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# The Avian Architect: Designing with Data

## Materials Needed

- A notebook or journal for field observations (the "Data Log")
- Pencils and colored pencils/markers
- Binoculars (optional, but highly recommended)
- A bird identification guide (book or app like Merlin Bird ID)
- A watch or timer
- A calculator or spreadsheet software (like Google Sheets or Excel)
- Graph paper or plain paper for sketching
- A ruler

## Learning Objectives

By the end of this lesson, you will be able to:

- Collect and organize observational data on local bird species and their feeding behaviors.
- Apply mathematical concepts (frequency, mean, median, mode) to analyze real-world biological data.
- Use data-driven insights to solve a design problem.
- Apply geometric principles to create a detailed, functional design for a bird feeder.
- Communicate your design process and justify your choices in a clear, written proposal.

## Lesson Overview

Welcome, field scientist and engineer! Many bird feeders are generic, but what if you could design the *perfect* feeder specifically for the birds in your backyard? In this project, you will act as both an ornithologist and a design engineer. You will first gather data on your local bird population and then use that mathematical evidence to design a custom bird feeder that caters to their specific sizes, numbers, and behaviors.

## Step-by-Step Instructions

### Part 1: The Ornithologist - Data Collection (2-3 days, 30 minutes per day)

Your first task is to become an expert on your local bird clientele. You need to observe them carefully and record what you see. Find a good spot where you can see birds (near an existing feeder, a tree, or a birdbath).

1. **Set Up Your Data Log:** In your notebook, create a chart with the following columns:
    - Date & Time
    - Bird Species (or a simple description like "small brown bird" if you're unsure)
    - Number of Birds Seen (of that species at one time)
    - Estimated Size (e.g., smaller than a sparrow, sparrow-sized, larger than a robin)
    - Behavior Notes (e.g., "perched for a long time," "ate quickly and left," "scared away smaller birds")
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2. **Conduct Observations:** Spend 30 minutes each day for 2-3 days watching for birds. Do this at the same time each day if possible (e.g., in the morning). Record everything you see in your Data Log. Be patient! Sometimes the birds take a while to show up.
3. **Be a Good Scientist:** Make your notes as detailed as possible. Did a large Blue Jay scare off a group of three small finches? Write that down! Did the chickadees seem to prefer clinging to the side of a branch instead of sitting on top of it? That's a crucial design detail!

Part 2: The Mathematician - Data Analysis (1 hour)

Now that you have your raw data, it's time to find the patterns. This is where you turn your observations into powerful information that will guide your design.

1. **Calculate Frequency:**
    - Which bird species did you see most often? Create a simple tally chart or bar graph to visualize the frequency of each species. This tells you who your main customers are.
2. **Analyze Group Size:**
    - Look at the "Number of Birds Seen" column for your most frequent species.
    - What is the **mode** (the most common group size)? This helps you decide how many perches or feeding ports you might need.
    - What is the **mean** (average) group size? (Add up all the numbers in that column and divide by the number of observations).
3. **Determine "Client" Size:**
    - Based on your frequency chart and size estimates, what is the most common size of bird you want to attract? Your design should accommodate them. For example, a feeder with tiny perches will be great for finches but unusable for doves.
4. **Synthesize Your Findings:** Write a one-paragraph summary of your data. For example: "*My data shows that Black-capped Chickadees are the most frequent visitors, usually arriving in pairs (mode=2). They are small birds that seem comfortable clinging. The larger Blue Jays, while less frequent, often intimidate the smaller birds. My design should prioritize small, clinging birds and potentially deter larger birds.*"

Part 3: The Engineer - Design & Blueprint (1.5 hours)

This is where your creativity comes in! Use your mathematical summary from Part 2 to design a bird feeder. You are not building it yet, just creating a detailed plan.

1. **Brainstorm:** Based on your data summary, sketch out 2-3 rough ideas. Think about these questions:
    - **Capacity:** How much seed should it hold, based on how many birds you saw?
    - **Access:** How will the birds get the food? Small holes? A tray? Will the perches be long dowels or small nubs for clinging? Your data on bird size and behavior is key here.
    - **Exclusion:** How can you make it difficult for squirrels or larger, "bully" birds to use it, if that was a problem you observed? (e.g., weight-activated perches, cage around the feeder, etc.)
    - **Materials:** What materials would be best? (Wood, plastic, metal?)
2. **Create Your Final Blueprint:** Choose your best idea and draw a detailed, to-scale blueprint on graph paper.
    - Include at least two views: a front view and a top-down view.
    - Label all dimensions clearly (e.g., length, width, height, diameter of perches/holes). These dimensions should be directly related to the size of your target birds.
    - Include a list of proposed materials.
    - Write short notes on the blueprint to explain specific features (e.g., "Drainage holes to keep seed dry," or "1/2-inch perch diameter, ideal for chickadee feet").

Assessment: The Design Proposal

To complete the project, assemble your work into a single "Avian Architect Design Proposal." This will demonstrate your full process from observation to final design. The proposal should include:

1. **Title Page:** The Avian Architect Proposal by [Your Name]
2. **Field Data:** A clean, typed or neatly written copy of your Data Log from Part 1.
3. **Mathematical Analysis:** Your frequency chart/graph, your calculations for mean and mode, and your one-paragraph summary of findings from Part 2.
4. **Final Blueprint:** Your detailed, labeled, multi-view drawing of the feeder from Part 3.
5. **Design Justification (Written Explanation):** A 2-3 paragraph explanation of your design. You must clearly connect specific features of your feeder back to the data you collected.
    - **Example:** "*I included four feeding ports because the average group size of finches was 3.5, so this allows the whole group to feed. The perches are only 1 inch long because my observations showed that larger birds like jays had trouble balancing on small branches, and this feature is intended to reserve the feeder for the smaller target species I observed most frequently.*"

Differentiation & Extension Ideas

- **For an extra challenge (Maths):** Calculate the volume of your proposed feeder to determine exactly how much birdseed it can hold. If a bag of seed costs $X and holds Y cubic inches, calculate the cost to fill your feeder. You could also research the metabolic rate of your target bird and calculate how long one fill-up would last for an average number of visitors.
- **For an extra challenge (Ornithology):** Research the specific dietary needs of the most common bird you identified. Does your feeder design work with the type of food they prefer (e.g., thistle seeds, suet, sunflower seeds)? Modify your design if needed.
- **For the tech-lover:** Create a 3D model of your feeder using free software like Tinkercad or SketchUp instead of a 2D drawing.
- **For the hands-on builder:** If you have the materials and supervision, try to build a real prototype of your design!

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