Statistics 461:
The Design and Analysis of Social Experiments with Cluster Randomization

Instructor: Larry V. Hedges
Office: 2046 N. Sheridan Road
Email: l-hedges@northwestern.edu

This course covers the design and analysis of social experiments conducted in field settings. Social experiments typically differ from laboratory experiments or experiments in the biological or physical sciences in two ways. First, most field experiments in the social sciences involve populations that have complex nested structure (such as students within classrooms within schools or individuals within communities). Consequently sampling plans are rarely simple random samples, but are typically multi-stage cluster samples. Second social experiments typically do not involve randomization of individuals to treatments. Instead, intact groups (such as classrooms, schools, or communities) are often randomized to treatments. These differences lead to somewhat different considerations in the design and analysis of social experiments than the design and analysis of laboratory experiments.

This course begins with an introduction to experimentation and why social experiments are necessary. Then we explore the structure of social populations, its implications for sampling designs and the implications of multistage sampling designs for summary statistics. We will explore notions from classical experimental design and the relation between ideas from experimental design and sample survey design. The idea of units of randomization and units of causal inference are introduced.

This course will focus exclusively on a few experimental designs that are most widely used in social experiments. For each design we will begin with examples of studies using the design, followed by an explication of the classical analysis of variance approach to the analysis of the design. Then we explore alternative analyses for the design. The alternatives typically include analyses using cluster means as the unit of analysis and multilevel mixed models (hierarchical linear models). Problems with using general linear model analyses will be discussed. Precision of treatment effect estimates, power analyses, sample size calculation, and determination of minimum detectable effect size are then examined.

Three classes of social experimental designs will be the primary focus of the course. The first is the hierarchical design where intact groups (such as schools, sites, or communities) are randomized to treatments. This design often has variants where intact subgroups (such as classrooms, divisions, or neighborhoods) are nested within the intact groups. The second class of designs includes the (generalized) randomized block design and its generalizations, where individuals (such as people) or units (such as classrooms) are assigned to treatments. A third class of designs involves repeated measurements on each individual (such as longitudinal designs) in addition to the treatment assignment structure.

Evaluation

The purpose of this course is to provide enough background for students to competently plan and analyze social experiments. Consequently, the course will include exercises in the design

and analysis of social experiments. These exercises will include the evaluation of design problems such as the evaluation of power, sample size, and minimum detectable effect size. The goal is for students to be able to prepare the kind of design justification that is required in research grant proposals to the National Institutes of Health, the National Science Foundation, or the Institute of Education Sciences. Exercises will also include analyses of data from social experiments. There will also be a take home final exam using ideas from the entire course.

Prerequisites

Students must have a background in statistics and research design at the level of a beginning graduate course on the general linear model. Some background in one of the quantitative social, medical, or biological sciences is helpful for students.

Textbooks

We will have no formal textbook for this class, although one book,

Bloom, H. S. (Ed.) (2005). *Getting the most out of social experiments*. New York: The Russell Sage Foundation.

is recommended. I also recommend that you obtain a book on classical experimental design (there are many to choose from although those by Roger Kirk and Ben Winer are classics) for reference. We will work with articles, working papers, and some notes that I will provide. As much as possible of this material will be available on the course website.

Course Outline

March 27 — Introduction to social experiments
Why are social experiments necessary? Surveys and experiments. Clustered sampling in social experiments. Consequences of clustered sampling for statistical analysis. Regression analysis and varieties of analysis of variance. Multilevel models for analysis of social experiments.

April 3 — Basic experimental design
Blocks and factors versus strata and clusters, crossing and nesting, and their relation to concepts in survey sample design. Group assignment and cluster randomization. Fixed and random effects. Units of causal inference. Examples of widely used designs.

April 10 — **NO CLASS**

April 17 — The hierarchical design with one level of nesting
Examples
Sampling model and mixed-effects analysis of variance

	Alternative analyses: Cluster means as the unit of analysis, hierarchical linear models, the general linear model Power, sample size, and optimality computations
April 24	The hierarchical design with two or more levels of nesting Examples Sampling model and mixed-effects analysis of variance Alternative analyses: Cluster means as the unit of analysis, hierarchical linear models, the general linear model
May 1	The hierarchical design with two or more levels of nesting Power, sample size, and optimality computations Consequences of omitting levels
May 8	The randomized block design and its generalizations with one level of nesting Examples Sampling model and mixed-effects analysis of variance Alternative analyses: Cluster mean differences as the unit of analysis, hierarchical linear models, the general linear model Power, sample size, and optimality computations
May 15	The randomized block design with two or more levels of nesting Examples Sampling model and mixed-effects analysis of variance Alternative analyses: Cluster mean differences as the unit of analysis, hierarchical linear models, the general linear model Power, sample size, and optimality computations
May 22	**NO CLASS**
May 29	Designs for longitudinal experiments Analytic models from HLM, structural equation modeling Power, sample size, and optimality computations
June 5	Experimental design, generalization, and scientific progress Experiments and social policy