Living in Water -- Living in Air

The Physics of Aquatic Animals and their Environment

Overview

Purpose

To enable students to learn principles of physics and biology in more accessible and memorable ways than the standard science curriculum and to inspire teachers to adopt an interactive approach to science education.

Educational Approach

The following methods will be used consistently in each of the exhibits:

1. The exhibits will use three-dimensional interactive experiences.

2. Each exhibit will demonstrate one principle of physics as it relates to the biology of an aquatic animal.

3. Each exhibit will feature one animal.

4. The exhibits will use high-interest animals such as sharks, piranhas, electric fish, whales, and dolphins.

The following methods will be used as appropriate in the exhibits:

5. Exhibit activities will include contrast of aquatic animals to human beings.

6. Exhibit materials/activities will relate the exhibit content to applied science.

7. Exhibit material/activities will relate the exhibit content to careers in which individuals apply these science concepts in their work.

Learning Goals

Through interactions with the exhibits, students will increase knowledge:

A. the basic principles that make living in water different than living in air: density, pressure, viscosity, velocity, and absorption of sound, attenuation of light, electrical conductivity

B. relationships between principles of physics and the basic functions of an aquatic animals such as movement, getting food

C. basic concepts of aquatic biology

D. applications of the principles of physics to the technology people design to function in aquatic environments

E. that all animal species adapt to survive in their environment

Through interpretations of the exhibits, students will increase skills:

A. observing phenomena

B. inferring cause-effect relationships

C. identifying patterns

D. recording data

E. making comparisons

F. making predictions

Note: Skills focus will vary with exhibit content and approach. The entire set of exhibits will provide for the development of the skills listed above.

Exhibit Specifications
Each exhibit will develop specific content and skills applications. A set of learning objectives will be specified for each exhibit. Objectives will be correlated directly to the Benchmarks in science education.

Recommended structure for Exhibit Plans:

Concept/ Principle	Exemplary Animal	Exhibit Format	Activity/ Interaction
Learning Objectives			

NOTE: The learning objectives will be identified based on the Benchmarks for Science, on the exhibit focus, and on the exhibit format. The learning objectives will be accomplished through the interaction with the exhibit, through the teacher's involvement, and through materials provided to prepare for and expand on the exhibit experiences.

Recommended Assessment Approaches

Two kinds of assessment will be conducted to determine the development of students and of teachers:

A. Standard, pre-test and post-test format
B. "Alternative" assessment.

The assessment will include both cognitive and affective development.

Cognitive Outcomes: Students' Development of Concepts, Information, Skills

Students will have the following opportunities to demonstrate their skills and apply the knowledge they gain through the interactions.

Alternative Assessment

The following "alternative approaches" to assessment can be adapted for use as activities integrated into the learning experience as well as culminating activities that can reinforce what has been learned and also be assessed to determine the outcomes.

1. Design an aquatic animal

   Students make "blueprint" for animal, including a "key" identifying features and rationale for them

   Program provides: Activity guide and "rubric" to assess student knowledge.

2. Construct an aquatic animal

   Students make models of the animals they designed.

   Program provides: Recommended materials and activities, "rubric" to assess student knowledge.

3. Make an exhibit to explain the Physics-Biology Connection

   Students plan and present small-scale interactive exhibits that illustrate the same ideas and/or that expand on the ideas they learned

   Program provides: Basic guide to planning an exhibit that illustrates a principle of physics in relationship to an aquatic animal, rubric to assess student knowledge and skills.

4. Write a "big book" for younger children to communicate "The Physics of Aquatic Animals"

Students write and illustrate display-like books for presentation of the exhibit content to younger students.

Program provides: Basic guide to making such a book and rubric to assess student knowledge and skills.

Standard Assessment

A Short-answer and multiple-choice pre-test and post-test will be designed to measure knowledge of concepts and information presented through the exhibits and ability to use skills developed through the exhibits.

Affective Outcomes: Students' Development

Student surveys will be administered to assess students' perception of the content of the exhibits. These surveys will ask students to:

1. Describe aquatic animals.
   Pre-survey and post-survey to determine differences in use of positive terminology.

2. Recommend ways to learn science.
   Ranking of different ways to learn science.

3. Explain how useful physics is.
   Decide what is most useful of what they learned.

Cognitive and Affective Outcomes: Teachers' Development

Teacher surveys rather than pre-tests/post-tests will be administered before and after the experience so that teachers feel they are positively involved in the process. The surveys will combine cognitive and affective items.

The surveys will assess:
A. knowledge of the principles developed through the program
B. knowledge of the benefits of teaching through interactive exhibits
C. ability to plan instruction to integrate physics and biology
D. appreciation for their own gains in knowledge through the program
E. appreciation for the program's approach

Teachers will be asked to assess the program's value to them through items relating to the following three areas:

1. Identify most effective parts of experience.

2. Indicate how much they have increased their own science knowledge.

3. Make a commitment to continue to use the approaches.