Open Your Class With This Tomorrow- *The Essential Guide to Effect Sizes: Statistical Power, Meta-Analysis, and the Interpretation of Research Results*

Activity: Simulating a Meta-Analysis in a High School Classroom

Objective: Students will simulate the process of conducting a meta-analysis by collecting studies, coding data, calculating average effect sizes, and interpreting results.

Materials Needed:

- A set of simplified research summaries or short articles (can be based on a topic relevant to the class, like the effects of exercise on concentration or the impact of different study methods on grades)
- Coding worksheets with categories like study type, sample size, and effect size
- Calculators or computers for basic calculations (e.g., mean and averages)

Step-by-Step Activity:

1. **Introduction to Meta-Analysis**
   Briefly explain meta-analysis in simple terms: "Meta-analysis is like putting together a puzzle of many smaller studies to see the bigger picture." Explain the steps involved, focusing on collecting data, averaging results, and interpreting findings.
2. **Selecting Studies**
   - **Activity**: Give students 3-5 short summaries of research studies. The studies should cover the same topic (e.g., "Does exercise improve concentration?") but have varying results.
   - **Group Work**: In small groups, students read through the studies and discuss which ones they will use for their "meta-analysis." They will select studies based on simple criteria like relevance to the topic, clarity of results, and sample size.
3. **Coding the Studies**
   - **Activity**: Hand out a simple coding worksheet where students will note key details about each study, such as:
     - **Study Type** (e.g., experiment, correlation)
     - **Sample Size** (e.g., number of participants)
     - **Effect Size** (e.g., "small," "medium," or "large")
   - **Discussion**: Students will code their studies individually, then compare their codes in groups to ensure they understand the terms and criteria.
4. **Calculating the Mean Effect Size**
   - **Activity**: After coding, students will calculate the "average effect size" by simply adding up the effect sizes from all the studies and dividing by the number of studies.
     - If using categories like "small," "medium," and "large," assign values (e.g., small = 1, medium = 2, large = 3) to simplify.

- **Group Work**: Have each group calculate the average effect size for their studies and share their results with the class.
- **Discussion:** Discuss drawbacks of this approach and what should be used instead.

5. **Statistical Significance**
   - **Activity**: Explain that statistical significance helps us know if the findings are likely real or just by chance. For simplicity, tell students that if the average effect size is above a certain threshold (e.g., an average of "2" for medium), the result is considered statistically significant.
   - **Group Work**: Each group will decide whether their findings are significant based on their calculated average effect size.
6. **Examining Variability**
   - **Activity**: Have students discuss the differences between the studies they chose. Do they see a pattern, or are the results very different?
   - **Discussion**: List the studies and their effect sizes. Ask students to discuss what might explain any differences in results (e.g., sample size, study methods).
7. **Interpreting Results**
   - **Activity**: Each group will present their findings to the class. They should answer questions like:
     - What does the average effect size tell us about the topic?
     - Are the results consistent, or is there a lot of variation?
     - What real-world implications could the results have (e.g., Should students exercise more to improve concentration)?
   - **Discussion**: After each presentation, allow the class to ask questions and discuss how the findings might be applied in real life.
8. **Reflection and Debrief**
   - **Activity**: Have students reflect on the process. What did they learn about how research studies can be combined? How can meta-analysis help us understand bigger trends in science and social issues?
   - **Discussion**: Ask students to share their thoughts on what they found challenging or interesting about the activity.

Teacher Background Knowledge

The meta-analytic process can be broken down into six key steps:

1. Collect the Studies
    a. Conduct a comprehensive search for all relevant research on the topic.
    b. Document the search process in detail.
    c. Exclude papers that don't report data or use qualitative methods.
    d. Set eligibility criteria that include measurement procedures and research designs.
2. Code the Studies
    a. Determine how many studies will be coded. If there are many, select a representative sample.
        i. Ensure the sample is large enough to test all relationships of interest.
        ii. Confirm that coded and uncoded studies don't differ in variables affecting the effect size calculation.
    b. Assign numerical codes to study characteristics.
        i. At minimum, code the study results and characteristics that influence accuracy.
        ii. This step can take many hours of detailed reading.
    c. Convert effects from the r family and d family into a common metric before combining.
    d. Ensure effect sizes are based on independent observations, avoiding issues when multiple papers report results from the same study.
    e. Consider study-specific features for coding, and be mindful of challenges like defining codes clearly and deciding what not to code, ensuring interrater agreement, and recoding studies if necessary.
3. Calculate a Mean Effect Size
    a. Avoid simply averaging the effect sizes.
    b. Instead, calculate a weighted mean effect size, correcting for measurement error and weighting by sample size.
4. Compute the Statistical Significance of the Mean
    a. Option 1: Convert the result to a z-score and check if the probability is less than 0.05.
    b. Option 2: Calculate a 95% confidence interval to see if it excludes the null value (zero).
5. Examine the Variability in Effect Size Estimates
    a. A wide confidence interval suggests the effect sizes are heterogeneous (how similar or different the results are), meaning they are not concentrated around a single population mean but spread across several means.
6. Interpret the Results
    a. The reviewer should assess the practical significance of the meta-analytic findings.