

Variation Lesson: The Great Jellybean Hunt

Adapted from Kenneth Macleod
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Synopsis

The goal of the game is to demonstrate how natural selection can act on populations to “fine tune” traits and characteristics. One specific purpose is to address a Lamarckian misconception of adaptation acquisition, being that organisms “acquire” traits out of “need.” This game reveals how natural selection and other evolutionary forces act on the variation already present to produce the animals we see today and in the fossil record.

Background Terms and Concepts with Teaching Guide:

- Scientific Method
 - Teachers need to cover the scientific method for the students to understand the concept of the game as an experiment. Additionally, the poster presentation will simulate that of a scientific poster focusing on the setup of an experiment (see worksheets).
- Species definition
 - Teachers need to explain what it means to be a species, specifically the biological definition, i.e. members of the same species can successfully reproduce and do so in natural settings.
- Extinction
 - A simple definition of this term will do, specifically distinguishing extinct animals from endangered ones.
- Predator/Prey relationships
 - Again, a simple explanation of these terms will supply students with the background they need. The activity itself will further explain how this relationship can affect natural selection and evolution.
- Ecosystem
 - It is important for students to realize that the environment an organism lives, eats, and reproduces in also can act as an evolutionary pressure. Changes in ecosystems have profound affects on organism evolutionary histories. Students can further investigate this in a second round of this activity with a change in substrate.
- Camouflage
 - Teachers can define and provide several animal examples of this term to sufficiently cover it.
- Traits/characteristics
 - Teachers need to be able to provide examples of individual traits of animals that assist it in acquiring food, defensive/camouflage, and attracting mates. Examples are the white fur of a polar bear, the beautiful tail feathers of the male peacock, and the sharp beaks of eagles.

Objectives: Students will be able to:

- Define terms:
 - Population
 - Adaptation as a trait
- Discuss natural selection and how a population can change depending on evolutionary pressures, such as predation and habitat.
- Discuss why variation is important to the process of natural selection and evolution.

Teaching Guide:

- 1) A distinction between population and species just needs to be made here.
- 2) For my students, a power point presentation introducing variation and adaptation as a characteristic and as a process was developed. It and notes for presentation are attached. This presentation is also appropriate, but not necessary as an introductory exercise for this lesson.

Grade Level:

7 - 9, can easily be adapted for high school and college.

Materials:

- 300 jellybeans (five colors: red, yellow, blue, dark green and light green). If the area is damp, try buttons or beans.
- 5 “feeding” adaptation types (chopsticks, tweezers, plastic knives, forks, and spoons).
- Worksheets (see attached)
- Cups (mouths)
- Whistle (start and stop feeding trails)
- Small bucket or large cup/container (collect captured prey)
- Stop watch or watch with second hand (time foraging trails)
- Graph paper (optional)
- Supplies for poster (optional)

Students will be presented with a single, yet variable, population of 300 jellybeans. This is good for about a class of 20-25 students. The jellybeans will be the ‘prey’ species and will consist of equal numbers of colors: red, yellow, and blue, dark green and light green. The jellybeans represent one, variable population of the same organism. The students will be designated as the “predators.” Predator groups will be assigned to groups (5 or 6) and will be titled by their feeding apparatus: chop sticks, plastic spoons, plastic knife, plastic forks, and tweezers. They will also be provided with a small cup representing their mouths. This is where the captured prey is kept throughout the foraging interval. The predator groups represent individual predator species with little variation, such as tigers, wolves, eagles, snakes, etc. Thus, there are **several** predator species hunting just **one** prey species.

Students will be required to make initial hypotheses based on the provided information and what they know about animal camouflage strategies to ranking jelly bean color from “least successful” (eaten the most) to most successful (eaten the least). Then students will make hypotheses ranking the predator “success” as well (see worksheet).

Time:

Preparation of jellybean habitat should take place before class for the game will take place in a grassy recreational area of the school campus. Beforehand, instructors spread the jellybeans in a marked area of at least 15m X 15m. Game itself should not take more than 45 minutes. This includes rules, prey collection, and data calculation. However, results and discussion questions can be sent home or finished during the next class period. This lesson also has an extension option of a poster presentation. Three more class periods are suggested for poster rough draft (see worksheet), construction and presentation.

Procedure:

- 1) Students will be given four one-minute-foraging intervals to collect as many jelly beans as possible (If the “habitat does not hide the jellybeans well, i.e. not very grassy area, decrease the foraging intervals or the students will find all the jellybeans before the foraging section of the game is finished).
- 2) After each interval, the number and color of the “eaten” jellybeans of each individual student will be recorded. After numbers are recorded, students need to dump captured prey into a receptacle, so they are not counted twice. Teachers can also reuse jellybeans for additional classes.
- 3) The least successful predator species will lose one member to the most successful predator species (individual chosen randomly). This part of the game will demonstrate what it means to be successful and how extinction can occur. Specifically, the predators catching the most prey will reproduce and the species will survive, while the predator species that is capturing the least amount of food, will not survive and the species will go extinct. Before beginning another trial, it might be helpful to ask the class, “Why is one predator species getting another member and one species losing a member?” In addition, a competitive atmosphere should be maintained to avoid students actually eating their prey.

- 4) Once the foraging section of this game has been completed, students need to stay in their predator species groups and add up all of their findings.
- 5) Back in the classroom, a table needs to be constructed on the blackboard illustrating the totaled number of prey and their colors for the whole class to see. This will allow the students to see overall trends and facilitate classroom discussion of results. A table for the overall class results is also provided in the worksheets.
- 6) The students can next compare the results to their previously written hypotheses, and make conclusions based on the evidence of the data.

Assessment & Evaluation:

Discussion of the results will be conducted in the classroom and will focus on how natural selection (by action of the predator and the surrounding ecosystem) can act on variation and how further generations of the jelly bean population would be the more “successful” colors of greens and browns. Why organisms go extinct can also be discussed with regards to the several “species” of predator. For example, the predator populations exhibit little variation, thus natural selection cannot act and the populations of plastic knives and chopsticks will probably go extinct. While the tweezers and spoons, which are well adapted, and will out compete the others for now, will increase in population size. If time permits, a second game will be played on different colored substrate to illustrate how habitat is a large part of natural selection and that changes in habitat/climate can have dramatic affects on an organism’s evolutionary history.

Assessment can be calculated by the discussion questions and a final test (see attached). The test will consist of a vocabulary section (matching word to definition) and a situational question. Provided is a picture and a scenario that will require the student to outline the adaptations illustrated by the animal’s physical and behavioral characteristics and make predictions based on what they have learned about natural selection.

Extension:

The experiment can also be presented to the class in poster form. Students will need to have been introduced to the scientific method in previous teaching units. Students should be familiar with the process and the appropriate sections necessary for

writing about an experiment (i.e. introduction, background, materials and methods, results, discussion). Worksheets will be provided to assist in organization (see attached).

A grading rubric has been prepared:

Making A Poster: The Jellybean Hunt

Grading Rubric

CATEGORY	4	3	2	1
Attractiveness	The poster is exceptionally attractive in terms of design, layout, and neatness.	The poster is attractive in terms of design, layout and neatness.	The poster is acceptably attractive though it may be a bit messy.	The poster is distractingly messy or very poorly designed. It is not attractive.
Grammar	There are no grammatical mistakes on the poster.	There is 1 grammatical mistake on the poster.	There are 2 grammatical mistakes on the poster.	There are more than 2 grammatical mistakes on the poster.
Required Elements	The poster includes all required elements as well as additional information.	All required elements are included on the poster.	All but 1 of the required elements are included on the poster.	Several required elements were missing.
Labels	All items of importance on the poster are clearly labeled with labels.	Almost all items of importance on the poster are clearly labeled with labels.	Several items of importance on the poster are clearly labeled with labels.	No important items were labeled.
Content - Accuracy	At least 7 accurate facts are displayed on the poster.	5-6 accurate facts are displayed on the poster.	3-4 accurate facts are displayed on the poster.	Less than 3 accurate facts are displayed on the poster.
Knowledge Gained	Student can accurately answer all questions related to facts in the poster and processes used to create the poster.	Student can accurately answer most questions related to facts in the poster and processes used to create the poster.	Student can accurately answer about 75% of questions related to facts in the poster and processes used to create the poster.	Student appears to have insufficient knowledge about the facts or processes used in the poster.

Standards:

This activity will address Arizona Science Standard Strand 1: Inquiry Process

- Concept 1
 - PO 1. Formulate questions based on observations that lead to the development of a hypothesis
 - PO 3. Explain the role of a hypothesis in a scientific inquiry
- Concept 2
 - PO 1. Demonstrate safe behavior and appropriate procedure
 - Po 3. Conduct a controlled investigation, utilizing multiple trials, to test a hypothesis using scientific processes.
 - PO 5. Keep a record of observations, notes, sketches, questions, and ideas using tools such as written and/or computer logs.
- Concept 3

- PO 1. Analyze data obtained in a scientific investigation to identify trends.
- PO 2. Form a logical argument about a correlation between a variable and sequence of events.
- PO 3. Analyze results of data collection in order to accept or reject the hypothesis
- PO 5. Formulate a conclusion based on data analysis
- PO 6. Refine hypothesis based on results from investigations.
- PO 7. Formulate new questions based on the results of the previous investigation
- Concept 4
 - PO1. Graphic representation of data
 - PO 2. Display data
 - PO 3. Communicate the results of an investigation with appropriate use of qualitative and quantitative information.
 - PO 5. Communicate the results and conclusion of the investigation.

The National Science Standards that are will be address include the concepts of

- Reproduction and Heredity
 - The characteristics of an organism can be described in terms of a combination of traits. Some traits are inherited and others result from interactions with the environment.
- Populations and Ecosystems
 - A population consists of all individuals of a species that occur together at a given place and time.
 - Populations of organisms can be categorized by the function they serve in an ecosystem.
- Diversity and Adaptations of Organisms
 - Millions of species of animals, plants and microorganisms are alive today. Although different species might look similar, the unity among organisms becomes apparent from an analysis of internal structures, chemical processes, and the evidence of common ancestry.
 - Biological evolution accounts for the diversity of species developed through gradual processes over many generations. Species acquire many of their unique characteristics through biological adaptation, which involves selection of naturally occurring variations in populations.
 - Extinction of a species occurs when the environment changes and the adaptive characteristics of a species are insufficient to allow its survival. Fossils indicate that many organisms that lived long ago are extinct. Extinction of species is common; most of the species that have lived on the earth no longer exist.

