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Can a Bird Build-a-Beak? Using Inquiry to Address Student Misconceptions about Animal Adaptation

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Can a Bird Build-a-Beak?

Photo by Nathan Ward

Using Inquiry to Address Student Misconceptions about Animal Adaptation

by **Katherine Larson** and **Mandy Kemp**

ABSTRACT: The fifth grade activity presented here is a modified version of a common cookbook approach to teaching animal adaptations. The original activity gave step-by-step directions that provided few opportunities for students to be engaged in deep thinking. In presenting our version of the activity, we make clear the critical role of the teacher in promoting higher order thinking and engagement. This animal adaptation activity helps students understand how the structure of various bird beaks determines the type of food it can successfully acquire and eat. This activity addresses two common misconceptions: that animals choose their adaptations and that animals adapt within their lifetime. This makes clear to students that "No, birds cannot build-a-beak!" *The activity presented here promotes National Science Education Content Standards A and C, as well as Iowa Teaching Standards 1, 2, 3, and 4.*

Animal adaptation is a life science topic addressed in elementary, middle and high school. The topic may be addressed simply from a structure and function perspective, but significant connections can also be made to biological evolution. Animal adaptation lessons may be easily modified into hands-on, heads-on experiences that are relevant to students' local natural environment. Far more than simply manipulating objects and following directions, heads-on experiences require students to think critically, make decisions, and defend those decisions. These mentally engaging concrete experiences are important for helping students understand abstract science ideas (Driver, 1997).

The degree to which an activity is inquiry-oriented depends on several factors such as safety, cognitive difficulty, and where the activity is situated in the academic year. Activities placed at the beginning of the year may have more directions and structure, while retaining the crucial feature promoting student thinking and decision-making. Scaffolds should be appropriately erected to more significant decision-making so that at some time during the school year students investigate a question they have proposed and develop action plans for tackling the question. Achieving this end requires that expectations for student engagement be clear and compelling, and that teachers actively and consistently teach students in a way that promotes thinking and other skills essential in inquiry.

The activity presented here was modified from an experience where students simply follow directions and complete the task without deeply thinking about the science idea addressed. We made modifications that require students to make more decisions and learn about the consequences of those decisions from an organism's perspective. We began by acknowledging some common misconceptions regarding adaptation. One mistaken notion is that organisms purposely decide to biologically adapt to their environment. A second problematic view is that these novel biological adaptations arise during the lifetime of an organism. This activity directly draws out and addresses these misconceptions. The teacher's role is crucial throughout the activity because effective questioning is needed to help students question their previous ideas and consider the scientifically accepted idea. This activity is appropriate for most 5th or 6th grade students and may be completed in one 75-90 minute block of time or in shorter sessions over two to three days.

Beginning with Questions

Begin by asking the class questions such as, “What are some traits/characteristics of birds?” and “How are birds different from each other?” This is important for accessing students' prior knowledge about birds and determining to what extent they have observed birds common to their locality and from other locations. If a significant number of students struggle with these questions, then prior to the activity described below, time should be devoted to having students observe birds and their behavior. Place all students' ideas on the board, while not confirming or denying any contribution, to encourage students to participate in the discussion. This method of putting all students' ideas on the board should be commonplace so that students come to know that their ideas will be respected. The list will likely be lengthy and include suggestions such descriptions of size, color, feet, beak, and form. Students might go beyond describing the characteristics of birds to addressing where they are found.

After having generated these ideas, provide time for students to investigate what birds eat and where they live. Send your students outside! Have them observe birds *prior to* accessing books, videos and the web. The time spent observing actual birds will peak their curiosity and is important for developing the habit of experiencing the natural world.

Modeling Bird Beak Adaptations

In order to help students make the link between a bird's beak structure and its function, now have students take part in an activity where they play the part of birds with different structures trying to acquire available food sources. Prior to class, set up six representations of different food sources (Table 1). Use common household items to model a variety of beaks that the children will possess during the activity. Have enough of these beak models so that all children possess a beak structure.

Suggested items to model bird beaks:

- needle nose pliers
- spatula
- chopsticks
- drinking straw
- regular pliers
- pasta ladle
- tweezers
- clothes pin

Have enough stations so that no more than two children may be at a station. For example, a class of twenty-four will have twelve pairs of students. Thus you will need two sets of the six habitats placed around the room. Appropriately space the different food source stations so that students focus on the task at hand rather than their neighbors. Make clear that organisms are born with particular structures and do not choose their biological features. For that reason, we assign a card to each group rather than permit them to choose a particular structure. On one side of the card is a picture of a particular bird, and on the other side is a picture of the household item that models that particular bird's beak. For instance, a hummingbird might appear on one side of a card and a straw on the other (with directions that the straw must be used by placing it in a substance, putting a finger over the top open end, and drawing it out).

Table 1. Classroom representation of food sources

Aquatic plants	Leaves and small plants in a bucket of water
Insects	Rice grains scattered in a box
Fish	Various suspended materials (rocks, assorted nuts)
Nectar	Water in a narrow graduated cylinder
Nuts	Sunflower seeds with the surrounding shell (ensure that students understand that the food is inside the shell)
Worms	Gummy worms in dirt placed in a bucket

Begin the activity by either assigning or permitting students to choose partners. Inform students that they will be modeling a variety of birds possessing different beak structures. Distribute the cards and then explain that their task is to visit each food source represented by the six different stations and attempt to acquire food using the beak adaptation model illustrated on the back of their assigned card. Explicitly tell students that organisms are born with particular structures and may not choose or alter their structure. Leave open the possibility that students can use their structure in unique ways. For example, one of Darwin's finches on the Galapagos Islands uses a twig, stick or cactus spine in their beak as a tool to dislodge grubs from trees.

For information on tool use by animals, visit:
http://www.stanford.edu/group/stanfordbirds/text/essays/Tool_Using.html
http://www.pigeon.psy.tufts.edu/psych26/tools.htm
http://www.pubmedcentral.nih.gov/picrender.fcgi?artid=1088865&blobtype=pdf
http://www2.unine.ch/webdav/site/ethol/shared/documents/tebbichbshary.pdf

Students are to use the apparatus that models the particular beak structure of their assigned bird to acquire the food sources available at each station. Explain to students that, in pairs, they will visit each station and attempt to acquire food. Ask students questions such as, “What information will likely be important to note at each station?”, “How will you remember that information?”, and “How will you ensure fair tests so that you can compare the success of your beak structure at each station?” These are initiatory questions that will likely require follow-up questions that play off students' responses. The first question is designed to help students consider the importance of making observations about each food source for later comparison. The second question is designed to have students consider the value of recording their information. The third question raises the issue of how students will determine how much food they have collected (number, volume, weight?) and how that will be fairly compared to how much food they have collected at other stations. When students offer that the time foraging for food at each station should be the same, ask how much time is needed to acquire accurate data. Answering these questions may require a few trials. After having conducted some trials, and with effective questions that help students assess when data saturation occurs, students typically decide that one minute collecting food is sufficient for acquiring accurate data. Each student is to take a turn and attempt to collect the food at each station. While one student is attempting to collect food, the partner serves as a timer.

Before having students go to the food stations, address appropriate behavior during the activity. Ask the students to list appropriate behaviors when using the structures and what are inappropriate behaviors. Pose these questions so that students gain an understanding of why certain behaviors are appropriate and others inappropriate. For example, you might ask, “What should be done prior to leaving a station?”, “What precautions should be taken at each station to reduce the need for a cleanup?” and “Why should the assigned apparatus only be used to collect food?”

After students begin the activity, move from group to group observing what they do and listening to what they are saying. Where appropriate, ask questions such as, “How is the device you are using to gather food similar to the beak of the bird on your card?”, “How is the device different?”, “How do you account for the amount of food you were able to gather at this station compared to station…?”, and “What kind of beak structure would be more successful at acquiring this sort of food?”. These questions promote critical thinking, and draw students' attention to the relationship of bird beak structure and function. This is also a good time to address misconceptions the students may have about bird beak adaptation. Walking around and listening to what the students have to say is one way to realize what misconceptions the students have, and in what direction the post-lab discussion needs to proceed. Misconceptions include the view that birds may purposely alter their beaks to better live in particular environments, and the view that a bird's beak structure changes over their lifetime to better fit the environment they are in.

When students have completed the activity and have helped clean and return the materials to their proper place, conduct a class discussion directed at how science works and biological adaptation. Begin by asking students how they chose to organize their data. Place their ideas on the board and after all ideas have been exhausted, ask students to consider the pros and cons of each suggestion. Address the nature of science by discussing with the class that scientists often put their ideas and data into a notebook. This data may look very different from how scientists present their data to other scientists or papers. This can be used to illustrate how public science often appears different than private science. An analogy useful for helping students understand this aspect of private and public science is personal writing in a diary compared to conveying relevant information in that diary to a wider audience. Students would place personal thoughts, ideas and their mistakes in a diary, but much of that information would not be relevant in describing to a general audience what you did during a period of time.

Once the students compromise on a data table format, the students should add all of the data on the board. Ask questions such as, “What do you notice about the data for habitat A?”, “Which beak structures worked well?”, and “Which beak structures didn't work well?” Draw students' attention to the key idea that the success of a bird beak depends on the environment a bird finds itself in. Scaffold this idea to several authentic examples of bird beaks and the function they serve. Show students pictures of various birds that clearly show the beak. Begin by showing students pictures of birds that live in a wide variety of habitats with various beak shapes such as: pelican, flamingos, bald eagles, humming bird, robin, heron, and a finch. These also correspond well with the various habitats from the lab activity. The teacher should then have the students in groups discuss what habitat these birds might live in and what they may eat based on their previous data and experiences.

When students have grasped the important relationships between structure, function and the environment in biological adaptation, address that even slight structural differences may have marked impact on how birds carve out their living. Darwin's Finches are commonly used to illustrate this, and many images of these birds are easily found on the internet by searching for "Darwin's Finches". Again, emphasize that organisms do not choose the structures they are born with, nor can they take on new features in their lifetime. The biological structures they possess are determined by what they inherit from their parents in a very complex process that cannot anticipate the environment.

For background information on Darwin's Finches, visit:
http://www.pbs.org/wgbh/evolution/library/01/6/l_016_02.html

Conclusion

This inquiry activity provides an important concrete experience useful for introducing and teaching about biological adaptation. When used prior to and alongside discussions of biological structure, function and adaptation, it helps students make the desired abstract connections. As with all inquiry experiences, the role of the teacher is critical in helping students reach desired outcomes. Effective questions, monitoring the entire classroom for appropriate behavior, addressing students' misconceptions, and creating scaffolds that help students develop an understanding of science content and the nature of science all create an engaging and productive classroom environment. This structured inquiry experience promotes mental engagement and inquiry experiences that may be further developed as the school year progresses.

References

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