Driving Question should be consistent with existing curriculum frameworks, including district and state guidelines; encompass real-world questions that students find meaningful; engage students in inquiry over an extended period; develop in students the knowledge and skills necessary to answer the question.

Learning Sets and Sessions

In this project, the Driving Question is divided into four related sub-questions. Learning Sets are organized around a sub-question that contains related concepts and activities. The purpose of the sub-questions is to facilitate the students in constructing a response that demonstrates their emergent understanding.

Learning Sets last 1-4 weeks each, depending on the complexity of the concepts included in each one. Each Learning Set begins with the purpose of the Learning Set, a calendar, background content information, an overview and detailed lesson plans.

Learning Sets in this project include:

Learning Set 1
A Closer Look at Our River
Learning Set 2
Where is Our River Located?
Learning Set 3
What Impacts Water Quality?
Learning Set 4
What is the Quality of Water in Our River?

Learning Sets are further divided into sessions that include specific activities focusing on a single concept. They provide information about the topic of the Learning Set and, ultimately, the Driving Question. Sessions last 1-6 days and contain detailed plans for enacting an activity.

Icons

Throughout this unit, icons (pictures) are used to represent key aspects of the project, such as teaching strategies, content information, technology, and anchoring experiences. These icons, found in the margins, are meant to help teachers enact the project by highlighting and providing helpful hints.
(See next page).

Icons

PRINCIPLES

Driving Question
The activity relates to the project's Driving Question.

Technology
Indicates when technology is being used.

Inquiry
Components of the inquiry process.

Assessment
Artifacts to be collected and/or evaluated.

Collaboration
Students working together to learn.

Anchoring Experience
Learning event which the students will revisit throughout the Learning Set and/or unit.

SUPPORT

Teaching Strategy
Suggested instructional techniques and classroom organization strategies.

Expected Student Outcome
Possible student answers or questions.

Content Information
Relevant information to the topic for the unit.

Reader
Suggested uses of the student reading material

Objectives and Outcomes

Detroit Public Schools Core Curriculum Outcomes
Content Standards 7th Grade

Explain how rocks are broken down, how soil is formed and how the earth's surface features change. Specific key concepts include: Describe and identify surface features using maps, Great Lakes, and rivers.

Design and conduct a scientific experiment.

Use appropriate tools and techniques to gather, analyze and interpret data.

Michigan Curriculum Framework Science Benchmarks

Standard I.1 Constructing New Scientific Knowledge

All students will ask questions that help them learn about the world; design and conduct investigations using appropriate methodology and technology; learn from books and other sources of information; communicate their findings using appropriate technology; and reconstruct previously learned knowledge.

Standard II.1 Reflecting on Scientific Knowledge

All students will analyze claims for their scientific merit and explain how scientists decide what constitutes scientific knowledge; how science is related to other ways of knowing; how science and technology affect our society; and how people of diverse cultures have contributed to and influenced developments in science.

Strand III. Using Scientific Knowledge in Life Science

Scientifically literate students and adults can use their knowledge to understand the world around them and to guide their actions. Important types of activities that use scientific knowledge include description and explanation of real-world objects, systems, or events; prediction of future events or observations; and the design of systems or courses of action that enable people to adapt to and modify the world around them. In the life sciences, real-world contexts in which scientifically literate people use knowledge are often described in terms of systems and subsystems, such as cells, organisms, and ecosystems.

Standard V.2 The Hydrosphere

All students will demonstrate where water is found on earth; describe the characteristics of water and how water moves; and analyze the interaction of human activities with the hydrosphere.

Generate scientific questions about the world based on observation. (Key concepts: See

Design and conduct simple investigations. (Key concepts: The process of scientific investigations—test, fair test, hypothesis, data, conclusion. Forms for recording and reporting data—tables, graphs, journals.

Use measurement devices to provide consistency in an investigation. (Key concepts: Documentation—laboratory instructions. Measurement units—milliliters, liters, teaspoon, tablespoon, ounce, cup, millimeter, centimeter, meter, gram, nonstandard units. Measurement tools: Balancing devices, measuring cups and spoons, measuring tape.

Use sources of information to help solve problems. (Tools: Forms for presenting scientific information, such as figures, tables, graphs. Real-world contexts: Libraries, projects where research is needed.)

Write and follow procedures in the form of step-by-step instructions, recipes, formulas, flow diagrams, and sketches. (Key concepts: Purpose, procedure, observation, conclusion. Real-world contexts: Following a recipe; listing or creating the directions for completing a task.)

National Science Education Standards

Content Standard A: Science as Inquiry

Abilities necessary to do scientific inquiry

- Design and conduct a scientific investigation.
- Use appropriate tools and techniques to gather, analyze, and interpret data.
- Develop descriptions, explanations, predictions, and models using evidence.
- Think critically and logically to make the relationship between evidence and explanations.
- Communicate scientific procedures and explanations.
- Use mathematics in all aspects of scientific inquiry.

Understandings about scientific inquiry

- Different kinds of questions suggest different kinds of scientific investigations.
- Current scientific knowledge and understanding guide scientific investigations.
- Mathematics is important in all aspects of scientific inquiry.
- Technology used to gather data enhances ccuracy and allows scientist to analyze and quantify results of investigations.
- Scientific explanations emphasize evidence, have logically consistent arguments, and use scientific principles, models, and theories.

Content Standard E: Science and Technology

Abilities of technological design

- Design solution or product.
- Implement a proposed design.
- Communicate the process of technological design.

Understandings about science and technology

* Perfectly designed solutions do not exist.
* Technological designs have constraints.

Content Standard F: Natural Hazards

- Internal and external processes of the earth system cause natural hazards, events that change or destroy human and wildlife habitats, damage property, and harm or kill humans. Natural hazards include earthquakes, landslides, wildfires, volcanic eruptions, floods, storms, and even possible impacts of asteroids
- Human activities also can induce hazards through resource acquisition, urban growth, land-use decisions, and waste disposal. Such activities can accelerate many natural changes.
- Natural hazards can present personal and societal challenges because misidentifying the change or incorrectly estimating the rate and scale of change may result in either too little attention and significant human costs or too much cost for unneeded preventive measures.

Content Standard F: Risks and Benefits

- Risk analysis considers the type of hazard and estimates the number of people that might be exposed and the number likely to suffer consequences. The results are used to determine the options for reducing or eliminating risks.
- Students should understand the risks associated with natural hazards (fires, floods, tornadoes, hurricanes, earthquakes, and volcanic eruptions), with chemical hazards (pollutants in air, water, soil, and food), with biological hazards (pollen, viruses, bacterial, and parasites), social hazards (occupational safety and transportation), and with personal hazards (smoking, dieting, and drinking).
- Individuals can use a systematic approach to thinking critically about risks and benefits. Examples include applying probability estimates to risks and comparing them to estimated personal and social benefits.
- Important personal and social decisions are made based on perceptions of benefits and risks.

AAAS Benchmarks for Science Literacy

The Physical Setting

B. The Earth
8. Fresh water, limited in supply, is essential for life and also for most industrial processes.
11. The benefits of the earth's resources such as fresh water, air, soil, and trees can be reduced by using them wastefully or by deliberately or inadvertently destroying them.

C. Processes that Shape the Earth
7. Human activities, such as reducing the amount of forest cover, increasing the amount and variety of chemicals released into the atmosphere, and intensive farming, have changed the earth's land, oceans, and atmosphere.

Materials

Software and Specialized Equipment

- River video or Virtual tour
- River video/Walk Observation Sheet
- Overhead projector
- Model-It program
- Computers
- Video of water sampling.

Miscellaneous

- 5 large jars with lids or soda bottles with lids
- Butcher block paper
- Markers
- Index cards
- Dot stickers
- 2 or 3 tall objects and 2 or 3 shorter objects
- Large waterproof tin tray
- Piece of transparency film
- Small spray bottle with water
- Newspaper
- Watershed Building Worksheets
- Transparency markers
- Maps includes:

The Great Lakes Topographic Map
is used to show the varying land elevations in Michigan. Then at the end of the session, students use this map to draw the flow of the water from the Great Lakes into the Atlantic.
The Rouge River Watershed Map
is used to predict areas of high, medium and low elevations and the flow of water within various branches of the river system.
The Major Michigan Watersheds Map
is used to map the flow of water from each watershed into the Great Lakes.
The Great Lakes Elevation map
is used to show the relative elevations of each Great Lakes in respect to one another.

Lab Equipment

- Clip, coffee, cocoa, salt, HCl, isopropyl alcohol, potassium permanganate or food coloring, river water
- River tank
  - 1 30 gal aquaria
  - a 1 meter plastic trough or rain-gutter with cap for one end
  - 1 submersible circulating aquaria pump with filter and screen
  - flexible pvc or rubber tubing, 2-3 cm in diameter
  - Sunny window or Florescent plant growth lights
  - saw horses and miscellaneous lumber for supports, hammers, nails, duct-tape
  - battery powered air stones (optional)
  - various river organisms, rocks, gravel, etc.
- Laser disc clip (Science Interaction Laser disc Grade Six)
- 4 water samples of various temperature
- Dissolved oxygen probes
- Stirring rod
- Data from Acid and fertilizer experiments
- Computer probes (dissolved oxygen and temperature)
- 4 water samples of various temperatures
- 30 gallon tank of river water
- 10 Low Cost Water Quality Monitoring Kit
- Ice cube trays or 14 petri dishes, spoons, forceps, turkey baster, magnifying glasses, large shallow light colored pan, gloves, goggles
- Pollution Tolerance Index sheet
- Stream Table pan of earth materials
- Two water supply containers
- 1 waste water catch basin
- 2 wooden slats