

Worcester Polytechnic Institute
Learning and Information Sciences
SS 590
Causal Inference
KH 203, Wednesdays 4:00 – 7:00 pm

Contact Information:

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I am available online by appointment via Webex or Google Hangout and in person by appointment.

I. Course Description

- II.** SS 590 Causal Inference is a doctoral level course emphasizing theory and application of methods in educational research that support making inferences about causal effects from experimental and non-experimental data.

Randomized Controlled Trials are considered the “gold standard” in research if we want to measure the effect of a treatment. But this is not the only way we can analyze and measure a treatment effect. In this course, we will explore the design, execution, and analysis of research with a goal of identifying the causal effect of a treatment. We will work through the language and mathematical structure of the potential outcomes framework to examine causal questions, within frameworks including both experimental and quasi-experimental design. This course will cover three connected sections of content:

- Rubin’s Causal Model (RCM) and the assignment mechanism using early papers by Rubin, Holland, Lord, Fisher, and Neyman.
- Causal Inference in Randomized Trials, Mediation and Moderation.
- Causal Inference in Quasi Experimental Designs including Regression Discontinuity and Matching Designs.

This course will focus on understanding causal inference and how it influences the formulation of research questions, research design, the statistical models and the interpretation of results allowing us to make causal claims. This course will include some theoretical and historical context to allow the student to follow the development of

current causal modeling frameworks. We will also examine policy questions, current publications, datasets, and research questions to analyze and critique the framework and claims of causality. Readings will be drawn from Murnane and Willett along with other books chapters. The lab portion of this course will provide students with opportunities to learn and apply techniques using SPSS.

III. Course Learning Objectives

By the end of this course, you will be able to

- demonstrate an understanding of the foundational theory of causal inference and how it has been applied educational policy research;
- analyze causal research using the Rubin Causal Model and potential outcomes framework,
- evaluate published research, research designs, and research ideas to identify threats to validity of causal claims,
- synthesize causal inference with research design to recommend solutions to threats to validity,
- analyze and apply statistical models that support the measure of the treatment effect to both experimental and quasi-experimental designs including regression discontinuity, matching, and instrumental variables,
- examine and deconstruct research methods to measure the impact of moderation and mediation.
- effectively use SPSS and analyze results to support execution of all methods discussed,
- create original work to support research of a causal question both experimental and quasi-experimental and with mediator or moderator variables using theory and applications from this course.

IV. Resource Requirements

There are three required textbooks adopted for this course and two optional textbooks. The required textbooks are:

American Psychological Association (2009). *Publication manual of the American Psychological Association* (6th ed.). Washington, DC: APA.

Field, Andy. *Discovering statistics using IBM SPSS statistics: North American edition*. Sage, 2017.

NOTE: Although there will not be weekly assigned chapters out of the Field book, it is my expectation that you will use the book to supplement your learning in cases where your background needs some scaffolding to the assigned content.

Murnane and Willett (2011). *Methods Matter*. New York: Oxford University Press.

The optional textbooks are:

Hayes, Andrew F. (2018). Introduction to Mediation, Moderation, and Conditional Process Analysis. New York: The Guilford Press.

Morgan, S. L., & Winship, C. (2015). Counterfactuals and causal inference. Cambridge University Press.

In addition, you are required to engage in activities using a computer and the following:

1. SPSS (version 23 or later)

IBM Statistical Package Software for Data Analysis. If you purchase the software, be sure to get the Premium Grad Pack which costs approximately \$90. Discounted student versions are available online through a variety of vendors such as the following: <https://studentdiscounts.com/spss.aspx>

2. Additional required readings and online content:

Access via Canvas Learning Management System.

3. Canvas LMS:

All graduate students have been assigned WPI e-mail accounts by the University and these should be used for course communication and activities.

V. Instructional Methods and Activities

Methods and activities for teaching and learning include:

1. Traditional Experiences

- a) Lecture by the instructor
- b) Textbook and article readings
- c) In class computer analysis in a lab environment

2) Collaborative Experiences

- a) In class discussions, debates and presentations
- b) Online discussions
- c) Group data analysis projects

3) Online Experiences

- a) Review of a variety of online content prior to or subsequent to attending class
- b) Occasional interaction with other students using online learning tools including discussion boards and Wikis. We will use one or two of these at least once. Based upon student interest and openness to the experience, I will create additional online learning and collaboration opportunities. This is a face to face course, and I respect that not all students may be enthusiastic about completing online work.

VI. Evaluation and Grade Assignment

The methods of evaluation and the criteria for grade assignment are:

- Problem Sets will provide students with the opportunity to practice statistical techniques which require the use of Excel and/or SPSS. In class labs will provide an opportunity for students to practice the techniques, and for these, solutions will be provided. Students will be given two attempts to master the technique, as demonstrated by completed analysis and accurate written description of the problem, method, and results. APA format is not required for Problem Sets.
- Short papers (1-4 pages) and in-class presentations will be used to provide a more in-depth presentation of student knowledge of a topic including literature reviews, abstracts, critiques, and responses to questions. Rubrics will be provided at the time of assignment.
- Data Analysis papers (1-4 pages) with a discussion of data analysis and interpretation will provide an opportunity for you to demonstrate your understanding of SPSS and your skill at interpretation and display of statistical results. Rubrics will be provided at the time of assignment.
- Final Assignment: Students will need to choose one of the following research projects, write a paper, and complete a 15-20 minute class presentation.
 - (1) Design and complete original research using either your own data or HSLs-09,
 - (2) Replicate research from a publication including data analysis, or
 - (3) Create an evaluative tool describing and showcasing one of the methods used in this course.
 - If you choose to complete original research or replicate research, this assignment will involve discussing the research questions and design, analyzing data using SPSS, interpreting results, writing a paper, and presenting results in class.
 - If you decide to create an evaluative tool, you will need to carefully critique at least 5 publications using the technique and provide a teaching summary on the strengths and weaknesses of the papers and the technique.
 - The assignment will be assessed based on integration of knowledge from class; focus of topic; depth of discussion; accuracy of methods; cohesiveness; synthesis of research; spelling/grammar; sources; APA citation. Internal citations and references must adhere to APA format, 6th ed. A secondary goal of this assignment is to provide you with a final product that is nearly publication or conference presentation ready.

The rubric will be provided at approximately mid-term when the project is officially assigned.

- More information on papers, problem sets, online activities will be provided at the time of assignment.

Grading/Assignments

Requirements	Percentage
Online and In Class Participation – Discussions, Online Discussion boards, and Debates,	15%
Problem Sets and Data Analysis Papers	20%
Short Papers, Research Summaries, and In Class Presentations	30%
Final Paper & Presentation	35%

Grading Scale

Grade	Range
A	90%-99%
B	80%-89%
C	70%-79%
D	60%-69%
F	<60%
AU	Audit
I	Incomplete

VII. Course Schedule and Policies

A. Course Schedule

A course schedule is located at the end of this document.

There will be no new assignments during breaks. However, students who wish to continue to work on their assignments are welcome to interact with me and each other using email and Canvas. Additional readings may be assigned throughout the semester. If you are falling behind in this class or struggling with concepts, please reach out right away so we can address these issues in a timely manner to ensure your success.

B. Assignments

Problem Sets should be compiled into a single digital document such as a pdf using a combination of Excel spreadsheets, Word Documents, and SPSS output and do not need to follow APA guidelines. All papers must be typed, doubled spaced, and spell checked. Cite references where applicable and follow APA (6th ed.) guidelines in doing so. All papers and projects should be submitted on or before the date that they are due. Internal citations and references must adhere to APA format, 6th ed. All papers should be submitted via Canvas. Email submissions can sometimes be lost, and so it is to the student's advantage to submit through Canvas.

VIII. Worcester Polytechnic Institute Policies

Academic Integrity

Students are expected to adhere to WPI's Academic Honesty Policy. Plagiarism is not tolerated. If you have questions about the policy, refer to the Student Guide to Academic Integrity at WPI.

The Student Guide to Academic Integrity, located on the university policies webpage <https://www.wpi.edu/about/policies/academic-integrity/student-guide> provides information associated with academic dishonesty inquiries. Students are expected to be

familiar with the policy and understand what constitutes violations of the policy. If unsure, students have an obligation to ask their Professors questions pertaining to the issue.

Special Accommodation

If you have a disability or medical situation for which you are or may be requesting an accommodation, you are encouraged to contact me as soon as possible. In addition, you should contact the Disability Services Office (DSO) as soon as possible to ensure that your accommodations can be arranged. The DSO should contact me with the specific details of your accommodations. The DSO office is located in Daniels Hall at 508-831-4908.

References

- American Psychological Association (2009). *Publication manual of the American Psychological Association* (6th ed.). Washington, DC: APA.
- Dougherty, S. M. (2015). Bridging the discontinuity in adolescent literacy? Mixed evidence from a middle grades intervention. *Education Finance and Policy, 10*(2), 157-192.
- Field, Andy. *Discovering statistics using IBM SPSS statistics: North American edition*. Sage, 2017.
- Freedman, D. (1991). Statistical Models and Shoe Leather. *Sociological Methodology, 21*, 291-313. doi:10.2307/270939
- Hayes, Andrew F. (2018). *Introduction to Mediation, Moderation, and Conditional Process Analysis*. New York: The Guilford Press.
- Holland, P. W. (1986). Statistics and causal inference. *Journal of the American statistical Association, 81*(396), 945-960.
- Murnane, R. J. & Willett, J. B. (2011). *Methods matter: Improving causal inference in educational and social science research*. New York: Oxford University Press.
- Rubin, D. B. (1974). Estimating causal effects of treatments in randomized and nonrandomized studies. *Journal of educational Psychology, 66*(5), 688.
- Shadish, W. R., Cook, T. D., & Campbell, D. T. (2002). *Experimental and quasi-experimental designs for generalized causal inference*. Boston: Houghton Mifflin.

Schneider, B., Carnoy, M., Kilpatrick, J. Schmidt, W.H., & Shavelson, R.L. (2007). *Estimating causal effects: Using experimental and observational designs*. Washington DC: American Educational Research Association.

Class	Class Date	Topic(s)	Required Readings*	In class activities	Assignment Due
1	8/28/2019	Introductions & Syllabus Review	Syllabus	Student Introductions	None
		The Fundamental Problem of Causal Inference? Topics from Murnane & Willett Chapters 1-2 and Morgan & Winship Chapter 1.		Discussion of research and causal inference	
2	9/4/2019	Using Regression in Causal Inference, Research Design.	Murnane & Willett Chapters 1-4; Freedman, D. A. (1991) Field Chapter 9.	Student Discussions. SPSS data analysis from M&W chapter 4	Brief discussion and one-page summary of one of the policy research examples from M&W.
3	9/11/2019	Rubin's Causal Model; Lord's paradox	Rubin (1974); Holland (1986)	Data Analysis showing Lord's paradox and Simpson's paradox	Problem Set: Analysis of Causal effects using regression and t tests.
4	9/18/2019	Threats to Validity in Causal Inference in Randomized Controlled Trials	Shadish, Cook, & Campbell: Chapters 2-3	In class activity analyzing and evaluating validity of research designs.	Problem Set: Analysis showing Lord's paradox and Simpson's paradox
5	9/25/2019	Threats to Validity in Causal Inference in Randomized Controlled Trials	Shadish, Cook, & Campbell: Chapters 2-3	Students will be assigned (or choose with instructor approval) an article and lead a discussion on validity of a piece of published research.	Short paper analyzing the validity of an assigned/chosen piece of published research.
6	10/2/2019	More challenges in randomized experiments; statistical power.	Murnane & Willett Chapters 5-6	In class activity: Statistical Power	TBD*

Class	Class Date	Topic(s)	Required Readings*	In class activities	Assignment Due
7	10/9/2019	Groups and Natural Experiments. Assignment of final project.	Murnane & Willett Chapters 7-8; Schneider et al., Chapter 4;	In class discussion of natural experiments. In class usage and discussion of HSLs 09 dataset.	Data Analysis Project: Statistical Power
	10/16/2019	Fall Break - No assignments or class			
8	10/23/2019	Moderation and Mediation	Fields Chapter 11; VanderWeele (2016) Murnane & Willett Chapter 11; Optional: Hayes, chapters 3 and 7	Data Analysis comparison of mediation to moderation	Provide topic for final project in a 2-3 page proposal (short paper format).
9	10/30/2019	Modeling to Test Mediation	Fields chapter 11; VanderWeele (2016) Murnane & Willett Chapter 11; Hayes, chapters 3 and 7	Data Analysis of Causal effects with mediation.	Short paper analyzing published research that utilizes mediation and/or moderation.
10	11/6/2019	Quasi-Experimental Designs: Regression Discontinuity	Murnane & Willett Chapter 9; Dougherty et al. (2015)	Data analysis with regression discontinuity	Data Analysis Project: Causal effects with mediation.
11	11/13/2019	Quasi-Experimental Designs: Instrumental Variables	Murnane & Willett Chapters 10-11	Data analysis with instrumental variables. Alternative, discussion of research that uses instrumental variables.	TBD*
12	11/20/2019	Quasi-Experimental Designs: Matching. Dealing with Bias in Treatment Effects - M&W Ch. 12;	Murnane & Willett Chapters 12		Short paper analyzing a research study that uses one of the quasi experimental designs discussed in class.
13	12/4/2019	Methodological Lessons- M&W Ch. 13;	Murnane & Willett Chapters 13	Student presentations	Student presentations

* Assignments including Required Readings are tentative and may be revised at the time of assignment.