

## ECE 608 Assignment #4: Power and Sample Size Calculations

### OVERVIEW

The purpose of this assignment is investigate the relationship between power, effect size, and sample size, to better appreciate how we can appropriately design studies to test scientific hypotheses.

This report is due by 11:30 **pm** July 3 using the R Notebook layout. This format will allow you to include written descriptions of your code, which will be important for future assignments on the statistical theory behind common statistical tests. Please submit this report via Learn for grading, **naming it [Your last name]\_Assignment4.Rmd** (e.g., Au\_Assignment4.Rmd)

### ASSIGNMENT INSTRUCTIONS [14 marks]

**You will need to load the following packages:** tidyverse, grid.extra, pwr, pwr2

You have been asked by the ECE department to conduct a trial within the University of Waterloo to evaluate the benefit of **active learning** vs **traditional lecturing** for undergraduate students in STEM (science, technology, engineering, and math). Fortunately, you have found an excellent **meta-analysis** that can help guide your investigation. Using the results from Freeman et al. (2014) *PNAS*, answer the following questions to help design your university-wide study. (HINT: *PNAS* is a very high profile journal; **you may need to look at the Supplemental Tables to answer the questions**).

1. Summarize the findings of the meta-analysis using the following prompts: [5 marks]
  - a. What is the purpose of the study?
  - b. Qualitatively describe Figure 2A.
  - c. What is the primary finding of the study?
  - d. Do a little research of your own and describe how **Hedges's g** differs from **Cohen's d**. Why might have the researchers used Hedges's g in their study?
2. The university is currently revising its budget and would like you to submit a few different study designs for your investigation. **How many** participants should you recruit for the following research questions? **Assume** that students do not experience both active learning styles and traditional styles (i.e., not a cross-over design). List both the anticipated **effect size** and estimated **total sample size** in your answer. (For this question, **assume that Hedges's g == Cohen's d**) [6 marks]
  - a) Using the suggested **overall effect size** reported across the 8 STEM disciplines, what is the sample size needed to find effects for a comparison between active and traditional lecturing styles.
  - b) What is the sample size needed to find effects for a study design comparing active learning vs traditional lecturing **between each** of the 8 STEM disciplines, assuming an effect size of  $f=0.5$  for **learning style**, and an effect size of  $f=0.2$  for **STEM discipline**?

- c) Using the `grid.arrange` function, create 3 side-by-side plots to show the sample size vs power curve for Engineering, Biology, and Mathematics disciplines. What sample size looks like an appropriate fit for all disciplines?
3. Using the first study design (2a), write up a **full sample size** calculation statement that you would submit for a grant application. Be sure to include all pertinent information that goes into your decision making, as discussed in class. [3 marks]