Propensity Score Matching and Higher Education

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with immense gratitude for friendship, mentoring, and introducing me to Propensity Score Matching

Some slides were adapted from a presentation given by Dr. Bobbie Frye, Achieving the Dream

Propensity Score Matching – Approximating Experimental Research in an Imperfect Setting

"From Descriptive Reporting to Predictive Action: A Practical Guide for Institutional Researchers"

SESUG 2025 | Analytics & Data Mining Track

How do you …

- … know a new intervention / program is making an impact?
- … or look back at the past and compare to the present when context has changed over time?
- … or remove variables that may be influencing results (confounding variables)?

The Institutional Research Challenge

📊 Traditional Approach:

- Descriptive statistics and correlational analyses
- "Students in Program X had higher graduation rates"
- Limited actionable insights

❓ Critical Questions We Can't Answer:

- **Causality:** Did the program actually cause better outcomes?
- **Prediction:** Which current students are at risk?
- **Targeting:** Who will benefit most from interventions?
- **Bias:** Are we comparing similar students?

🚨 The Problem:

Selection bias makes it impossible to determine true program effectiveness

A PSM Approach

🔄 **Three-Stage Methodology:**

Stage 1: Causal Inference

- Use propensity score matching to create comparable groups
  → *Addresses selection bias*

Stage 2: Predictive Modeling

- Apply logistic regression to predict student outcomes
  → *Enables early intervention*

Stage 3: Actionable Insights

- Generate specific recommendations for student success
  → *Drives evidence-based decisions*

📈 **Result: Move from "*What happened?*" to "*What will happen?*" and "*What should we do?*"**

Propensity Score Matching

How Propensity Scores Work - https://www.youtube.com/watch?v=gMDVhFU38XU&t=215s

Example

Testing the Efficacy of Educational Interventions on Matched Student Samples: A Primer for Propensity Score Matching in R.

Evans, Nicholas D., Perez, Perla C., & Morera, Osvaldo F. (2025). *Journal of STEM Outreach, 8*:1, 1-9. https://files.eric.ed.gov/fulltext/EJ1489363.pdf

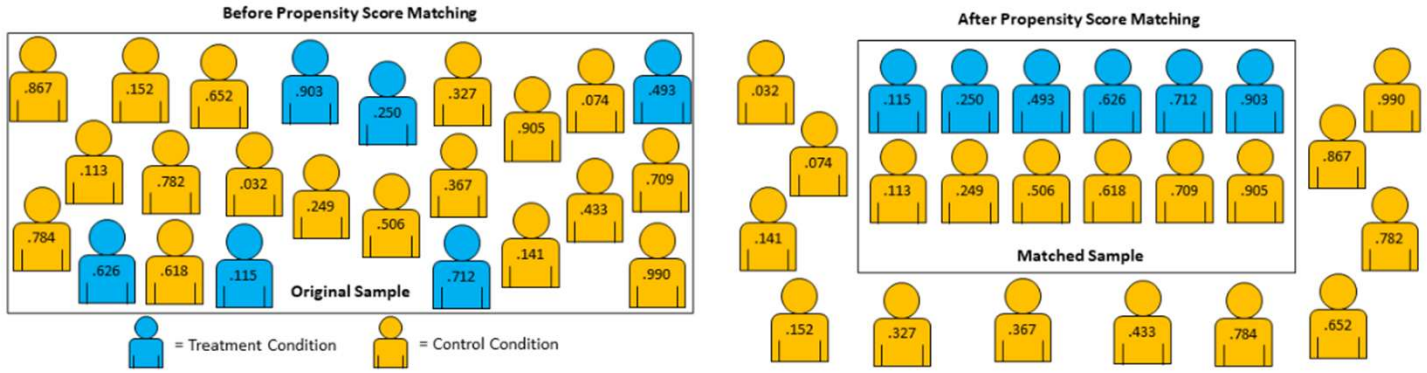


Figure 1. Propensity Score Matching Visual Depiction. Note: Values for each participant indicate their corresponding propensity scores.

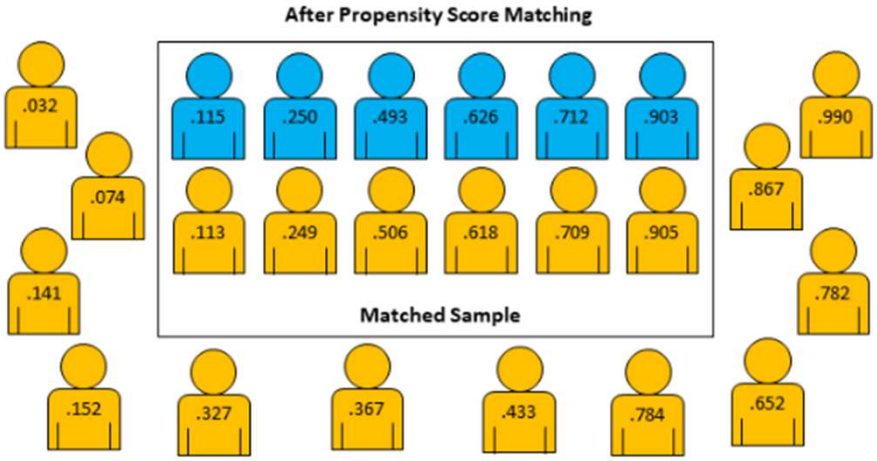
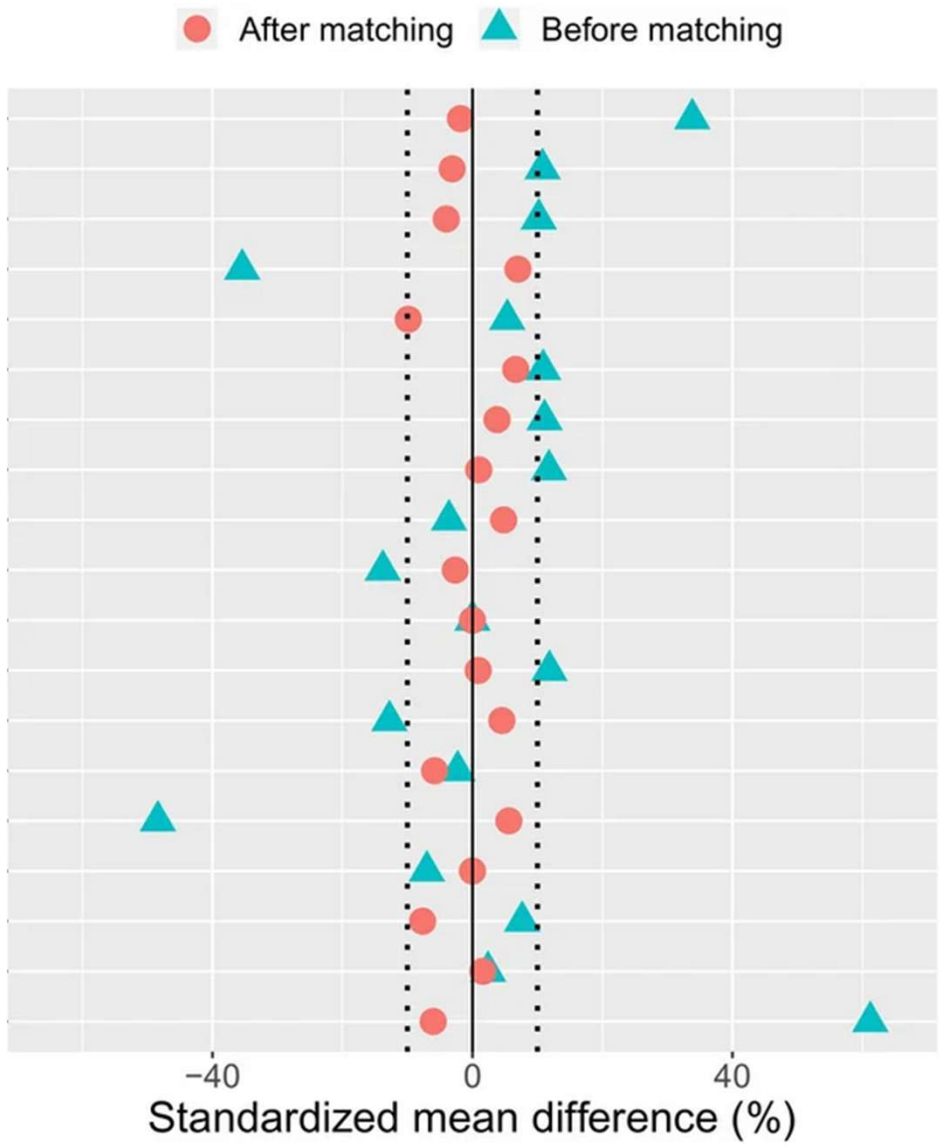


Table 2. *Demographics of ACE vs. Matched Control.*

Demographics	**ACE** (n = 29)		**Matched Control** (n = 29)	
Gender	Female	25 (86.2%)	Female	25 (86.2%)
	Male	4 (13.8%)	Male	4 (13.8%)
Ethnicity	Hispanic	29 (100%)	Hispanic	29 (100%)
	Non-Hispanic	0 (0%)	Non-Hispanic	0 (0%)
Race	White	29 (100%)	White	29 (100%)
English Language Learner	Yes	6 (20.7%)	Yes	5 (17.2%)
	No	23 (79.3%)	No	24 (82.8%)
Special Education	Yes	2 (6.9%)	Yes	2 (6.9%)
	No	27 (93.1%)	No	27 (93.1%)
Migrant Status	Yes	0 (0%)	Yes	0 (0%)
	No	29 (100%)	No	29 (100%)
Homeless Status	Yes	1 (3.4%)	Yes	0 (0%)
	No	28 (96.6%)	No	29 (100%)

Love Plot

Image from https://www.researchgate.net/figure/Love-plot-showing-the-standardized-mean-difference-SMD-before-and-after-PS-matching_fig1_368585187



How to match?

- Exact Match
- Best Estimated Match (several approaches possible)

An Introduction to Propensity Score Methods for Reducing the Effects of Confounding in Observational Studies.
Austin, Peter C.(2011). Multivariate Behavioral Research, 46, 399-424.
https://doi.org/10.1080/00273171.2011.568786

Resources

Videos

Python

- https://www.youtube.com/watch?v=_JkYHdDIKqA

R

- https://www.youtube.com/watch?v=rHVGj1F1D_4

SAS

- https://documentation.sas.com/doc/en/pgmsascdc/9.4_3.4/statug/statug_psmatch_videos.htm

STATA

- https://www.youtube.com/watch?v=T0NLe8EImOM

Tutorials

Python

- https://builtin.com/data-science/propensity-score-matching

R

- https://pmc.ncbi.nlm.nih.gov/articles/PMC11187614/
- https://rpubs.com/mbounthavong/propensity_score_r

SAS

- https://documentation.sas.com/doc/en/statug/latest/statug_psmatch_examples.htm

STATA

- https://www.ssc.wisc.edu/sscc/pubs/stata_psmatch.htm

Papers

Propensity Score Matching for Education Data: Worked Examples

Powell, Marvin G., Hull, Darrell M., & Beaujean, A. Alexander (2020). *The Journal of Experimental Education, 88:*1, 145-164.
https://doi.org/10.1080/00220973.2018.1541850

Propensity Score Analysis: Recent Debate and Discussion

Guo, Shenyang, Fraser, Mark, & Chen, Qi (2020) *Journal of the Society for Social Work and Research, 11*, 3, 463-482. https://doi.org/10.1086/711393

Comparing the Performance of Propensity Score Matching Algorithms from Multiple Programming Languages

Briggs, Catherine & Eid, Sherrine (2024). SAS Institute, Inc.
https://www.lexjansen.com/phuse-us/2024/re/PAP_RE04.pdf

First Steps

🤔 Let's Discuss:

Implementation

- What challenges would you face with your institutional data?
- Which analytical approaches would be most valuable for your context?
- What barriers might exist to implementing these methods?

Methodology

- How do you handle missing data in your analyses?
- What ethical considerations are most important at your institution?
- How do you communicate statistical results to non-technical stakeholders?

Potential Research Projects

What might you do with PSM?

Retention	Pell
Completion	Short Terms
Course Delivery	Use of AI
Transfer	…

PSM in Higher Ed

Assessing the impact of hybrid teaching on students' academic performance (2024)

First-Year Progression and Retention of Autistic Students in Higher Education (2020)

Does Teacher Encouragement Influence Students' Educational Progress? (2017)

Comparing the Educational Attainment of Community College Transfer Students and Four-Year College Rising Juniors (2011)

Effects of honours programme participation in higher education (2017)

Thank you!

Today's Presentation

- Slides or Digital Handout?
- Thoughts?
- Suggestions?

Please reach out …

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AEWAS Consulting

- SAS support (coding, training)
- Data analysis & visualization
- Data literacy / fluency
- Instructional design / development
- Short and long-term projects