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ABSTRACT

Research indicates that the effectiveness of instruction in the elementary classroom is enhanced when it incorporates materials that actively engage students in the generation of scientific explanations. To this end, this document describes an exercise that allows Kindergarten students to explore the basic principles of animal behavior in an interesting and fun way. As part of the activity, students explore the characteristics of terrarium animals, and create and test ideas (alternative hypotheses) about environmental factors that the animals prefer. Along the way, the teacher has an opportunity to introduce several principles of animal behavior, and students have an opportunity to apply them to explain their observations. This lesson is one of a collection of twenty learning cycle-based lessons developed for the Phoenix Urban Systemic Initiative. (Contains 13 references.) (Author/ASK)

TESTING ALTERNATIVE HYPOTHESES ABOUT ANIMAL BEHAVIOR

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ABSTRACT

Research indicates that the effectiveness of instruction in the elementary classroom is enhanced when it incorporates materials that actively engage students in the generation of scientific explanations. To this end, the present exercise allows Kindergarten students to explore the basic principles of animal behavior in an interesting and fun way. As part of this activity, students explore the characteristics of terrarium animals. They create and test ideas (alternative hypotheses) about environmental factors the animals prefer. Along the way, the teacher has an opportunity to introduce several principles of behavior, and students have an opportunity to apply them to explain their observations. This lesson is one of a collection of 20 learning cycles developed for the Phoenix Urban Systemic Initiative.

INTRODUCTION

A primary goal of standards-based instruction in the elementary grades is to engage students in exploratory activities that are real to them so they gain content competency and acquire critical reasoning skills (e.g. National Academy Press, 1998; National Research Council 1990; American Association for the Advancement of Science, 1989). As we implement the National Science Education Standards, our goal is to create lessons that align with multiple standards by promoting science content mastery, understanding of inquiry, and an awareness of the nature of science. We also want lessons which are quick to prepare, fun, and interesting. We have found that the interactive, hands-on learning cycle format best accomplishes these goals. Learning cycles consist of exploratory activities guided by the scientific method in three instructional phases: exploration, term introduction, and concept application (Atkin & Karplus 1962; Karplus & Thier 1967; Lawson 1988, 1991; Lawson, Abraham & Renner 1989; Science Curriculum Improvement Study 1974).

During exploration, students investigate new phenomena that raise questions and enable them to discover patterns in those new phenomena. Term introduction allows teachers to introduce specific terms related to the discovered patterns. The concept application activities enable students to apply newly constructed concepts in contexts that broaden and deepen their understanding.

Effectiveness of the learning cycle method has been assessed across a variety of teaching settings and at all educational levels. A review of more than 60 such studies can be found in Lawson, Abraham and Renner (1989). This review concludes that the learning cycle method is very effective in terms of improving students' attitudes, achievement, and scientific reasoning skills.

The learning cycle has many advantages over traditional instructional approaches, especially when the development of inquiry skills is an important goal. Because many studies have shown that a large proportion of our students have poorly developed inquiry skills, it seems reasonable that the learning cycle deserves more widespread implementation in elementary science classrooms.

But, can the learning cycle method be used to provoke student inquiry in Kindergarten? A recently developed learning cycle designed to do just that starts by posing the descriptive question, "What environmental factors do terrarium animals prefer?" Students intuitively know that all species share many characteristics, but do different animals prefer the same environmental factors as humans? And if so, what are they? To answer these questions, students explore the characteristics of terrarium animals. They create and test ideas (alternative hypotheses) about environmental factors the animals prefer. Along the way, the teacher has an opportunity to introduce several principles of behavior, and students have an opportunity to apply them to explain their observations. This lesson is one of a collection of 20 learning cycles developed for the Phoenix Urban Systemic Initiative.

THE LESSON

Title: What environmental factors do *Isopods* prefer?

Synopsis: Children observe *Isopod* movement in a terrarium and generate questions about why they move. The create and test ideas (alternative hypotheses) about which environmental factors the animals prefer.

Suggested time: 2 - 3 hours.

Materials

soil	magnifiers
Isopods	vegetables (lettuce, carrots, or potato)
large terrarium with lid	ice
water	water dish
rocks	leaf litter

Objectives

1. To design experiments about environmental factors that *Isopods* prefer.
2. To analyze data that separate responses due to chance from responses due to a specific cause.
3. To organize and communicate the reasoning used to come to a conclusion.

Pre-lesson Activity

Establish a terrarium using a water dish, rocks, plants and *Isopods*. Feel free to add to the terrarium any materials you feel are appropriate. Relocate it daily so that there are noticeable differences in the behavior of the animals. Note: you will want to take this opportunity to review safety procedures for working with the terrarium animals.

Engagement Activity

Student observations should provoke questions about the terrarium and behavior of the animals. In a group discussion, ask students what they observe. Write words for their observations on the board or chart paper. Begin with a discussion such as the following, "You may have noticed the little gray "bugs" in our terrarium. Some people call these pill bugs, others call them wood lice or sow bugs. A scientist would call them *Isopods*. *Isopods* are actually animals. They are part of a large group of animals which includes better known members such as crabs, shrimp, and lobsters. If you look closely at an *Isopod*, you will see that it has many legs, a segmented body, and two antennae. Does an *Isopod* have eyes, ears, a nose? They move about and appear to know where they are going. How do *Isopods* sense their environment? Can they see, smell, hear, or communicate with one another?"

Questions used at this stage are important. Research and experience have shown that student hypothesis generation is best facilitated when the teacher asks divergent rather than convergent questions. Divergent questions are open ended and allow students to generate alternative explanations. Ask questions such as the following: "Where are the animals?" "What do you think each animal is trying to do?" "Why?" "What do you think each animal likes (prefers)?" "How could we find out?"

Young learners are likely to suggest that light, water, food, or soil caused the differences in the *Isopods'* behavior. No value judgements should be placed on the varying ideas at this time. Feel free to add to the list any hypotheses you feel have been overlooked. Discuss the students' suggestions. The purpose of this activity is not to arrive at a single "correct" explanation for an observation, but to introduce students to the process of generating and testing alternative hypothetical explanations.

Exploration

Remind children of the central question "What do you think each animal prefers?" Ask students to think of a way to test their ideas (hypotheses). You should also feel free to suggest some tests as well. Some examples of student generated hypotheses and ways of testing them include the following:

Hypothesis: They like to be near food
if... this hypothesis is correct
and... we put food on one side of the terrarium and not the other
then... a majority of the animals should move to the side with the food

Hypothesis: They like the wet dirt
if... this hypothesis is correct
and... we put wet dirt on one side of the terrarium and dry dirt on the other side
then... a majority of the animals should move to side with the wet dirt

Hypothesis: They like the dark

if... this hypothesis is correct

and... we make one side of the terrarium dark and the other side light

then... a majority of the animals should move to the dark side

Have students work in groups. Monitor student understanding by asking them to describe their experimental designs. Provide feedback, but allow them to conduct their experiments as they think best.

After all students have conducted their experiments, bring them together for a group discussion. It is a good idea to list words for the variables tested and summarize results on the board or wall chart (see Figure 1). Discuss, which if any, of the ideas (alternative hypotheses) tested are supported or not supported by the results. Remind students that just because one animal reacts in a particular way does not mean that they all will. To separate responses due to chance from responses due to a specific cause, a majority of the animals must have reacted. If equal numbers of animals were found in both conditions, then they didn't prefer one or the other.

Now introduce and define the term hypothesis if you have not already done so. Explain that the ideas they have been testing are hypotheses. Point out that in science, hypotheses are neither proven nor disproved, merely judged by the results. Indeed, a conclusion may not be agreed to by everyone.

This process models the way science is actually practiced. Some hypotheses are supported. Other hypotheses are contradicted. Over time, therefore, some hypotheses are retained while others are rejected. Some questions that have been raised have not ever been satisfactorily answered. Often, in the course of completing one investigation, many additional questions are raised. Even a supported hypothesis may not be agreed to by all. The process may start all over again when someone else generates another explanation (alternative hypothesis) and figures out a way to test it.

Term Introduction

Bring the group together for a class discussion. Introduce the following terms generated from this lesson: habitat, terrarium, prefer, behavior, *Isopod*, animal, hypothesis, and science. Encourage students to use these terms in subsequent investigations and assignments.

Concept Application

For young learners, ongoing care of animals in the terrarium will serve as an appropriate application for the concepts learned in this lesson. Ask students to maintain the conditions they have found that the animals prefer.

You may also wish to continue your discussion of the experimental results with open ended questions or activities that allow application of the concepts introduced here. For example, you may wish to use suggestions from the list below:

If the data did not support a hypothesis, have students offer an explanation for the results.

Ask students what might be done to improve their experiments for the future. Have them illustrate their ideas.

Have students repeat the experiment using another terrarium animal such as a snail or worm. What similarities do they observe? What differences?

Ask what other questions these results have brought to mind.

Evaluation

Ideally, evaluation of inquiry activities should emphasize both content and process skills. For example, you may wish to use suggestions such as the following:

While the class is engaged in the inquiry activity, observe each student's performance.

Use portfolios to collect products of individual student work such as results of experiments, drawings, stories, self evaluations, or responses to concept application questions.

Observe students as they make presentations to the class, interact with peers, and use computers or classroom materials.

You may also wish to collect examples of group work for evaluation.

CONCLUSIONS:

Research indicates that the effectiveness of instruction in the elementary classroom is enhanced when it incorporates materials that actively engage students in the generation of scientific explanations. To this end, the present exercise allows students to explore the basic principles of animal behavior in an interesting and fun way. As part of this activity, students are asked to evaluate each others' work and resolve inconsistencies. This leads to considerable interaction and class discussion. Collection of individual and group work provides the teacher with opportunities for ongoing assessment and feedback.

Comments from students and teachers indicate that this interactive, hands-on approach is beneficial in learning the topic. For example, one teacher reported that "the students were very excited in trying to carry out their test for what they wanted to do. Lots of excitement and group dynamics as they worked as a team." Another teacher noted "students were engaged, making classroom management easy. Few materials so materials management was no problem," and "they really loved it and felt successful." These comments serve as an excellent indication of how implementing the National Science Education Standards can positively impact elementary students and teachers on a day to day basis. We hope you will try this and other learning cycles with your students.

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FIGURE 1. Format for summarizing results

Name ______________________________ Date _____________

Our Question:

Our idea (*hypothesis*):

Our test or experiment:

Our predicted result:	Our actual result (*data*):

Our conclusion:

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