EDP 382K-6: Structural Equation Modeling

Spring 2014 – Unique #: 11175 TTH 11:00 - 12:30 SZB 422

Instructor
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Required Course Material

- Kline, R. (2010). *Principles and Practice of Structural Equation Modeling (3rd Ed.)*. New York: Guilford Publications.
- Byrne, B. (2011). *Structural Equation Modeling with Mplus: Basic Concepts, Applications, and Programming*. New York: Taylor & Francis Group.
- Class notes and selected articles available on our Blackboard website in the *Course Documents* section. Class notes will be posted prior to the day on which the notes are discussed in class and may be retrieved on Blackboard: http://courses.utexas.edu.

Course Overview

Prerequisites for the course include Experimental Design and Statistical Inference or equivalent, Correlation and Regression or equivalent, and Survey of Multivariate Methods or equivalent. This course will build upon students' knowledge of multivariate statistical analysis by introducing them to one of the newer multivariate techniques – structural equation modeling. This technique encompasses an entire family of methods known by many names, among them covariance structure analysis, latent variable analysis, confirmatory factor analysis, path analysis, and causal modeling. An understanding of structural equation modeling will be developed by relating it to students' previous knowledge of multiple linear regression and exploratory factor analysis, and expanding to allow for correlated and causally related latent constructs.

This course assumes no prior experience with this technique, and is intended as both a theoretical and practical introduction. The software package M*plus* will be used for exploring and providing support for structural models. Students interested in purchasing a version of this program for their personal use can order a $195, $240, or $350 (depending upon future types of analyses to be conducted) student discount copy. There is also a free M*plus* demo version (with certain limitations) available for download. For more information on the M*plus* program, go to the following website: http://www.statmodel.com. Another option to consider is the Stats Apps Server offered by the Division of Statistics and Scientific Computation which allows students and faculty access to a number of statistical and mathematical applications, including M*plus*, through a terminal server. It costs a minimum of $5 per year for storage if you have a Windows Services Account with the Austin Disk Services Option. Additional storage requires an additional fee. To set this up, go to: http://ssc.utexas.edu/software/stat-apps-server.

In general, the course will proceed through the following topics; some will take much longer than others.

- Recursive path analysis
- Confirmatory factor analysis
- Structural equation models
  - Developing a theoretically based model
  - Constructing a path diagram of causal relationships
  - Converting the path diagram into a set of structural and measurement equations
  - Estimating the proposed model using M*plus*
  - Assessing the identification of the model equations
  - Evaluating the goodness of fit
  - Making theoretically justified modifications to the model

- Special types of structural models
  - Models over time
  - Higher-order construct models
  - Multi-group models
  - MIMIC models for latent means comparisons
  - Structured means models
  - Latent variable growth curve models
- Dangers in modeling

Course Assessment

1. Quizzes: At the start of six Thursday class meetings approximately every other week (1/30, 2/13, 2/27, 3/20, 4/10, 4/24), a short quiz will be administered. Each quiz will cover material from the lessons since the last quiz (unless otherwise specified) and should not take more than 15 minutes. You may use one 8.5"x11," two-sided page of notes (students will likely be much better prepared if they don't need to rely on it). Missed quizzes may not be made up unless arrangements have been made prior to class. You will be able to drop your lowest quiz grade.

2. Take-Home Exams: There will be two comprehensive take-home exams handed out. The exams will contain both multiple-choice and free-response items. Students are on their honor to do the exams completely independently; students found doing otherwise will be subject to the maximum university penalties.

Exams are due as specified in class, and should be submitted on time for full earned credit. Late work will be accepted for full earned credit IF AND ONLY IF arrangements are made with me PRIOR TO DUE DATE. Otherwise, 5% of the points possible will be deducted for each weekday the exam is late.

3. Optional Homework Assignments: Optional homework will be assigned throughout the course in order to give students a chance to apply and practice the concepts learned in class. Some will involve using M*plus* software. The optional homework assignments will not be graded, however, the answers will be posted for students to check their own work. While these assignments are not due for a grade, they will help students better prepare for the quizzes and take home exams and master the material.

Course Grades

Your quizzes and exams will be averaged according to the percentages (weights) shown below. Grades will be posted to our Blackboard website (under the *My Grades* section) – please periodically check for any keypunch errors. Final grades will then be assigned based on the scale below:

Assessment	*Weight*
Total quiz points converted to a percentage	50%
Total take home exam points converted to a percentage	50%

Overall Course Percent	*Grade*
93% - 100%	A
90% - 92%	A-
87% - 89%	B+
83% - 86%	B
80% - 82%	B-
77% - 79%	C+
73% - 76%	C
70% - 72%	C-
below 70%	F

Unless a computational error has been made, grades will not be changed after the end of the semester.

No Extra Credit: Your course grades are based only on the above information. There will be no extra-credit opportunities.
Grades of "Incomplete:" Unless the student can demonstrate that near catastrophic events have led to a case of extreme hardship, grades of "Incomplete" will not be given.
Attendance: Attendance will not be part of your grade. Students who attend class, of course, tend to be better prepared for assignments.

Accommodations For Persons With Disabilities

Students with disabilities who require special accommodations need to get an accommodation letter that documents the disability from the Services for Students with Disabilities (471-6259 voice or 471-4641 TTY for users who are deaf or hard of hearing). This letter should be presented to the instructor in each course at the beginning of the semester and accommodations needed should be discussed at that time. Five business days before an exam, the student should remind the instructor of any testing accommodations that will be needed. See the following website for more information: http://ddce.utexas.edu/disability/.

SELECTED ARTICLES FOR THE COURSE – a variety of applied and theoretical papers

Loehlin, J. C. (1998). *Latent Variable Models: An Introduction to Factor, Path, and Structural Analysis.* 3rd Edition. Mahwah, NJ: Lawrence Erlbaum Associates. *Pages 2-17.*

- *An excellent introduction into path diagrams and path tracing.*

Howard, G. S., & Maxwell, S. E. (1982). Do grades contaminate student evaluations of instruction? *Research in Higher Education, 16*, 175-188.

- *A nice example of path analysis, including the decomposition into direct and indirect effects.*

Bennett, R. W., Gottesman, R. L., Rock, D. A., & Cerullo, F. (1993). Influence of behavior perceptions and gender on teachers' judgments of students' academic skill. *Journal of Educational Psychology, 85*, 347-356.

- *Another nice example of path analysis. Although not as complete as the previous article, it includes results for multiple samples.*

Preacher, K. J., & Hayes, A. F. (2008). Asymptotic and resampling strategies for assessing and comparing indirect effects in multiple mediator models. *Behavior Research Methods, 40*, 879-891.

- *An explanation concerning bootstrapping with indirect effects*.

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

- *Simulation study in which more rigorous cutoff values were recommended when assessing model fit indices.*

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

- *The title of this article says it all!*

Galassi, J. P., Schanberg, R., & Ware, W. B. (1992). The Patient Reactions Assessment: A brief measure of the quality of the patient-provider medical relationship. *Psychological Assessment, 4*, 346-351.

- *A nice example of a confirmatory factor analysis in which the authors used an independent sample to cross-validate their model.*

Newcomb, M. D., & Bentler, P. M. (1988). Impact of adolescent drug use and social support on problems of young adults: A longitudinal study. *Journal of Abnormal Psychology, 97*, 64-75.

- *A very complex model, but the authors have done a great job explaining the methods and presenting the results. This can be used as a template for writing up results from more complex models.*

Raykov, T., & Widaman, K. F. (1995). Issues in applied structural modeling research. *Structural Equation Modeling: A Multidisciplinary Journal, 2*, 289-318.

- *A nice review of issues.*

McDonald, R. P., & Ho, M.-H. R. (2002). Principles and practice in reporting structural equation analyses. *Psychological Methods, 7*, 64-82.

- *A thorough discussion of current practices in SEM reporting.*

Mueller, R. O. (1997). Structural equation modeling: Back to basics. *Structural Equation Modeling: A Multidisciplinary Journal, 4*, 353-369.

- *A nice little reminder about some SEM issues that we often lose sight of.*

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.

- *Provides a reasonable theoretical overview of means modeling.*

Gallo, J. J., Anthony, J. C., & Muthén, B. O. (1994). Age differences in the symptoms of depression: A latent trait analysis. *Journal of Gerontology: Psychological Sciences, 49,* 251-264.

- *An application of a MIMIC approach to testing for differences on latent means.*

Lawrence, F. R., & Hancock, G. R. (1998). Assessing the change over time using latent growth modeling. *Measurement and Evaluation in Counseling and Development, 30*, 211-224.

- *A didactic piece introducing latent growth models.*

Stoolmiller, M., Duncan, T., Bank, L., & Patterson, G. R. (1993). Some problems and solutions in the study of change: Significant patterns in client resistance. *Journal of Consulting and Clinical Psychology, 61*, 920-928.

- *A nice example of using SEM to assess change over time, as well as the factors affecting that change.*

Cliff, N. (1983). Some cautions concerning the application of causal modeling methods. *Multivariate Behavioral Research, 18,* 115-126.

- *One of the classic criticisms of structural equation modeling. A must for novices and veterans who get too caught up in the "mathemagic" of causal modeling and forget the principles of sound research.*

Breckler, S. J. (1990). Applications of covariance structure modeling in psychology: Cause for concern? *Psychological Bulletin, 107*, 260-273.

- *A good companion article to the Cliff (1983) piece.*

Additional articles concerning the following topics discussed in class are also posted on our Blackboard course site:

Model modification issues
FIML estimation with missing data
Measurement invariance
Latent mean comparisons

Calendar

Following are the topics to be covered and the readings that students are expected to be doing, whether or not the material is explicitly addressed in class. Students should keep up with the readings from all sources. Topics and assignment due dates are subject to change, if we don't move as fast as anticipated.

Dates	Lecture	Topic	Kline (conceptual)	Byrne (Software)	Course Articles (applications)
1/14; 1/16	*1*	Course Introduction; Review of correlation and multiple regression; Terminology	Ch. 1, 2, 4	Ch. 1	
1/21; 1/23	*2*	Introduction to path analysis; Effect decomposition	Ch. 5 (pp. 91-112) Ch. 6 (pp. 124-137)		Loehlin Howard & Maxwell Bennett et al.
1/28; 1/30	*3*	Path analysis continued; Introduction to Mplus syntax **Quiz 1 on 1/30/14**		Ch. 2 (pp. 19-27)	
2/4; 2/6	*4*	Mplus syntax continued; Model estimation and fit indices	Ch. 7, 8		Hu & Bentler Marsh et al.
2/11; 2/13	*5*	Model comparison; Introduction to confirmatory factor analysis **Quiz 2 on 2/13/14**	Ch. 5 (pp. 112-117) Ch. 6 (pp. 137-144)	Ch. 2 (pp. 27-40)	Galassi et al.
2/18; 2/20	*6*	More CFA; Construct reliability; Two-factor models; Comparing models	Ch. 9 (pp. 230-251)	Ch. 3	
2/25; 2/27	*7*	Modification of models; Structural equation modeling (or "hybrid" models); Models over time **Quiz 3 on 2/27/14**	Ch. 5 (pp. 118-121) Ch. 6 (pp. 144-149)	Ch. 4	Newcomb & Bentler
3/4; 3/6	*8*	Full SEM models **Take Home Exam 1 Due 3/6/14**	Ch. 10	Ch. 6	Raykov & Widaman McDonald & Ho Mueller
3/11; 3/13		**Spring Break – No Classes**			
3/18; 3/20	*9*	Continue full SEM models **Quiz 4 on 3/20/14**	Ch. 3		
3/25; 3/27	*10*	Categorical data analysis; Higher order models		Ch. 5	
4/1; 4/3	*11*	Multiple group modeling	Ch. 9 (pp. 251-261)	Ch. 7-9	
4/8; 4/10	*12*	Latent means: MIMIC and SMM **Quiz 5 on 4/10/14**	Ch. 11 (pp. 299-304; 316-326)		Hancock Gallo et al.
4/15; 4/17	*13*	Continuation of latent means			
4/22; 4/24	*14*	Growth curve models; Multilevel issues **Quiz 6 on 4/24/14**	Ch. 11 (pp. 304-316) Ch. 12 (pp.343-354)	Ch. 11-12	Lawrence & Hancock Stoolmiller et al.
4/29; 5/1	*15*	SEM Cautions; Course evaluation **Take Home Exam 2 Handed Out-Due 5/8/14**	Ch. 13		Cliff Breckler

Other selected structural equation modeling references you may wish to consult

Bollen, K. A. (1989). *Structural equations with latent variables*. New York, NY: John Wiley & Sons.

Bollen, K. A., & Long, J. S. (1993). *Testing structural equation models*. New York, NY: John Wiley & Sons.

Byrne, B. M. (1998). *Structural equation modeling with LISREL, PRELIS, and SIMPLIS: Basic concepts, applications, and programming*. Mahwah, NJ: Lawrence Erlbaum Associates, Publishers.

Hancock, G. R. & Mueller, R. O. (2006). *Structural equation modeling: A second course*. Greenwich, CT: Information Age Publishing.

Hayduk, L. A. (1987). *Structural equation modeling with LISREL*. Baltimore, MD: The Johns Hopkins University Press.

Kaplan, D. (2008). *Structural equation modeling: Foundations and extensions (2nd Ed.)*. Thousand Oaks, CA: Sage Publishing.

Loehlin, J. C. (2004). *Latent variable models: An introduction to factor, path, and structural equation analysis (4th Ed.)*. Mahwah, NJ: Lawrence Erlbaum Associates.

Marcoulides, G. A. & Schumacker, R. E. (1996). *Advanced structural equation modeling: Issues and techniques*. Hillsdale, NJ: Lawrence Erlbaum and Associates.

Maruyama, G. M. (1997). *Basics of structural equation modeling*. Thousand Oaks, CA: Sage Publications.

Mueller, R. O. (1996). *Basic principles of structural equation modeling: An introduction to LISREL and EQS*. New York, NY: Springer.

Raykov, T. & Marcoulides, G. A. (2006). *A first course in structural equation modeling (2nd Ed.)*. Mahwah, NJ: Lawrence Erlbaum Associates.

Schumacker, R. E. & Lomax, R. G. (2010). *A beginner's guide to structural equation modeling (3rd Ed.)*. New York, NY: Routledge Academic.