



"Developing Scientific Questions" Classroom Activity Guide

Season 1, Episode 1

Overview

This classroom activity guide complements S1:E1, in which Matthew speaks with Susan Alberts, who co-directs the Amboseli Baboon Research Project, a long-term longitudinal study of wild baboons.

This accompanying classroom activity guide focuses on **developing and refining scientific questions**, especially those that address proximate or ultimate questions about animal behavior. This guide includes three activities which address the key concepts and student learning targets described below.

This resource is designed to be flexible and adapt to your specific course. We provide three classroom activities. Each activity can stand-alone, the activities can also be mixed and matched with each other, or these activities can be integrated with your existing materials. These materials are designed as adaptable and editable starting points, feel free to make the changes necessary for these to be useful in your specific classroom.

Key Concepts

- Articulating scientific questions is a learned skill
- Investigating the immediate physiological or environmental factors that cause a behavior helps to develop a proximate explanation for the behavior
- Investigating the evolutionary forces that cause a behavior helps to develop an ultimate explanation for the behavior

Student Learning Targets

- Identify features of useful scientific questions (Activity Options A,B)
- Write and refine an approachable scientific question (Activity Option B)
- Distinguish between questions addressing proximate and ultimate explanations (Activity Option A,C)
- Articulate the role of proximate and ultimate questions in the study of animal behavior (Activity Option C)

Prior Knowledge

Before beginning these activities, students should:

- Complete any "Before Class" exercise described in the activity
- Be familiar with the traditional formulation of the scientific method
- Have a rudimentary appreciation for basic scientific research

Activity Option A - Discussion

Proximate and Ultimate Questions in the Amboseli Baboon Research Project

Target Audience

- Undergraduate students in an animal behavior or behavioral ecology course

Description

This discussion is a follow up to the podcast episode. We provide a few discussion prompts and tips for guiding your class to have a fruitful and informative conversation about the Amboseli Baboon Research Project.

Materials Needed

- A device capable of playing podcasts
- Discussion Guide Worksheet

Implementation Suggestions

Before Class

- Students should listen to Episode 1 of the Animal Behavior Podcast
- Encourage students to make a few notes while listening -- some specific prompts are included on the student-facing Discussion Guide Worksheet

During Class

(student facing instructions are provided on the Discussion Guide Worksheet)

- Think-pair-share activities to warm students up for discussion
 - Ask students to review their notes from the podcast and work with a partner, to think about how they would edit Dr. Albert's definition of behavior or why they would leave it the same. Have pairs share with the class
 - Have students review their ideas about questions that you might need a long term data set to answer and work with a partner come up with one possible question to present to the class. Encourage them to be ready to explain why they think this is an interesting and addressable scientific question. As a class, discuss the process of developing and refining scientific questions and identify proximate vs. ultimate questions.
- Group Discussion
 - Possible prompts include their ideas about experimental design (Q3 on Discussion Guide Worksheet), their reactions to the organism-focused/question-focused distinction discussed by Dr. Alberts and Matthew (Bullet point 3 on Discussion Guide Worksheet), integrating local communities into field based research and/or the role of women in primatology.

After Class

- Students could complete a short "exit ticket" detailing one interesting take-away they got from the discussion

Activity Option B

Asking and Refining Approachable Scientific Questions

Target Audience

- Undergraduate students in an animal behavior or behavioral ecology course
- Undergraduate students in an inquiry based introductory biology course or lab

Description

This activity helps students practice and develop a scientific approach to investigating the world around them. We provide a worksheet and instructor guide to facilitate a group discussion about articulating and refining scientific questions

Materials Needed

- Worksheet copies for each student
- Whiteboard/Chalkboard
- Projector and Computer with internet access (optional)
- Internet enabled device for each pair of students (optional)

Implementation

Before Class

- No pre-class work is necessary, this activity is designed to be a first introduction to the topic

During Class (see Teaching Tips for more specific instructions)

- Introduce the activity (see prompts/ideas on instructor guide)
- Class brainstorm/discussion about questions the scientific method can and cannot address
- Students work in groups to identify and refine scientific questions
- Students report out about their process
- Instructor wrap up

After Class

- The instructor could assign a brief writing assignment or discussion board post asking students to repeat the in class activity with a set of questions the instructor designed to introduce the topic of the next class/unit or a set of questions more targeted to the specific content of your course.

Teaching Tips: Asking and Refining Approachable Scientific Questions

- Have students work in pairs and encourage conversation
- This activity involves students working in pairs/small groups and at least two “mini-lectures”
- **Mini-lecture number 1** is a brief overview of the “scientific method” – you can place this overview wherever makes sense to you, but we would suggest having the students complete the first three questions on their handout with a partner, and then bring them back for a quick discussion. You could open that discussion by asking for their responses to the first question (what counts as science, what doesn’t, why?) and then ask them what they think a “scientific approach” is (this term is used in questions two and three). From there, transition into asking them what they know/remember about the “scientific method and record their thoughts on the board.
 - In your overview of the scientific method, make sure to introduce that scientific questions should be testable and be able to be addressed by collecting evidence through observations and experiments.
- **Mini-lecture number 2** is an introduction to the idea that scientists have to break down big questions into small pieces. You can place this mini-lecture right after mini-lecture 1, but be aware that it has a different main takeaway. In this mini-lecture, you can give examples of breaking down big questions into small pieces using examples you are familiar with from your own research, or by walking students through the activity exploring the Alberts Lab website (described on the student handout). Perusing the website yourself beforehand will make the second approach go more smoothly.
 - In this mini-lecture, it will be useful to introduce the terms independent and dependent variable. We’re hoping that students will be able to construct questions that are specific enough that they imply particular independent and dependent variables.
- After mini-lecture 2, have the students complete the Alberts Lab portion of the worksheet on their own. If you used the Alberts Lab website in your mini-lecture, ask them to find another example from the website. If you didn’t use the Alberts Lab website in your mini-lecture, it would be a good idea to pull it up on a classroom computer and show the students the publications tab.
 - Expect students to struggle with identifying specific questions from article titles. Walk around the room and help them as they work through this exercise. Ask them to articulate the connection between the specific article they chose and the big questions described on the landing page of the website.
- After working through the Alberts Lab example, the final part of this exercise is asking students to creatively come up with their own specific question that addresses the big question of “*Why are humans so much better at cooperating than most other animals are?*” You can easily edit this question to something more appropriate for your specific class/expertise. If students have time to complete this in class, you can have a brief wrap up discussion where students share their questions and you point out how multiple lines of evidence are used in science. You can also assign this activity as homework.



Activity Option C

Developing Proximate and Ultimate Questions

Target Audience

- Undergraduate students in an animal behavior or behavioral ecology course

Description

This activity helps students internalize the differences between proximate and ultimate questions.

Materials Needed

- Copy of "Proximate and Ultimate Questions in Fuzzles" for each student or projector to show to whole class
- Blank paper, markers, and reposition-able tape or magnets

Implementation

Before Class

- No pre-class work is necessary, this activity is designed to be a first introduction to the topic
- Alternatively, to save class time, you could have students complete the first bullet point of the "During Class" activities as a pre-class exercise.

During Class

- Students review the proximate and ultimate questions figure. Each pair of students develops a new proximate and a new ultimate question about the fuzzle, or about their organism of choice.
- Students report out.
- Ask students to share their reactions to this distinction. Do they find one type of question more intuitively appealing? Why? Why not?
- Have students work in pairs to write another question on the blank paper - encourage them to write large.
- On the board, create two columns: Proximate and Ultimate. Have students exchange questions with another pair and then decide which column to place their new question into. As a class, discuss what was easy/difficult about this process.
- As an extension, you could use this activity to introduce Niko Tinbergen's Four Questions, if this is part of your syllabus. You could have students sort questions into a grid, instead of 2 columns.
- If you are pairing this with the podcast discussion exercise, you could ask students to consider the questions Susan Alberts and her team investigated in the baboons. Are these proximate or ultimate questions? What other questions does her work inspire you to ask?

After Class

- The last bullet point of the "During Class" activities could easily be formatted as an after class writing assignment, if you prefer.