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# K-12 Partnership Lesson Plan

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# *Geeked about Beaks*

# *Inquiry learning about survival and reproduction*

## Overview

In this lesson, students will learn about survival, reproduction, selection, adaptation, and evolution all while playing hands-on games and constructing their knowledge through experience. Students get to be birds and compete against their classmates to eat the most seeds. This activity demonstrates how small beaks are better at getting small seeds, whereas large beaks are better at getting large seeds. Next, students become part of a bird population with a variety of beak sizes. Depending on the weather, big, small, or medium seeds are common that year. Students observe how populations change over time based on the environment. Students explain why the population changes over time, and they also make predictions about what will happen to the population in future years

This topic connects to many K-6 topics, including organism’s needs in their environments, competition, adaptation, survival, reproduction, and evolution. Additionally, this lesson helps students practice important inquiry skills: graphing and interpreting data.

**Objectives**

At the conclusion of the lesson, students will be able to:

* Describe how physical characteristics of an organism affect what it can eat, which then impacts its survival and reproduction
* Explain why a population might change over time based on the environment
* Make predictions about how a population might change over time based on the environment
* Draw graphs from game outcomes, summarize patterns, and interpret what is happening to the population over time
* Compare game outcomes and explain why populations look different depending on the environmental conditions they experienced over time

**Length of Lesson**

One 25-minute time period and one 45-minute time period. Can occur back-to-back or separately.

**Grade Levels**

K-6

**Standards covered (NGSS)**

Disciplinary Core Ideas:

*Elementary School*

* **K.LS1-1**: use observations to describe patterns of what plants and animals (including humans) need to survive
* **1**-**LS3-1**: make observations to construct an evidence-based account that young plants and animals are like, but not exactly like, their parents
* **3**-**LS4-3**: construct an argument with evidence that in a particular habitat some organisms can survive well, some survive less well, and some cannot survive at all
* **3**-**LS3-2**: use evidence to support the explanation that traits can be influenced by the environment
* **3**-**LS4-2**: use evidence to construct an explanation for how the variations in characteristics among individuals of the same species may provide advantages in surviving, finding mates, and reproducing

*Middle School*

* **MS-LS2-4:** construct an argument supported by empirical evidence that changes to physical or biological components of an ecosystem affect populations
* **MS-LS4-4**: construct an explanation based on evidence that describes how genetic variations of traits in a population increase some individuals’ probability of surviving and reproducing in a specific environment

Cross Cutting Concepts:

* Patterns
* Structure and function
* Stability and change of systems

Science and Engineering Practices

* Developing and using models
* Analyzign and interpreting data
* Engaging in argument from evidence

***Previous Michigan Standards Met:***

* **S.IP.0#.16**: construct simple charts from data and observations
* **S.IA.0#.12**: share ideas about science through purposeful conversations
* **S**.**IA.0#.13**: communicate and present findings of observations
* **S**.**RS.0#.11**: demonstrate scientific concepts through various illustrations, performances, models, exhibits, and activites
* **S**.**RS.02.15**: use evidence when communicating scientific ideas
* **S**.**IA.03.13**: communicate and present findings of observations and investigations
* **S**.**IA.04.11 & S.IA.05.11**: summarize information from charts and graphs to answer scientific questions
* **S**.**IP.05.16 & S.IP.06.16**: identify patterns in data
* **L**.**OL.00.11**: identify that living things have basic needs
* **L**.**OL.01.13**: identify the needs of animals
* **L**.**HE.01.11 & L.HE.02.11**: identify characteristics (for example: body coverings, beak shape, number of legs, body parts) that are passed on from parents to young
* **L**.**OL.03.32**: identify and compare structures in animals used for controlling body temperature, support, movement, food-getting, and protection (for example: fur, wings, teeth, scales)
* **L.EV.03.12**: relate characteristics and functions of observable body parts to the ability of animals to live in their environment (sharp teeth, claws, color, body coverings)
* **L**.**EV.04.22**: identify how variations in physical characteristics of individual organisms give them an advantage for survival and reproduction
* **L**.**EV.05.11**: explain how behavioral characteristics (adaptation, instinct, learning, habit) of animals help them to survive in their environment
* **L.EV.05.12**: describe the physical characteristics (traits) of organisms that help them survive in their environment
* **L**.**EC.06.21**: describe common patterns of relationships between and among populations (competition, parasitism, symbiosis, predator/prey)
* **L**.**EC.06.23**: predict how changes in one population might affect other populations based upon their relationships in the food web

**Materials**

Part 1 (Seed Eating Game)

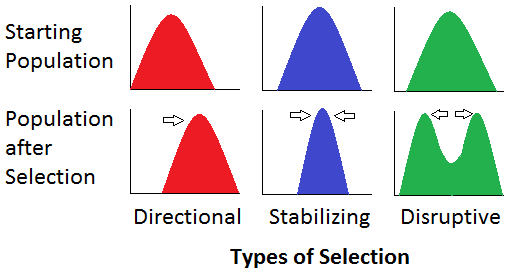
* Clothespins (small, medium, large)
* Beads (small, medium, large)
* Small plastic cups

Part 2 (Bird Beak Population Game)

* Powerpoint on selection and evolution
* Bird Beak Game (board, beak size cards, game pieces)
* Bird Beak Game instructions
* Bird Beak Game worksheet
* Outcomes of Bird Beak Game excel file for teachers to preview game outcomes

**Background**

This lesson explores ideas in selection, survival, reproduction, and evolution based on experiments with Darwin’s finches, which are a classic example of evolution in response to the environment. The there are two games played in this lesson: The Seed Eating Game and the Bird Beak Population Game. The Seed Eating Game demonstrates that certain sized beaks are better at getting certain sized seeds. Darwin’s finches have a variety of beak sizes, and each beak size is adapted to particular food types and sizes. The Bird Beak Population Game illustrates 3 kinds of selection: directional, stabilizing, and disruptive (See the diagram below). Directional selection occurs when individuals are favored with particular traits above or below the population mean. In the diagram, it looks as if the population distribution has shifted in one direction. Stabilizing selection occurs when intermediate individuals are favored. This makes the population distribution look compressed toward the center. Disruptive selection occurs when intermediate individuals are disfavored and individuals with high and low values do well. This makes the population distribution look like two peaks with a valley in the middle. Your students will encounter these types of selection later on in their education. So it will be helpful if your students have seen these types of selection before, as they will in this game, even if they are not explicitly described.



### Activities of the session

**PART 1**: Seed Eating Game (25 min)

1. Introduction
   1. We are going to play a game where you are birds that have different sized beaks. There are 3 sizes of seeds. Your goal is to eat as many seeds as you can.
2. Set up for the game (Explain what each material represents in the game as you pass things out)
   1. Put students in small groups of about 3. (*Consider playing on the carpet so beads don’t roll everywhere.)*
   2. Give each student 1 size of clothespin (beak). Make sure there is at least 1 small, 1 medium, and 1 large beak in each group.
   3. Give each student a plastic cup (stomach).
   4. Distribute beads (seeds) to each group.
      1. For each small beak, give 10 small seeds.
      2. For each medium beak, give 10 medium seeds.
      3. For each large beak, give 10 large seeds.
3. Explain how to play
   1. As quickly as you can, use only your beak to pick up as many seeds as you can and place them in your stomach.
   2. We will keep playing until all the seeds are eaten.
4. PLAY!
5. Discuss outcomes
   1. In their groups, have students count the number of seeds of each size that they ate.
   2. Have students compare what they ate to other beak sizes and come up for reasons why.
   3. Have groups report out about the seed size that was most commonly eaten by each beak size and give reasons why that happened.
   4. *Note:* Two things are happening.
      1. *Physical limitations*. Some of the beaks are size-limited, e.g., the small beak can’t pick up the large seed.
      2. *Competition*. Even though the largest beak could pick up all of the seeds, the smaller birds are competing for smaller seeds, so the bird with the largest beak is unlikely to get very many of these.
   5. *Extensions:*
      1. Have students play in groups greater than 3 to see how competition with birds with similar sized beaks affects how many seeds you get of each kind.
      2. Discuss seed eating strategies students with each beak size use.
      3. Discuss that big seeds = a lot of food and small seeds = a little food. How does this affect potential eating strategies?
      4. Have each group draw a graph of the number of seeds of each size that were eaten by each bird with different beak sizes. Groups share their graphs with the class and explain why these patterns occurred.

**PART 2**: Bird Beak Population Game (45 min: 30 min game; 15 min PowerPoint)

(*Note: You can preview the outcomes of the 3 weather scenarios in the Excel file “Outcomes of Bird Beak Game”*)

1. Follow the Bird Beak Game Rules to set up the game & play 3 rounds.
   1. During the game, have students fill out their Bird Beak Game Worksheets, which guide them to describe and explain patterns in the data as well as make predictions. (*You may choose to print each worksheet on a different color of paper to make later discussion and comparison easier.*)
   2. Have students share their descriptions of patterns and predictions within their groups and then with the class to help clarify relationships between the environment and effects on the population over time.
   3. There are 3 Weather Scenarios that demonstrate the different kinds of selection
      1. Weather Scenario 1: Directional
      2. Weather Scenario 2: Stabilizing
      3. Weather Scenario 3: Disruptive
   4. You can also play a random weather version of the game using the “Weather Dial” (spinner). You may want to try this after doing 1 or more of the above scenarios so students see what repeating or alternating patterns do to the population over time.
2. After completing the game and discussions, use the PowerPoint to provide examples for the experiences students just had with the game.

**Resources**

* A brief background on Darwin’s finches

<http://www.pbs.org/wgbh/evolution/library/01/6/l_016_02.html>

* A game develop by UC Berkeley that is similar to the Seed Eating game described here.

<http://www.ucmp.berkeley.edu/education/lessons/clipbirds/>

**Extensions and Modifications**

1. You can combine the two games into one.
   1. Follow steps 1-4 in PART 1 above, playing one round of the game.
   2. Then simulate a change in the weather, like in PART 2, for successive rounds by changing the distribution of seed sizes while keeping the total number of seeds the same. For example, in a group of 3 you started with 1 small, 1 medium, and 1 large beak and 10 small, 10 medium, and 10 large seeds. If the weather became progressively drier each successive round might look like this:
      1. 15 small; 10 medium; 5 large
      2. 20 small; 5 medium; 5 large
      3. 25 small: 5 medium; 0 large

But you can be creative with other options like all wetter years, etc.

* 1. **Each student** should collect data (see data sheet on pg 6) on their success in each successive round (3 rounds total is usually sufficient). Then they can graph their “fitness” in each weather condition (e.g., “normal”, “dry”, “drier”) as in PART 1 #5.e.iv above.

1. Play the game as an entire class using students to graph the changing population. The rules are the same, but play outside or in the gym where each student represents one of the colored rectangles. To play to Year 3 in Weather Scenario 1, you need 26 students. To play to Year 3 in Weather Scenario 2, you need 22 students. To play to year 4 in Weather Scenario 3, you need 27 students. But perhaps chairs or other objects could stand in if you don’t have enough students. Students that didn’t survive in one year could play another bird born in a following year.
2. Play the Bird Beak Population Game with new colonization events (1-2 birds of each beak size enter the population) or catastrophes (e.g., hurricanes that wipe out 50% of the birds). Have students discuss how these events change the population directly after the event and a few years later after weather has favored individuals with certain beak sizes.
3. Have students research Darwin’s finches. Students could write an essay about how information they found supports or adds to what they learned in the game.
4. Students could imagine their own game with different organisms and food types. Students could think of different ways predators find food, such as by color or by smell.

**Assessment**

Students complete the worksheet and describe patterns of change over time in populations and make predictions about what future populations would look like based on specific environmental conditions.

Test students’ understanding of the impacts of the environment by having them develop their own Weather Scenarios to illustrate different patterns of change in the population over time.