Exploring Relationships Between Quantitative Variables

Objective

Work in small groups to collect data from classmates, create a scatterplot, estimate correlation using the ellipse method, and describe the relationship using the DUFS framework (Direction, Unusual features, Form, and Strength).

Materials Needed

- Chart paper or printed **equal-scale graph paper**
- Ruler or measuring tape
- Markers or pencils
- Class shared data form (Google Form or paper slip)
- Calculator or phone (optional for actual r calculation)
- "Measure the Correlation" worksheet

Step-by-Step Directions

Step 1: Select Your Variable Pair (3 minutes)

Each group chooses a **unique** pair of quantitative variables. Examples:

- **Height (cm) vs Wingspan (cm)** — expected strong positive linear
- **Hand span (cm) vs Foot length (cm)** — expected moderate positive
- **Ruler drop distance (cm) vs Taps in 10 seconds** — expected negative
- **Minutes since last ate vs Hunger rating (0–10)** — expected curved positive
- **Birthday (day of year, 1–365) vs Shoe length (cm)** — expected near zero

Step 2: Collect Your Data (12 minutes)

- Access the shared class data form for survey variables
- For measurement pairs, collect data from at least 12–18 classmates
- Record all data pairs in your data table

Step 3: Plot the Data — EQUAL SCALES REQUIRED! (8 minutes)

Critical: Both axes must use the **same scale**
Example: If 1 cm = 10 units on the x-axis, then 1 cm = 10 units on the y-axis
This is **essential** for the ellipse method to work correctly!

- Label both axes with variable names and units
- Mark the scale clearly (e.g., "1 grid square = 5 units")
- Plot all data points accurately

Step 4: Draw and Measure the Ellipse (8 minutes)

1. Draw a **symmetrical ellipse** that encompasses most of the data cloud
2. Mark and draw the **major axis** (longest diameter)
3. Mark and draw the **minor axis** (perpendicular to major, shortest diameter)
4. Measure both axes in centimeters
5. Apply the formula:

$$\boxed{r \approx \pm\left(1 - \frac{\text{length of minor axis}}{\text{length of major axis}}\right)}$$

6. Determine the **sign** based on the direction of the pattern:
   - Positive (+) if pattern slopes upward
   - Negative (–) if pattern slopes downward

Step 5: Write Your DUFS Statement (5 minutes)

Use this template to describe your results:

> "The association between _____ and _____ appears linear/curved/no pattern with a positive/negative/no direction and weak/moderate/strong strength.
> Our ellipse estimate gives $r \approx$ _____, which supports/confirms this description.
> We observed [describe any outliers, clusters, or unusual features].
> Although there is an association, **correlation does not imply causation**."

Step 6: Create Your Poster (4 minutes)

Your poster must include:

- ☐ Title with both variable names and units
- ☐ Group members' names
- ☐ Data table (12–18 ordered pairs)
- ☐ Labeled scatterplot with **equal scales stated**
- ☐ Ellipse with major/minor axes clearly marked
- ☐ Calculated r value with work shown
- ☐ Complete DUFS statement in context
- ☐ "Correlation $\neq$ Causation" reminder

Step 7: Gallery Walk — Peer Review (5 minutes)

Walk around and leave two sticky notes on other groups' posters:

1. **Green note:** What you think the sign of r should be and why
2. **Yellow note:** One unusual feature you notice (outlier, cluster, curve, etc.)

Quick Reference

Strength Guidelines	**Based on $\lvert r\rvert$**
Strong	$\lvert r\rvert > 0.7$
Moderate	$0.4 \leq \lvert r\rvert \leq 0.7$
Weak	$\lvert r\rvert < 0.4$

Form	**Look for...**
Linear	Points follow a straight line pattern
Curved	Points follow a curved pattern
No pattern	Points scattered randomly

Extension Activity (If Time Permits)

Use Desmos or a graphing calculator to find the actual correlation coefficient r. Compare it to your ellipse estimate. Why might they differ? Consider:

- Was your ellipse truly symmetrical?
- Did you use perfectly equal scales?
- Are there outliers affecting the calculation?
- Is the relationship actually linear?