

Psychology 6302
Fall 2015

Structural Equation Modeling

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Office hours: Thursday 10:00 am – 11:50 am and by appointment
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Lectures: 10:30 am – 11:50 am on Mondays and Wednesdays; Health Sciences 213

Textbooks: Kline, R.B. (2011). *Principles and Practice of Structural Equation Modeling (3rd edition)* Guilford: New York.

Selected readings will also be made available. They will either be located downstairs in the Main Office or will be emailed to you.

Course Objective:

This course will build upon knowledge of multiple regression (and factor analysis) by introducing you to structural equation modeling (SEM). SEM is also known as covariance structure analysis, latent variable analysis, and causal modeling. We will take a step-by-step approach in talking about SEM, by first covering path analysis and confirmatory factor analysis and then building to the latent path model.

This course assumes no prior experience with SEM and is intended as both a theoretical and practical introduction to the topic. The course will use the LISREL 8.8 software package for examining structural models and class time will be devoted to learning LISREL 8.8. LISREL will be available on a number of machines in the Vinson Lab throughout the semester. The computers that have the full version of LISREL 8.80 installed are: dbvlab18 (utep tag #132801), dbvlab20 (utep tag #132803), dbvlab21 (utep tag #132796), and dbvlab23 (utep tag #132798).

You can also download a free version of the student version of LISREL at the following website: <http://www.ssicentral.com/lisrel/downloads.html>. The student version limits the number of variables that you can analyze at one time (I think it is 12 variables). Products from Scientific Software (which includes LISREL) can also be rented for 6-months and for 12-months). Their website is www.ssicentral.com.

LISREL manuals will also be made available for you to borrow (probably by checking them out in the main office). I am “old school” when it comes to using LISREL and I type out LISREL syntax. I will teach you how to type out LISREL syntax. I am trying to upgrade my training, as PRELIS can be used to read in data to create .psf files. These .psf files have many wonderful features (for example, you can do multilevel modeling in PRELIS and you can impute missing data in PRELIS).

Other LISREL manuals that will be made available that allow for easier LISREL programming (the SIMPLIS language). There is a point-shoot-click version of LISREL (the interactive version of LISREL). Using SIMPLIS or the Interactive version is acceptable, but I'll teach using LISREL syntax. As you will see in the class, more of the "state of the art" procedures like modeling interactions require the use of LISREL syntax, so it is important to know what LISREL syntax means. A series of useful guides on LISREL from Kansas University will also be made available in the class.

In addition, I will also try to teach you *MPlus* syntax. *MPlus* is available on the machines that have LISREL on them. I have used *MPlus* a little, so this will be a work in progress. *MPlus* manuals will also be available. You may have a choice of doing your homework in LISREL or with *MPlus*.

Topics to be covered in this class will be covered are:

- Review of regression
- State of the art in the assessment of statistical mediation
- path analysis
- model identification, estimation and evaluation
- confirmatory factor analysis
- latent variable path analysis
- special types of structural models
 - higher-order construct models
 - multi-group models
 - MIMIC models and structured means models for latent means comparisons
- latent variable growth curve models
- special topics if time allows (e.g., multilevel structural models, power analysis in SEM, nonlinear models, mixture models)

Course Prerequisites:

It is expected that you will have had the Psychology 5310 (Experimental Design) and 5311 (Correlation and Regression) or equivalent courses in other departments. While Psychology 5323 (Psychometrics) is not a pre-requisite, a background knowledge of factor analysis would be helpful. I can refer you to the text that I used in Psychology 5323 for relevant chapters on factor analysis.

Evaluation:

Course grades will be based on points earned from the following sources:

Homework assignments	30%
Take-home Midterm Exam	30%
Final group project	30%
Presentation of group class project	10%

Take-Home Midterm Exam

I would like to treat this class as a seminar class, but I will also incorporate a take-home midterm exam at a to-be determined point in the class. You will have 1-2 weeks notice before the midterm. You will work on the exam individually and the only person you can talk to about the exam is the instructor (and the TA, if one is assigned).

Homework:

Homework problem sets will usually be passed out during class and due 1 to 2 weeks later (depending on the length of the assignment). Late homework assignments **will not be accepted**. There may be as few as 4 homework assignments and as many as eight homework assignments this semester.

Neatly written work is acceptable. If computer output is required for the homework, include only the part which is necessary for the solution and edit out any irrelevant output. Please do not write, "You can find the answer on page 87 of the output," as I do not want to go through 87 pages of output. The statistical software that will be used is LISREL, which can be accessed in the Vinson Laboratory, located in Room 202 of the Psychology Building.

Final Project

Based on your own data, your advisor's data or data from an available source, students will work in groups of 1-4 and will write a final paper and give a presentation during the last two weeks of class. Details concerning the final project and presentation will be provided as the semester progresses.

You should start hunting down for some data that capitalizes on the topics learned in this class. Once you have an idea, even a vague one, please see me so that we can discuss whether it warrants a suitable final project.

Policy on Auditors

Student and faculty auditors are welcome in the class, as long as they complete the required university audit form (see attached). However, my first priority is to the students who are registered for the class. Students in the class get first dibs on seats in the class. In addition, if seating in the computer lab becomes a problem, registered students get first dibs on the 4 machines with LISREL. I also ask that auditors not submit any homework assignments or take

any exams, as it is extra work on my part and the TA's part. If your attendance becomes sporadic, I expect that you will not slow down the class questions that were covered in prior lectures.

In short, your completion of the university audit form allows you the privilege of listening to the course material (and that is all). If your attendance requires additional time of my TA, additional time of myself or takes away from the learning experience from the registered students in the class, you should not audit this class.

Evaluation

Scores between 85.0% and 100% constitute an A. Scores between 70% and an 85% constitute a B. The instructor may also incorporate a curve to look for gaps in the distribution to aid in the determination of your grade.

Course structure and requirements:

1. Class attendance is expected and students will be responsible for all material covered in lectures, class handouts and assigned readings. If, for some reason, you are unable to attend class, ask one of your classmates for any materials that were distributed in class (as I will **not** hold onto materials for you).
2. With regard to lectures, there is no such thing a stupid question. If you have a question, someone else probably has that same question. Feel free to ask any questions during the lectures.
3. Make-up exams will be given only under extraordinary circumstances, such as documented sickness, hospitalization or death of a family member (funeral card required). In some other cases, exceptions will be made if **advance notice of absence** is provided. As the midterm is a take-home exam, I do not see this being a problem.
4. Check emails often. I will probably email you data sets for your homework assignments.
5. **Please turn off all pagers, beepers and other electronic devices before entering class.** They are a distraction to other students in the class and to the professor.
6. **Office Hours and Appointments:** If you have questions concerning the topics of this course, you can stop by to see me during my office hours or you can make an appointment to see me. If you stop by my office and you do not have an appointment to see me, I will ask you to schedule an appointment to see me and I will answer your question during that appointed time. This policy also applies to students who come to my office door with "questions that will only take a minute to answer" or students who seek help minutes before a homework assignment is due. This same standard will also apply for your interactions with the teaching assistant (assuming a teaching assistant is assigned)
7. **Conduct of Graduate Students:** Students enrolled in this course are graduate students and I have certain expectations of graduate students. As you are pursuing an advanced professional degree, I expect that you will act in a professional manner. Asking for extensions on assignments because you are busy with other

courses/projects/papers/conference presentations is not professional. In addition, I also expect that you will show respect for everyone in the class.

- 8 **Academic Misconduct:** The university has a responsibility to promote academic honesty and integrity and to develop procedures to deal effectively with instances of academic dishonesty. Students are responsible for the honest completion of their own work, for the appropriate citation of sources, and for respect of others' academic endeavors.

In other words, plagiarism, cheating and academic dishonesty will not be tolerated in this class. Plagiarism consists of using another person's ideas, words, or assistance, while failing to acknowledge this person. If you must submit someone else's work as if it were your own, you must acknowledge the original author/original source. As you may be asked to write sections of homework problems in a way that would be communicated in an professional journal (i.e, summarize your results for a Results section in a paper submitted to the *Journal of Behavioral Decision Making*), it is your responsibility to know what constitutes plagiarism. Information on plagiarism and academic dishonesty can be found at <http://www.utep.edu/dos/acadintg.htm> If I suspect any incidence of academic dishonesty on the homeworks or the exams, I will be more than happy to forward suspected material to the Dean of Students Office.

- 9 If you have an identified disability that may affect your performance in this class, please see the instructor (no later than the second class) or contact the Center for Accommodations and Student Services in Room 106 of the Student Union (phone 747-5148) such that provisions can be made to ensure that you have an equal opportunity to meet all the requirements of this course.

- 10 Should you decide you need to drop the class for whatever reason (poor performance in the class, etc.) , it is your responsibility to know the last date to withdraw from the class in order to receive a W (October 30). You will not be able to withdraw from this class after this date. In addition, Census Day is September 9th, which is the last day to drop the class without a W appearing on your transcript.

Tentative Course Schedule

Enclosed is a tentative schedule of the order of the topics that will be covered. This ordering may change throughout the semester.

Topic	Kline
Matrix algebra	Handout to be distributed
Background/overview	Chapters 1-4
Mediation and moderation	Handout to be distributed
Model Identification: Algebraic Rules	Class lecture
Path analysis and model estimation	Chapters 5
Assessing Model Fit	
Model Identification: Identification Rules	Chapter 6
Estimation	Chapter 7
Hypothesis testing, power analysis and fit indices	Chapter 8
Confirmatory factor models and higher order models	Chapter 9
Multiple group confirmatory factor analysis	Chapters 11
Latent Variable Path Analysis	Chapter 10
Parcels and latent variable path analysis	Class lecture (and part of Chapter 7)
MIMIC Models	Chapter 11
Latent Growth curve models	Chapter 11
Nonlinear SEM	Chapter 12
SEM Cautions	Chapter 13

Supplemental Readings (more may be added)

Path Analysis Application

Howard, G.S. & Maxwell, S.E. (1982). Do grades contaminate student evaluations of instruction? *Research in Higher Education*, 16, 175-187.

Model Identification

Rigdon, E.E. (1995). A necessary and sufficient identification rule for structural model estimated in practice. *Multivariate Behavioral Research*, 30, 359-383.

On the Use of Fit Indices to Evaluate Model Fit

Barrett, P. (2007). Structural equation modeling: Adjudging model fit. *Personality and Individual Differences*, 42, 815-824.

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

Marsh, H. W., Hau, K.-T., & Wen, Z. (2004). In search of golden rules: Comment on hypothesis-testing approaches to setting cutoff values for fit indexes and dangers in overgeneralizing Hu and Bentler's (1999) findings. *Structural Equation Modeling*, 11, 320-341.

Millsap, R.E. (2007). Structural equation modeling made difficult. *Personality and Individual Differences*, 42, 875-881.

Mulaik, S. (2007). There is a place for approximate fit in structural equation models, *Personality and Individual Differences*, 42, 883-891.

Yuan, K-H (2005). Fit indices versus test statistics. *Multivariate Behavioral Research*, 40, 115-148.

Comparing Nested Models

Cheung, G. W., & Rensvold, R. B. (2002). Evaluating goodness-of-fit indexes for testing measurement invariance. *Structural Equation Modeling*, 9, 233-255.

Yuan, K-H., & Bentler, P. M. (2004). On chi-square difference and z tests in mean and covariance structure analysis when the base model is misspecified. *Educational and Psychological Measurement*, 64, 737-757.

Confirmatory Factor Analysis Primer

Streiner, D.L. (2006). Building a better model: An Introduction to Structural Equation Modeling. *Canadian Journal of Psychiatry*, 51, 317-324.

SEM Approaches to Assessing Measurement Invariance

Hancock, G. R. (1997). Structural equation modeling methods of hypothesis testing of latent variable means. *Measurement and Evaluation in Counseling and Development*, 30, 91-105.

Steenkamp, J., & Baumgartner, H. (1998). Assessing measurement invariance in cross-national consumer research. *Journal of Consumer Research*, 25, 580-591.

Parcels and Latent Path Analysis

Bandalos, D. L., & Finney, S. J. (2001). Item parceling issues in structural equation modeling. In G. A. Marcoulides (Eds.). *New developments and techniques in structural equation modeling* (pp. 269–297). Mahwah, NJ: Lawrence Erlbaum Associates.

Coffman, D.L., & MacCallum, R.C. (2005). Using parcels to convert path analysis models into latent variable models. *Multivariate Behavioral Research*, 40, 235–259.

Little, T. D., Cunningham, W. A., Shahar, G., & Widaman, K. F. (2002). To parcel or not to parcel: Exploring the question, weighing the merits. *Structural Equation Modeling*, 9, 151–173.

Sterba, S.K. & MacCallum, R.C. (2010). Variability in parameter estimates and model fit across random allocations of means to parcels. *Multivariate Behavioral Research*, 45, 322-358.

Latent Curve Models

Byrne, B.M. & Crombie, G. (2003). Models and testing change: An Introduction to the Latent Growth Curve Model. *Understanding Statistics*, 2, 177-203.

Power Analysis in SEM

MacCallum, R. C., Browne, M. W., & Sugawara, H. M. (1996). Power analysis and determination of sample size for covariance structure modeling. *Psychological Methods*, 1, 130-149.

MacCallum, R. C., Widaman, K. F., Zhang, S., & Hong, S. (1999). Sample size in factor analysis. *Psychological Methods*, 4, 84-99.