# Psy 523/623 Structural Equation Modeling
# Syllabus Spring 2025

## Instructor

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## Meeting Times and Location

Tu-Th, 10:00 – 11:50 AM, Cramer Hall 307. Possible lab session time in FMH B155 on Thursdays.

## Text

Kline, R.B. (2023). *Principles and Practice of Structural Equation Modeling, Fifth Edition.* New York: Guilford. ISBN: 978-1-4625-5191-0.

The older edition (Fourth Edition, 2016) can be substituted and covers nearly all of the same topics, but will be less up-to-date. See online access through the PSU library: https://search.library.pdx.edu/primo-explore/fulldisplay?docid=CP71250299430001451&context=L&vid=PSU&lang=en_US&search_scope=all&adaptor=Local%20Search%20Engine&tab=default_tab&query=creator,contains,kline,AND&query=title,contains,Principles%20and%20Practice%20of%20Structural%20Equation%20Modeling,AND&mode=advanced&offset=0

## Optional Text

Bollen, K.A. (1989). *Structural equations with latent variables*. New York: Wiley. Available at the bookstore or used copies may be obtainable online. ISBN: 0471011711. Online access through the PSU library: https://onlinelibrary.wiley.com/doi/book/10.1002/9781118619179

## Prerequisites

I assume that students have taken at least one graduate statistics course that covers statistical hypothesis testing at the graduate level and simple and multiple regression analysis, such as Psy 521/621 Univariate Quantitative Methods and Psy 522/622 Multiple Regression and Multivariate Quantitative Methods.

## Overview

This course is intended to introduce students to structural equation modeling. Structural equation modeling (sometimes referred to as covariance structural analysis) is a regression-based technique that incorporates elements of path analysis and confirmatory factor analysis. The general goal is to provide a thorough background in the conceptual aspects, statistical underpinnings, and application of this method rather than a tutorial on a specific software package. At the end of the course, I expect students to have a solid, conceptual foundation of structural modeling issues, be able to analyze data using any SEM package, be able to critically evaluate professional articles, and be able to write up results from structural modeling analyses.

## **Readings and Commentaries** (10%)

There will be several readings assigned each week taken from the text and supplemental sources. The readings will often include an example article that applies SEM. Please read the material prior to class and be prepared for discussion. Students will be required to turn in a **one-page (total) commentary** on all of the readings **each week on Tuesday by 9 am via email** (in the body of the email please—no attachments). The commentaries should be an informal set of questions, comments, or summary information (summarize only if you cannot think of anything else to say) about the articles. The purpose of the commentaries is to make sure the class is prepared for discussion and to help me identify discussion topics and sources of confusion in the readings. I will assign 2 (complete and well-considered), 1 (did not read some/lacking effort/too long), or 0 (did not read most/minimal effort/late/nothing) points to each, with one freebie for the quarter.

## **Homeworks** (90%)

There will be three homework assignments which will primarily consist of data analysis and write-ups of SEM problems using the demo version of the statistical program, Mplus (Muthen & Muthen,1998-2017), and the lavaan package in R.

**Homework due dates are:** 5/1, 5/22, 6/10 (10 AM Tues finals week). Please bring paper copy (if you cannot be in class that day, let me know and we will make alternative arrangements). Late assignments are not accepted without penalty (10% per day) unless there are extenuating circumstances, such as illness or family emergency. Please let me know if there are extenuating circumstances as early as possible.

**Grades**
Grades are based on an average of the three homework assignments (90%) and weekly commentaries (10%). Total percentages will be assigned the following grades: ≥ 90 = A, 85-89.9 = B+, 80-84.9 = B, 75-79.9 = C+, 70-74.9 = C.

**Software**
This is not a course about software but I would like you to learn the basics of a software program and begin to apply what we learn to real analysis problems. I choose Mplus and lavaan partly because they have relatively simple syntax, allowing us to focus more on statistical and applied issues rather than debugging programs or other software headaches. Some data preparation and descriptive analysis using SPSS or R may be required (let me know if this will be an inconvenience for some reason). The demo version of Mplus Version 8.9 can be downloaded from the following internet site: http://www.statmodel.com/demo.shtml. The demo version has no limitations on analysis types but allows no more than six dependent variables and two independent variables. R software is available at http://www.r-project.org/. The lavaan package is installed by running `install.packages("lavaan", dependencies=TRUE)` the command line. More information is available at http://lavaan.ugent.be/.

**Software Resources**
You will be able to do assignments and learn the basics of Mplus and the R package lavaan without any additional software readings or documentation. But here are some additional resources that you may wish to check out. The Mplus users guide, which can be downloaded from the Mplus website (http://www.statmodel.com), is a good introduction to the software, including the syntax options and a large number of examples. The book by Geiser (Geiser, C. (2012). *Data analysis with Mplus*. New York, NY: Guilford. ISBN: 1462502458) provides some general SEM material but focuses mostly on software illustration of a variety of models. The text by Wang & Wang (Wang, J., & Wang, X. (2019). Structural equation modeling: Applications using Mplus, second edition. Wiley. ISBN: 1119422701) is a more complete and somewhat more technical SEM text that includes Mplus illustrations.

The lavaan pdf guide (https://faculty.washington.edu/matsueda/courses/529/Readings/Lavaan%20tutorial.pdff) has most of the crucial syntax information and is similar to the Mplus guide in its array of examples. The texts by Beaujean (Beaujean, A. A. (2014). *Latent Variable Modeling Using R: A Step-by-Step Guide.* New York: Routledge. ISBN: 1848726996) and by Gana and Broc (Gana, K., & Broc, G. 2019, *Structural Equation Modeling with lavaan*. Wiley. ISBN: 1786303698) are both general SEM texts that focus on lavaan illustrations exclusively.

**Other Resources**
There are several internet sites devoted to SEM that may be of use. Dave Kenny has a great website with introductory material on most SEM topics at http://davidakenny.net/cm/causalm.htm (including a free pdf copy of his book, *Correlation and Causation*). There is a SEM discussion list called SEMNET which you can subscribe to through the following site: https://listserv.ua.edu/cgi-bin/wa?SUBED1=semnet&A=1. The Mplus website has lots of example programs, white papers, and an Mplus discussion section http://www.statmodel.com/.

**Diversity, Equity, and Inclusion**
Portland State University's Department of Psychology is fully committed to diversity, equity, and inclusion. Our department fosters a vibrant intellectual environment in which human diversity is recognized and valued in all its forms. We support learning, research, and outreach activities that promote the values of diversity, equity, and inclusion. My goal is to create a learning environment that is accessible, equitable, inclusive, and

welcoming. I am committed to fostering mutual respect and full participation for all students. If there are any incidents or conditions that you feel do not conform to these goals, please discuss them with me.

**Sexual Harassment, Sexual Violence, and Discrimination**
As an instructor, one of my responsibilities is to help create a safe learning environment for my students and for the campus as a whole. Please be aware that as a faculty member, I have the responsibility to report any instances of sexual harassment, sexual violence and/or other forms of prohibited discrimination. If you would rather share information about sexual harassment, sexual violence or discrimination to a confidential employee who does not have this reporting responsibility, you can find a list of those individuals or contact a confidential advocate at 503-725-5672. For more information about Title IX please complete the required student module Creating a Safe Campus in your D2L.

**Disabilities**
I am happy to make any necessary arrangements with students who have a disability and are in need of academic accommodations. If you have not done so already, please contact the Disability Resource Center, 116 Smith Memorial Student Union, http://www.pdx.edu/drc/, Email: drc@pdx.edu, for assistance and any testing arrangements. I would appreciate it if you would check with me as soon as possible to discuss any needed accommodations and to make sure that I have received a faculty notification letter. If any aspects of instruction or course design result in barriers to your inclusion or learning, please let me know.

**Course Readings**
**Psy 523/623 Structural Equation Modeling**
**Spring 2025**

**Primary Text:** Kline, R.B. (2023). *Principles and Practice of Structural Equation Modeling, Fifth Edition*. Guilford.
**Homework due dates <u>are underlined</u>** (due by 10 AM). (Readings from Kline 2016 fourth edition in gray type).

**Commentaries are due at 9 AM on Tuesday of each week** (second date listed in each topic section below)

## 4/3,4/8 Overview and History of SEM and Matrix Algebra

Kline, Chapter 1 "Promise and Problems" (Chapter 1)

Tabachnick, B. G., & Fidell, L. S. (2013)., Appendix A, "A Skimpy Introduction to Matrix Algebra" in *Using multivariate statistics, sixth edition*. Pearson (*Optional*: Section A.7)

Pedhazur, E.J. (1997). Chapter 6, "General method of multiple regression analysis: Matrix operations." In *Multiple regression in behavioral research: Explanation and prediction (3rd Edition)*. Fort Worth: Harcourt Brace. (pp. 135-140, 145-154 only).

Kenny, D.A. (1979). Chapter 2, "Covariance Algebra" in *Correlation and causation.* New York: Wiley.

*Optional (regression review):* Kline, Fourth Edition, Chapter 2, "Regression Fundamentals"; Pedhazur, E.J. (1997). Chapter 2, "Simple linear regression and correlation" & Chapter 5, "Elements of multiple regression analysis: Two independent variables" in *Multiple regression in behavioral research: Explanation and prediction (3rd Edition)*. Fort Worth, TX: Harcourt Brace.

## 4/10,4/15 Path Analysis

Loehlin, J. (2004), Chapter 1 "Path Analysis" (pp. 1-16, 23-28 only), *Latent Variable Models*, Fourth Edition.

Kline, Chapter 3 "Steps and Reporting" (pp. 32-36 only) (Chapter 7, pp. 145-149 only).

Kline, Chapter 7 "Parametric Causal Models" (Chapter 6)

Kline, Chapter 20 "Enhanced Mediation Analysis" (pp. 350-356 only) (Chapter 8, pp. 181-185)

*Example article:* Christ, N. M., Contractor, A. A., Wang, X., & Elhai, J. D. (2020). The mediating effect of rumination between posttraumatic stress disorder symptoms and anger reactions. *Psychological Trauma: Theory, Research, Practice, and Policy, 12*(6), 619.

*Optional*: MacKinnon, D. P., Cheong, J., Pirlott, A. G., & Smyth, H. L. (2023). Statistical mediation analysis in psychological research. In H. Cooper, M. N. Coutanche, L. M. McMullen, A. T. Panter, D. Rindskopf, & K. J. Sher (Eds.), A*PA handbook of research methods in psychology: Research designs: Quantitative, qualitative, neuropsychological, and biological, 2nd ed, Vol. 2* (, pp. 435–458). American Psychological Association

## 4/17,4/22 Confirmatory Factor Analysis I: Theory, Model Fitting Concepts, and Software

Loehlin, J. (2004), Chapter 1 "Path Analysis" (pp. 16-22 only), Latent Variable Models, Fourth Edition.

Kline, Chapter 14 "Confirmatory Factor Analysis" (Chapter 9)

Flora, D. B., & Flake, J. K. (2017). The purpose and practice of exploratory and confirmatory factor analysis in psychological research: Decisions for scale development and validation. *Canadian Journal of Behavioural Science/Revue canadienne des sciences du comportement, 49*(2), 78-88.

*Optional:* Preacher, K.J., & MacCallum, R.C. (2003). Repairing Tom Swift's electric factor analysis machine. *Understanding Statistics, 2*, 13-43

*Optional:* Chapter 9 Exploratory Factor Analysis. Pituch, K. A., & Stevens, J. P. (2016). *Applied multivariate statistics for the social sciences: Analyses with SAS and IBM's SPSS.* New York: Routledge.

Optional: Bollen, K.A., & Hoyle, R.H. (2023). Latent Variables in Structural Equation Modeling. In R.H. Hoyle, *Handbook of structural equation modeling*, second edition (pp. 97-109). Guilford.

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## 4/24,4/29 Confirmatory Factor Analysis II: Model Comparisons and Fit indices

Hayduk, L. A. (1987). Ch. 5 (pp. 127-139 only). "Estimating Structural Coefficients with Maximum Likelihood Estimation" in Structural equation modeling with LISREL: Essentials and advances. Jhu Press.

Kline, Chapter 9, "Global Estimation and Mean Structures" pp. 132-136 only and Chapter 10 "Model Testing and Indexing", pp 156-161, 164-170 only (Chapter 11, pp. 231-239 only)

West, S.G., Wu, W., McNeish, D., & Savord, A. (2023). Model Fit in Structural Equation Modeling. In R.H. Hoyle, *Handbook of structural equation modeling*, second edition (pp. 185-205). Guilford.

*Example article:* Rutter, L. A., & Brown, T. A. (2017). Psychometric properties of the generalized anxiety disorder scale-7 (GAD-7) in outpatients with anxiety and mood disorders. *Journal of Psychopathology and Behavioral Assessment, 3*9, 140-146.

*Optional*: Ferron, J. M., & Hess, M. R. (2007). Estimation in SEM: A concrete example. *Journal of Educational and Behavioral Statistics, 32*, 110-120.

*Optional*: Hu, L.-T., & Bentler, P. (1999). Cutoff criteria for fit indexes in covariance structure analysis: Conventional criteria versus new alternatives. *Structural Equation Modeling, 6*, 1-55.

## 5/1,5/6 Full Structural Models I: Practical Issues, Model Modifications, & Missing Data

Newsom, J. T., Hachem, Z. A., Granger, A. M., & Denning, E. C. (2022). Where Did I Go Wrong with My Model? Ten Tips for Getting Results in SEM. *Structural Equation Modeling: A Multidisciplinary Journal*, *30*(3), 491-500. https://doi.org/10.1080/10705511.2022.2101113

Enders, C.K. (2013). Fitting Structural Equation Models with Missing Data. In R.H. Hoyle, *Handbook of structural equation modeling*, second edition (pp. 223-240). Guilford.

*Example article*: Newsom, J. T., Shaw, B. A., August, K. J., & Strath, S. J. (2018). Physical activity–related social control and social support in older adults: Cognitive and emotional pathways to physical activity. *Journal of Health Psychology, 23*(11), 1389-1404.

*Optional article*: Newman, D. A. (2014). Missing data: Five practical guidelines. *Organizational Research Methods, 17*, 372-411.

## 5/8,5/13 Full Structural Models II: Nonnormality, Categorical Variables, & Alternative Estimators

Finney, S.J., & DiStefano, C. (2013). Nonnormal and categorical data in structural equation modeling. In G.R. Hancock & R.O. Mueller (Eds.), *Structural equation modeling: A second course, 2nd edition* (pp. 439-492) Charlotte, NC: Information Age Publishing.

*Example article:* de Beer, L., Rothmann Jr, S., & Pienaar, J. (2012). A confirmatory investigation of a job demands-resources model using a categorical estimator. *Psychological Reports*, *111*, 528-544.

*Optional*: Kaplan, D., & Depaoli, S. (2012). "Bayesian Structural Equation Modeling." In Hoyle, R. H. (Ed.), *Handbook of structural equation modeling*. New York: Guilford press.

## 5/15,5/20 Multigroup Structural Models

Kline, Chapter 22 "Measurement Invariance" (Chapter 16)

Widaman, K.F., & Olivera-Aguilar, M. (2023). Investigating measurement invariance using confirmatory factor analysis. In Hoyle, R. H. (Ed.), *Handbook of structural equation modeling* (pp. 367-384). New York: Guilford press.

*Example article:* Yap, S. C. Y., Donnellan, M.B., Schwartz, S.J., et al. (2014) Investigating the structure and measurement invariance of the Multigroup Ethnic Identity Measure in a multiethnic sample of college students. *Journal of Counseling Psychology, 61*, 437-446.

## 5/22,5/27 Issues of Causality and Longitudinal Modeling

Kenny, D.A. (1979). Chapter 1, "Correlational Inference", in *Correlation and causation.* New York: Wiley.

Newsom, J.T. (2024). Chapter 4, "Fundamental concepts of stability and change". *Longitudinal Structural Equation Modeling: A Comprehensive Introduction, Second Edition*. New York: Routledge.

Newsom, J.T. (2024). Chapter 5, "Cross-lagged panel models" (pp. 138-157, 163-166 only). *Longitudinal Structural Equation Modeling: A Comprehensive Introduction, Second Edition*. New York: Routledge.

Example article: Burkholder, G.J., & Harlow, L.L. (2003). An illustration of a longitudinal cross-lagged design for larger structural equation models. *Structural Equation Modeling*, *10*, 465-486.

*Optional:* Bollen, K.A., & Pearl, J. (2013). Eight myths about causality and structural equation models. In S.L. Morgan (Ed.), *Handbook of Causal Analysis for Social Research* (pp. 301-328), New York: Springer

*Optional:* Kline, Chapter 9 "Nonparametric Causal Models", pp. 79-82, 84-96 (Chapter 8)

## 5/29,6/3 Latent Means and Growth Curve Models

Kline, Chapter 9 "Global Estimation and Mean Structures" pp. 147-150 only (Chapter 15)

Newsom, J.T. (2024). Chapter 7, "Linear latent growth curve models" (pp. 199-232 only). *Longitudinal Structural Equation Modeling: A Comprehensive Introduction, Second Edition*. New York: Routledge.

*Example article:* Hussong, A. M., Curran, P. J., Moffitt, T. E., Caspi, A., & Carrig, M. M. (2004). Substance abuse hinders desistance in young adults' antisocial behavior. *Development and Psychopathology*, *16*, 1029-1046.

*Optional*: Thompson, M.S., & Green, S.B. (2013). Evaluating between-group differences in latent variable means. In G.R. Hancock & R.O. Mueller (Eds.), S*tructural equation modeling: A second course, 2nd edition* (pp. 163-218). Charlotte, NC: Information Age Publishing.

## 6/5,6/10* Wrapping Up, Reporting, Cautions

Kline, Chapter 23 "Best Practices in SEM" (Chapter 18)

Mueller, R. O., & Hancock, G. R. (2008). Best practices in structural equation modeling. In J.W. Osborne (Ed.), *Best practices in quantitative methods* (pp. 488-508). Thousand Oaks, CA: Sage.

McCoach, D.B., Black, A.C., & O'Connell, A.A. (2007). Errors of inference in structural equation modeling. *Psychology in the Schools, 44*, 461-470.

*HW 3 due Tuesday, finals week