

Title – “Brachyhypopomus – Adaptive Communication in the Amazon”

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Primary Subject - Science

Grade Level - 5

INSTRUCTIONAL OBJECTIVE:

After using a song and movement activities to guide the discussion and exploration of the adaptive communication of a species of electric fish in the Amazon River, students will be able to describe a model of how this species adapted its physical characteristics to survive and relate this back to the initial mammalian adaptation of the middle ear to evade reptilian predation.

STANDARDS:

Texas State Performance Indicator (SPI) 0507.2.1: Life Science – Food Webs: Describe the different types of nutritional relationships that exist among organisms

- Formative/Summative Assessment: Evaluate producer/consumer, predator/prey, and parasite/host relationships.

Texas State Performance Indicator (SPI) 0507.5.2: Life Science – Adaptation: Identify physical and behavioral adaptations that enable animals such as, amphibians, reptiles, birds, fish, and mammals to survive in a particular environment

- Formative/Summative Assessment: Design a model to illustrate how an animal's physical characteristics enable it to survive in a particular environment

INDICATORS:

Students will be able to discuss the evolutionary dilemma of Brachyhypopomus, the electric fish, and how it adapted its communication abilities to ensure a greater chance of survival.

MOTIVATION:

To gain the students' interest, the lesson begins with teaching the students the chorus of “The Dilemma of Brachyhypopomus.” The first verse of the song engages the students in the initial foundations of the fish’s adaptive problem and a simulation of Amazonian whitewater is passed around to help students identify with the fish’s dilemma.

MATERIALS:

- Glass jar with screw-on lid
- ¼ - ½ cup clay-based cat litter
- Map of South America
- Computer and/or projector with sound amplification

STRATEGIES:

- Visual reenactment
- Music
- Movement

- Classroom discussion
- Cooperative learning

VOCABULARY:

- **Whitewater** – a term used to describe certain tropical muddy brown rivers (i.e. Amazon, Napo, Orinoco) whose high content of suspended minerals and sediment makes them virtually opaque
- **Predator** – any organism that exists by hunting and feeding upon other animals
- **Prey** – any animal hunted or seized for food
- **Reproduction** – a process by which an organism produces other organisms similar to itself; ensures successful continuation of a species
- **Conductor** – a substance that conducts electricity, heat, etc.
- **Electrocyte** – (Electro – electricity; cyte – cell) cells whose main job is to generate an electrical current and move that current out of the cell
- **Electroreceptor** – (Electro – electricity; receptor – that which receives) cells whose main job is to detect and receive electrical current
- **Frequency** – the number of cycles of a wave; typically measured in relation to 1 second
- **Adaptation** – an inherited or acquired biological modification that better ensures an organism’s survival in its given environment

ADAPTATIONS:

- The hearing impaired student, will be given handouts on what is discussed in the movie and class.
- The learning disabled student in reading will be given the focal points of the lesson one week in advance or highlighted text material.

DIFFERENTIATION OF INSTRUCTION:

Tiered Assignment: The students that are functioning on a lower level of comprehension will be given assignments that equate with their abilities.

DEVELOPMENTAL PROCEDURES:

- Students are introduced to Brachyhypopomus as an electric fish that lives in South America and shown a photo of the fish on the computer. The audio file (or youtube video) is then turned on and this guides the students through the chorus of “The Dilemma of Brachyhypopomus” and encourages them to sing along whenever the chorus is sung (or shown) throughout the lesson. (If an audio file is used, it would be helpful for the teacher to write the lyrics to the chorus and the verses on the board, flip chart, etc.)

Chorus:

What is a fish to do, I say

Oh, what is a fish to do?

I'll have to adapt if I want to survive -

That's what a fish is to do.

- Students sing along with the chorus and then the teacher plays the first verse of the song which lays the foundation for describing some of the environment and ecosystem of *Brachyhypopomus* and the initial foundations of the fish's evolutionary dilemma. If using an audio file, the teacher should display the words to this verse for students to also read along with and then pause the audio file (or youtube) after the chorus following this verse for the first period of discussion.

Verse 1:

My name is *Brachyhypopomus*

I'm a fish in the Amazon River.

My world is so dense that I cannot see

How can I find food and swim playfully

When catfish and eel are waiting for me

And would rather just eat me for dinner?

Repeat Chorus

P A U S E

- Where is the Amazon River?
- Why might *Brachyhypopomus*'s world be so "dense" that it cannot see?
 - **Vocabulary:** *whitewater*
 - **Activity:** Put ¼ to ½ cup of clay-based cat litter in the bottom of a pint or quart-sized canning jar. Add water to the top and screw on the lid tightly. Shake the mixture vigorously and this will produce a brown/gray, muddy mixture of suspended sediment with some of the heavier sediment settling to the bottom. Pass the jar around as a simulation of whitewater and encourage students to imagine being a fish trying to survive in that kind of environment. (**Note: Discard this mixture outside and not down a sink or toilet as the cat litter tends to expand and becomes a clogging agent for pipes.**)
- Why are there catfish and eels "waiting" for *Brachyhypopomus*?
 - **Vocabulary:** *predator, prey*
- The audio file (or youtube) is again played and students hear the 2nd verse which further clarifies the fish's problem. If using an audio file, the teacher should again display the words to this verse for students to also read along with and then pause the audio file (or youtube) after the chorus (students encouraged to sing along) following this verse for the second period of discussion.

Verse 2:

My name is Brachyhypopomus

I'm a fish in a quandary not simple.

What else can I use to navigate,

To have conversations, communicate,

To declare my attraction and court a mate

Without a detectable ripple?

Repeat Chorus

P A U S E

- Why would Brachyhypopomus want to navigate, communicate, and “court a mate” without making a “ripple”? What senses do we primarily use as humans to do these things?
 - **Vocabulary:** *reproduction*
 - **Activity:** Since Brachyhypopomus can't use sight effectively because of its environment, this activity can be used to help students explore what happens when they are asked to do a cooperative task without the use of one of their primary senses.
 - Divide students into groups of 8 – 10 students and have each group stand in a circle with one student in the middle of the circle. The students forming the circle are the “Brachys” and the student in the center is the predator (catfish or eel). Without using their voices, students in the circle have to find a way to signal to each other that they are going to change places by running across the circle before the predator detects what's happening. Multiple swaps (i.e. more than 2 students trading places) can take place simultaneously and if the predator figures it out and slides into a vacant spot on the circle while 2 “Brachys” are changing places, then the student no longer having a spot on the circle edge becomes the new predator. Ideally, the “Brachys” are working together cooperatively to outwit the predator. (Activity adapted from Augusto Boal's “Games for Actors and Non-Actors)
 - Follow-up questions:
 - When you were a “Brachy,” how did you signal to other “Brachys” that you were ready to change places?
 - When you were a predator, what senses did you use to detect what was happening?
 - In this game, you weren't allowed to use your voice but you could use sight. Since Brachyhypopomus can't see in the water, do you think it could use sound? What happens to sound in water?

- The audio file (or youtube) is played for the final time and students hear the 3rd verse which describes the fish's adaptive solution. If using an audio file, the teacher should again display the words to this verse for students to also read along with. This verse ends with the final chorus (students encouraged to sing along) to be followed by the final discussion period and activity.

Verse 3:

My name is Brachyhypopomus

And my answer's now coming up roses.

I'll send out my own electricity


And cloak it in rather high frequencies

That only my kinfolk can receive

Right under our predators' noses.

Repeat Chorus

P A U S E

- How does electricity travel in water compared to sound?
 - **Vocabulary:** *conductor*
- How do you think Brachyhypopomus generates its own electricity? How does it detect or "hear" the electricity being sent by other fish?
 - **Vocabulary:** *electrocyte, electroreceptor*
- If catfish and eel also have electroreceptors, how do you think Brachyhypopomus "outwits" its predators?
 - **Vocabulary:** *frequency*
 - **Activity:** Explain that sound and electricity both travel in the form of a wave. Have students move one arm up and down traveling in the form of a wave () to get the feeling of this in their bodies. Set up one part of the room as the starting point and one part as the finish and designate this distance to equal one second. As each student travels between the two points, have them count how many times they make a wave with their arm and then use this number to demonstrate the concept of frequency (i.e. waveforms per second).
 - **Application:** The electroreceptors of the catfish and eels only detect low frequency electrical current. Brachyhypopomus has additional electroreceptors that detect higher frequency currents and its electrocytes, therefore, over time have adapted to send out higher frequency electrical signals that only other "Brachys" can detect while the predators remain unable to detect the signal.
 - **Vocabulary:** *adaptation*
 - This is a similar adaptation to what happened when mammals first evolved from reptiles. The middle ear and vocalization ability of

mammals evolved to transmit and receive higher frequency sounds that reptiles were and are unable to detect as their sound receptors are wired only for low frequency sounds.

ASSESSMENT:

The students will be asked to accurately explain what adaptation is and discuss how the electric fish adapted its ability to communicate via electrical signals to better survive the difficult environment of the Amazon River.

TEACHER REFERENCES:

- “The Dilemma of Brachyhypopomus” audio file (or youtube)
- Dr. Michael Markham’s “For the Public” webpage about his Brachyhypopomus research:
http://www.michaelmarkham.net/research_public.html