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# K-12 Partnership Lesson Plan

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# *Angry Birds*

# *Exploring Behavioral Trade-offs*

## Overview

Animals have limited supplies of energy and often must chose which activities to focus on at the expense of others. In this activity students will play a game that explores the trade-off between aggression and parental behavior. In part A, students will explore the role of aggression in acquiring a territory. In part B, students will explore the trade-off between parental behavior and aggressiveness and learn there are multiple ways to be successful.

**Objectives**

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

* Explain how aggression impacts an organism’s success
* Explain how environmental characteristics shape the benefits of aggression
* Explain the trade-off between aggression and parental behavior

**Length of Lesson**

This lesson will take approximately 45-60 minutes, depending on the emphasis on graphing and length of discussion

**Grade Levels**

Grades 9-12, could be adapted for 7-8

**Standards covered (NGSS)**

Disciplinary Core Ideas:

 *Middle School*

* **MS-LS2-1**: analyze and interpret data to provide evidence for the effects of resource availability on organisms and populations of organisms in an ecosystem
* **MS-LS2-4**: construct an argument supported by empirical evidence that changes to physical or biological components of an ecosystem affect populations
* **MS-LS1-4**: use argument based on empirical evidence and scientific reasoning to support an explanation for how characteristic animal behaviors and specialized plant structures affect the probability of successful reproduction of animals and plants respectively
* **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

*High School*

* **HS-LS4-2:** construct an explanation based on evidence that the process of evolution primarily results from four factors: (1) the potential for a species to increase in number, (2) the heritable genetic variation of individuals in a species due to mutation and sexual reproduction, (3) competition for limited resources, and (4) the proliferation of those organisms that are better able to survive and reproduce in the environment
* **HS-LS4-4**: construct an explanation based on evidence for how natural selection leads to adaptation of populations

Cross Cutting Concepts:

* Patterns

Science and Engineering Practices

* Developing and using models
* Planning and carrying out investigations
* Analyzing and interpreting data
* Engaging in argument from evidence

***Previous Michigan Standards Met:***

* **B3.5d**: describe different reproductive strategies employed by various organisms and explain their advantages and disadvantages
* **B1.1D**: identify patterns in data and relate them to theoretical models
* **B1.1E**: describe a reason for a given conclusion using evidence from an investigation
* **B1.1f**: predict what would happen if the variables, methods, or timing of an investigation were changed
* **(can be extended to incorporate) B5.1e**: explain how natural selection leads to organisms that are well suited for the environment (differential survival and reproduction of chance inherited variants, depending upon environment conditions)

**Materials**

* Hula hoops or anything else that can mark a small “territory”. These should be labeled with 2 colors, one to indicate “high quality” and “low quality” territories
* Strategy cards, 1 per participant (available on Angry Birds lesson page on the KBS GK-12 website)
* Clip boards
* Popsicle sticks with ends colored. Approximately 1/3 should be the “high quality” color, 1/3 the “low quality color”, and 1/3 blank to represent individuals without territories.
* (optional) offspring cards (on website), ping pong balls, candy, or anything else small that can represent offspring. You need 8x each high quality territory and 5x each low quality territory

**Background**

Trade-offs are wide-spread throughout the animal kingdom. Animals have only a limited supply of time and energy they can devote to their daily activities. On a species wide level, these trade-offs can be seen in different reproductive strategies. Some species spend their energy making many babies, but provide little or no care. Other species raise only a few offspring but spend considerable energy raising them to adulthood.

Within a species different individuals may solve these trade-off in different ways. For instance, in many bird species some individuals are bold, aggressive, and very good at protecting their territories, while other individuals are more shy but also more dutiful in caring for their young. The environment strongly influences which of these strategies is most successful. When there is fierce competition for a few high quality territories or resources, aggressive individuals have an edge in the competition. However, if energy is limited and being aggressive also limits the time and energy an animal can spend on its offspring, aggressive individuals might not produce the most babies.

In this activity students will take on the role of a bird raising offspring in a population with limited territories and explore the influence of aggressiveness on reproductive success in two different conditions. In the first condition, fighting is free and birds with different aggressive strategies merely compete for low and high quality territories. In the second condition, the birds involved in fights have less energy left to produce offspring. The one who produces the most offspring wins!

### Activities of the session

###  *Setting up the game*

1. Without seeing the colors on the end, each student draws a popsicle stick. One color corresponds to “high quality” territories, the other to the “low quality” territories, and blank sticks correspond to “floaters” starting without a territory.
2. Set-up the territory quadrates (hula hoops, etc.) in a “population”. The number of quadrates with the “high quality” color and “low quality” should match the number of students who drew those popsicle sticks.
3. With the strategy cards (see attached), form a deck with one third “high aggression”, one third “medium aggression” and one third “low aggression” card and mix well.
4. With the cards face down, each student picks a card. This remains secret.
5. Once students have a strategy and an initial territory, go stand in a matching territory square. If the student drew a blank stick, they start off the game in the “floater” pool.
6. (optional) The instructor passes out offspring to students who have territories. Students on high quality territories start with 8 offspring and students on low quality territories start with 5 offspring.

*Part A: The “Fight for Free” Game*

Round 1:

1. Each “floater” picks one territory owner to challenge. Compare strategy cards and follow the instructions to determine who wins. More aggressive strategies beat less aggressive strategies. Ties are broken with rock-paper-scissors.
2. The winner now stands in the territory square. The loser joins the floater pool.
3. (optional) The instructor redistributes offspring. Students in the floater pool give up their offspring, students on high quality territories gets 8 and low quality territories get 5.

Round 2:

1. Just like round 1, each floater picks one territory owner to challenge. Follow the same steps as above.

Round 3:

1. Same as round 2.
2. Calculate your final score. If you are using the optional offspring cards, this score is simply the number of offspring each student is holding after the final round. Students remaining on “high quality” territories get an offspring score of 8 students remaining on “low quality” territories get an offspring score of 5, and students in the floater pool get an offspring score of 0.
3. For the entire population, count the total number of offspring produced by each strategy and the number of students with each strategy in the data sheet on the handout. Calculate the average number of offspring produced by each aggression strategy.

*Part B: The “Cost to Fighting” Game*

Round 1:

1. Like part A, each floater picks a territory owner to challenge.
2. The winner keeps the square, the loser joins the floater pool.
3. Both the challenger and the territory owner who was challenged put a tally mark in the “number of fights” box on the data sheet to indicate they had a fight that round. Territory owners who were not challenged do not write anything. (optional) If using cards, etc. to represent offspring, each student should tell the instructor how many fights they’ve had so far before they hand out offspring each round. Offspring are deducted following the rule on the strategy card. High aggressions strategies pay a cost of 2 offspring per fight, medium aggression strategies pay a cost of 1 offspring per fight, and low aggression strategies fight for free.

Round 2:

1. Repeat round 1.

Round 3:

1. Repeat round 2.
2. Calculate your final score with the help of the table in the student handout and the strategy card. As before, “high quality” territories get a score of 8, “low quality” territories get a score of 5, and floaters get a score of 0. Then subtract the cost of fighting multiplied by the number of fights that occurred. High aggression strategies pay a cost of 2 offspring per fight, medium aggression strategies pay a cost of 1 offspring per fight, and low aggression strategies fight for free.
3. Count the total number of offspring produced by each strategy and the number of students with each strategy in the data sheet on the handout. Calculate the average number of offspring produced by each aggression strategy.
4. (optional) If using offspring cards, the number that are no longer held by a student represent offspring that “could have been” and serve as a visual representation of the energy tradeoff.

*Conclusions:*

1. Using the class data for the “Part A: the ‘fight for free’ game”, make a bar graph of the average number of offspring produced for the three aggression strategies on the first graph template in the data sheet.
2. Using the class data for the “Part B: the cost of fighting game”, make another bar graph for the three aggression strategies in the second graph template.
3. Answer the post questions. See the attached “answer key” for possible answers.

**Resources**

* A student hand-out with data tables, post activity questions, strategy cards, offspring cards, and teacher answer key are available on the Angry Birds lesson page on the KBS GK-12 website.

**Extensions and Modifications**

This activity can be used to illustrate evolution and natural selection by allowing the successful strategies to “reproduce”. At the end of the game, the strategies in the floater pool “die”, the strategies on the low quality territories remain in the game, and the strategies on the high quality territories convert one of the floaters to their strategy. Repeat as many times as you like.

Numbers can be added to the graph template axes for less advanced students.

**Assessment**

 The data sheet contains post activity questions.