# Methods for Causal Inference in Educational Research

## January/February 2022

## Dr. Isa Steinmann

This workshop aims to communicate theoretical knowledge about causal and non-causal inference, illustrate methods for causal inference from experimental and observational data, and exemplify hands-on applications of the methods in R.

Causal research questions aim to isolate effects of a treatment on those who got the treatment, independent of other effects and differences between the treated and untreated. The most straightforward way to answer causal research questions is to conduct randomized trials like in pharmaceutical studies, for instance. In many fields including education, randomized trials are however very difficult to conduct, due to practical, ethical, or financial reasons, among others. Therefore, educational research often has to rely on observational data, i.e. information that stems from pure observations of educational processes and outcomes without an interference of the researchers. Under specific circumstances, it is however possible to isolate causal effects anyway. This course will cover some of these methods both from a theoretical and practical perspective. Real example studies from the field of education will help to understand the assumptions and prerequisites behind these methods and to evaluate their scope critically.

The workshop will cover the following topics:

1. The potential outcome framework
2. Randomized trials
3. Regression models
4. Instrumental variable approaches
5. Regression discontinuity designs
6. Differences-in-differences approaches

The workshop encompasses lecture and interaction formats, group work, as well as practical exercises in the R environment. After a successful completion of the course, the students

* have a deep understanding of the potential outcome framework,
* have a broad knowledge about the assumptions, prerequisites, and procedures of randomized trials, regression models, regression discontinuity designs, differences-in-differences approaches, and instrumental variable approaches,
* can critically read and interpret results of causal inference studies,
* can apply methodological peculiarities of the causal inference methods in own analyses, and
* can develop own causal inference research questions and approaches.

## 

## Required Readings

Before each session, the participants read one book chapter or empirical study as preparation. All required readings are specified in the session schedule below and in Leganto.

## Slides and Materials

All slides and materials will be uploaded to Canvas.

## Session Schedule

| 1 | Introduction   * Time: 17 January 2022, 12:15-14:00h * Main instructor: Isa Steinmann * Required reading: Shadish, Cook, & Campbell (2002), chapter 1 |
| --- | --- |
| 2 | Designing Experiments   * Time: 20 January 2022, 12:15-14:00h * Main instructor: Isa Steinmann * Required reading: Shadish, Cook, & Campbell (2002), chapter 8 |
| 3 | Randomized Trials I   * Time: 24 January 2022, 12:15-14:00h * Main instructor: José Manuel Arencibia Alemán * Required reading: Angrist & Pischke (2015), chapter 1 |
| 4 | Randomized Trials II   * Time: 26 January 2022, 12:15-14:00h * Main instructor: José Manuel Arencibia Alemán * Required reading: Shadish, Cook, & Campbell (2002), chapter 9 |
| 5 | Regression Models   * Time: 31 January 2022, 12:15-14:00h * Main instructor: Isa Steinmann * Required reading: Angrist & Pischke (2015), chapter 2 |
| 6 | Further Control Strategies   * Time: 03 February 2022, 12:15-14:00h * Main instructor: Isa Steinmann * Required reading: - |
| 7 | Instrumental Variable Approaches   * Time: 07 February 2022, 12:15-14:00h * Main instructor: José Manuel Arencibia Alemán * Required reading: Angrist & Pischke (2015), chapter 3 |
| 8 | Regression Discontinuity Designs I   * Time: 10 February 2022, 12:15-14:00h * Main instructor: José Manuel Arencibia Alemán * Required reading: Angrist & Pischke (2015), chapter 4 |
| 9 | Regression Discontinuity Designs II   * Time: 14 February 2022, 12:15-14:00h * Main instructor: Isa Steinmann * Required reading: Luyten (2006) |
| 10 | Differences-in-Differences Designs I   * Time: 17 February 2022, 12:15-14:00h * Main instructor: Isa Steinmann * Required reading: Angrist & Pischke (2015), chapter 5 |
| 11 | Differences-in-Differences Designs II   * Time: 21 February 2022, 12:15-14:00h * Main instructor: Isa Steinmann * Required reading: Strello, Strietholt, Steinmann, & Siepmann (2021) |
| 12 | Lessons Learned and Closing   * Time: 23 February 2022, 12:15-14:00h * Main instructor: Isa Steinmann * Required reading: Rutkowski & Delandshere (2016) |

All sessions take place in Forskningsparken Basis 314. In case of Covid-related requirements, sessions might be held digitally.

## Assignment Requirements

The written assignment has to be submitted by **20 April 2022**.

The task is to discuss three published empirical articles which use methods for causal inference from non-experimental data. The three articles must be chosen from the list below. For each study, the report contains:

* A summary of the background and motivation of the study (i.e., why was the study conducted, what was the theoretical background, what did the literature review show)
* The identification of the causal question investigated in the study (i.e., what are treatment, outcome, and assumed causal mechanism)
* A critical discussion of the causal identification approach against the design principles of the respective causal inference method (i.e., what was the statistical approach, in how far were assumptions of the methods met)
* A critical summary of the findings of the study (i.e., what were the findings that directly relate to the research question, what were important other findings)
* A concluding discussion about the extent to which the causal question was appropriately answered by the study (i.e., were the statistical conclusions valid, were the conclusions internally and externally valid, are there other explanations for the findings, which limitations were and were not discussed by the authors)
* A recommendation on how this or similar future studies could be improved

The written assignment will be evaluated (pass vs. fail) against the following criteria:

* Structure: The overall report contains a title page and 3 reports on empirical studies from the list below. The 3 reports contain the subsections (1) background, (2) research question, (3) methods, (4) findings, (5) discussion, and (6) literature list.
* Scope: Each of the three reports must be limited to 4-5 pages. The overall report is therefore limited to 12-15 pages in addition to the title page.
* Readability: The text is in correct and clear, scientific English. Sections have appropriate headings and all abbreviations are introduced.
* Format: The format follows the APA standard (see <https://apastyle.apa.org/instructional-aids/student-paper-setup-guide.pdf>)
* File format: The written assignment is submitted as one PDF.

The written assignment is failed if it does not follow the above-mentioned criteria for the reports’ content, structure, scope, readability, format, and file format or if it is not submitted in time. The written assignment is failed if it misrepresents the empirical studies or methodological approaches.

## 

**List of empirical studies that can be discussed in written assignment**

Belfi, B., Haelermans, C., & De Fraine, B. (2016). The long‐term differential achievement effects of school socioeconomic composition in primary education: A propensity score matching approach. *British Journal of Educational Psychology, 86*(4), 501-525.

Falch, T., Nyhus, O. H., Strøm, B. (2014). Causal effects of mathematics. *Labour Economics, 31*, 174-187.

Fergusson, D. M., McLeod, G. F., & Horwood, L. J. (2014). Unemployment and psychosocial outcomes to age 30: a fixed-effects regression analysis. *Australian & New Zealand Journal of Psychiatry, 48*(8), 735-742.

Grewenig, E., Lergetporer, P., Werner, K., Woessmann, L., & Zierow, L. (2021). COVID-19 and educational inequality: How school closures affect low- and high-achieving students. *European Economic Review, 140*, 103920

Hanandita, W., & Tampubolon, G. (2014). Does poverty reduce mental health? An instrumental variable analysis. *Social Science & Medicine, 113*, 59-67.

Hwang, S. H. J. & Cappella, E. (2018). Rethinking early elementary grade retention: Examining long-term academic and psychosocial outcomes, *Journal of Research on Educational Effectiveness, 11*(4), 559–587.

Lesik, S. A. (2007). Do developmental mathematics programs have a causal impact on student retention? An application of discrete-time survival and regression-discontinuity analysis. *Research in Higher Education, 48*(5), 583-608.

Nye, B., Hedges, L. V., & Konstantopoulos, S. (2000). The effects of small classes on academic achievement: The results of the Tennessee class size experiment. *American Educational Research Journal, 37*(1), 123–151.

Rosén, M. & Gustafsson, J. E. (2016). Is computer availability at home causally related to reading achievement in grade 4? A longitudinal difference in differences approach to IEA data from 1991 to 2006. *Large-scale Assessment in Education, 4*(5), 1–19.