The University of Texas ARLINGTON

Department of Management

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MANA6390-001

Advanced Research Methods - Structural Equation Modeling

Fall 2015
Thursdays 2:00-4:50 PM
Room COB 252

Professor

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Course Materials

Prerequisites: *Regression*
Multivariate Statistics (BSAD-6314) – can be waived on a case by case basis.

Required Textbook: Muthén, L. K., & Muthén, B. O. (1998-2012). *Mplus user's guide*. Seventh Edition. Los Angeles, CA: Muthén & Muthén. Cost = $75 from www.statmodel.com It can also be downloaded for FREE in pdf form from http://www.statmodel.com/ugexcerpts.shtml

Optional Textbooks: E. Kelloway, E. K. (2015). *Using Mplus for Structural Equation Modeling.* 2nd edition. Thousand Oaks, CA: Sage.

Byrne, B. M. (2012). *Structural equation modeling with Mplus: Basics, concepts, applications, and programming*. New York: Routledge.

Software: I will be using Mplus version 7.XX for teaching and demonstration purposes. I am purposefully not requiring an introductory textbook for this class because I require all students to have access to full versions of some form of SEM program and at least have shared access to a user's reference guide for that program. Besides Mplus, there are other commercial packages such as LISREL, AMOS and EQS. I know that the costs of the full versions of these programs are sometimes outside of Ph.D. students' means. There are some alternatives, though, that you should consider. First, many departments have already purchased a full version of a SEM program for one or more faculty members. You (or the department) can purchase an add-on user license agreement (a site license with one additional user) to the original license agreement, typically at substantial savings. Details as to how this works may be found at http://www.statmodel.com/ for Mplus and

http://www.ssicentral.com/ordering/index.html for LISREL, and while I have never used it, information for EQS may be found at http://www.mvsoft.com/ . Further, AMOS is owned by SPSS. If you already have a licensed version of SPSS, you can purchase AMOS as an add-on module.

If you choose to purchase Mplus, you only need the Mplus base program ($195 for the student pricing with a signed license addendum form) for this class. However, if you are interested in categorical outcomes or multilevel analyses for future analyses, you may want to purchase the combination add-on version of the program ($350). However, Mplus will also allow you to pay the difference if you ever choose to upgrade to that version at a later time.

Finally, you should be aware that if you use any program other than Mplus, I will not be able to assist you with syntax errors. Thus, **Mplus is by far the most important program to purchase for the class.** However, I don't want that to detract you from using other programs if costs forbid you because I also firmly believe that one of the best ways to learn SEM is to jump into it without any "lifesaving" mechanisms. In short, you're smart and you'll figure it out, and then you'll be the expert.

Class Recordings: I'll be using the Echo recording system this semester that allows me to record audio and PowerPoint from my laptop. If things go as planned, after each class I will be able to upload a link to the class recording. This will allow you to review and download the class lecture as a means to reinforce your learning. Please note, the recordings are erased after each semester, so if you want to keep them make sure to download them to your computer.

Course Objectives

The major purpose of this course is to provide a foundation into structural equation modeling (SEM) techniques and issues. Underlying this purpose is my sincere hope to demystify SEM. That is, SEM is largely a "glorified" regression procedure, and in that vein, if you have a good grasp of multiple regression, you already have an understanding of some of the basics underlying SEM. Unlike ordinary regression, though, SEM: (a) doesn't assume that measurement error is zero; and (b) can simultaneously estimate parameters representing the whole model rather than just pieces of the model. The use of the term "foundation" in the first sentence is purposeful in that this is an introductory course in SEM. The outcome that I wish to achieve is to give you the knowledge and skills to test ordinary models. Testing more complex models, such as multilevel ones, would be part of an advanced SEM course or require further reading on your own (that should be manageable after the knowledge gained from this course).

Course Requirements

Readings. Each class, there are readings assigned which are either on blackboard or consist of pages from the Mplus user's guide. You are required to read the assigned readings **before** the day they are assigned. Also, the readings are listed in order of importance. The class is very discussion-based. Thus, it's important that you have a grasp of the readings before coming to class and make note of questions to ask me for clarification. For empirical articles, it is not important that you know (or read) the conceptual information in the article; just read for

discussion of the method or statistical technique. Readings that are assigned as "suggested readings" are solely to supplement your knowledge of the topic. I don't expect you to read those articles for class. They are primarily suggested as a guide for future reference on the subject.

PLEASE NOTE, starting 9/3 I am going to use a random sequence generator and call on the first person in the random sequence to tell me the three key learning points from the first assigned reading. I will subsequently call on the next person from the sequence to do the same for the second reading, and so forth and so on until we've covered the readings I feel are important for that day. For example, on 9/3 there are 3 readings and I will call on 3 people to each give me three key learning points for a particular reading. This is truly random each and every time. Thus, you could be called upon multiple times during the semester or not at all.

Examinations. There is one examination (see schedule below) worth 40% of your final grade. The exam will primarily be of the essay variety, but could vary from this format. It will assess both conceptual understanding and application of SEM (e.g., interpreting M*plus* results).

Homework. There are numerous homework assignments throughout the course accounting for 25% of your total grade. Homework will be assigned on Thursday and due on Tuesday at 9am to give me time to review. Then, we'll discuss them the following Thursday class. The intent is to get you to conduct the analyses yourselves and stimulate discussion about any problems. Homework will be graded on a scale of 1-10, depending on a) the level of effort put forth to conduct the analyses, b) the level of knowledge exhibited, and c) the correctness of the results. The former two components will be weighed more heavily than the latter. I openly encourage you to consult other students to help you writing syntax and for problems you incur with M*plus*. I feel that is the best way for you to learn the program. However, **each student's results and interpretation of results should be their own work. Exact duplicates of other's work will result in a grade of "0" for both parties involved.** Further, the excuse, "I couldn't get M*plus* to run my model" will not be acceptable and I encourage you to not wait until Monday night to do your homework because you inevitably will run into programming problems due to human error.

Course Project. This is the remaining 35% of your course grade. Given the diversity of students taking this course, I am willing to negotiate project structure with each student individually. No matter the structure of the project, the objective must require applying SEM to a data set.

The project and accompanying paper report involves **much more** than simply doing a SEM analysis. The student's report must begin with a short review and discussion of the theoretical rationale of the focal paper in the context of other work in the field. The report will examine the extent to which the use of SEM to test that theoretical model is either appropriate or inappropriate. Students will examine the properties and development of the measures used in the paper (**Note: the majority of your measures should be multi-item scales, and your measures will need to be REFLECTIVE, not FORMATIVE)**, in light of methods discussed in this course. Further, students will undertake the analyses by themselves. I expect the report to focus on the steps involved in the analyses and proper presentation of results as well as discussion of those results. If students have no access to data, UTA has a public database full of data (http://www.icpsr.umich.edu/icpsrweb/ICPSR/). I strongly encourage you to explore the public access data, as there are many interesting questions to be answered with public access data that can lead to a high quality publication. **Also, please note that no "Incomplete" grades will be given for this course.**

Schedule of Events (*Please note that the following schedule is subject to change.)*

Topic 1 – Introduction to SEM
R 8/27 – Class overview

R 9/3
Readings:
Chapter 3: Correlation (pp. 37- 60). In Schumacker, R.E., & Lomax, R.G. (2004), *A beginner's guide to structural equation modeling* (2nd Edition). Mahwah, NJ: Lawrence Erlbaum.

Rigdon, E. E. (1998). Chapter 9: Structural equation modeling. In G.A. Marcoulides (ed.), *Modern Methods for Business Research* (pp. 251-294). Mahwah, NJ: Lawrence Erlbaum.

Weston, R. & Gore, P. A. (2006). A brief guide to structural equation modeling. *The Counseling Psychologist, 34*, 719 – 751.

Chapter 1: Data Management in SPSS (pp. 1–8). In Geiser, C. (2013), *Data analysis with Mplus.* New York: Guilford press.

Topic 2 – Mpluseese Please!
R 9/10
Readings:
Chapter 1: Introduction (pp. 1-12) & Chapter 2: Getting Started with Mplus (pp. 13-18). In Muthén, L. K., & Muthén, B. O. (1998-2012), *Mplus user's guide*. Seventh Edition. Los Angeles, CA: Muthén & Muthén.

Chapter 15: Matrix Approach to Structural Equation Modeling (pp. 406- 456). In Schumacker, R.E., & Lomax, R.G. (2004), *A beginner's guide to structural equation modeling* (2nd Edition). Mahwah, NJ: Lawrence Erlbaum. **[Even though this chapter details LISREL output, it's important to understand the matrix notation. Understanding the LISREL output is secondary.]**

Appendix: Introduction to Matrix Operations (pp. 457- 469). In Schumacker, R.E., & Lomax, R.G. (2004), *A beginner's guide to structural equation modeling* (2nd Edition). Mahwah, NJ: Lawrence Erlbaum.

Chapter 2: Using the Mplus Program (pp. 19-39). In Byrne, B. M. (2012), *Structural equation modeling with Mplus: Basics, concepts, applications and programming*. New York: Routledge.

Chapter 2: Reading Data into Mplus (pp. 9-23). In Geiser, C. (2013), *Data analysis with Mplus.* New York: Guilford press.

Suggested Readings:
Appendix A: Matrix Algebra Reviw (pp. 449-465). In Loehlin, J. C. (2004). *Latent variable models: An introduction to factor, path, and structural equation models* (4th Edition). Mahwah, NJ: Lawrence Erlbaum.

Homework 1:
You will be given some matrices and models to diagram using Matrix and Mplus syntax.

Topic 3 – SEM Basics: Common Practices & Concerns
R 9/17
Readings:
Chapter 4: SEM Basics (pp. 61-78). In Schumacker, R.E., & Lomax, R.G. (2004), *A beginner's guide to structural equation modeling* (2nd Edition). Mahwah, NJ: Lawrence Erlbaum.

Anderson, J.C., & Gerbing, D.W. (1988). Structural equation modeling in practice: A review and recommended two-step approach. *Psychological Bulletin, 103*, 411-423.

Landis, R.S., Edwards, B.D., & Cortina, J.M. (2009). On the practice of allowing correlated residuals among indicators in structural equation modeling. In C.E. Lance & R.J. Vandenberg (eds.), *Statistical and Methodological Myths and Urban Legends: Received Doctrine, Verity, and Fable in the Organizational and Social Sciences* (pp. 193-218). New York, NY: Routledge.

Suggested Readings:
Edwards, J. R. (2011). The fallacy of formative measurement. *Organizational Research Methods, 14,* 370-388.

Chen, F., Bollen, K. A., Paxton, P., Curran, P. J., & Kirby, J. B. (2001). Improper solutions in structural equation models: Causes, consequences, and strategies. *Sociological Methods & Research, 29,* 468-508.

Topic 4 – Model Fit & Modification
R 9/24
Readings:
Chapter 3: Testing the Factorial Validity of a Theoretical Construct (pp. 43-93). In Byrne, B. M. (2012), *Structural equation modeling with Mplus: Basics, concepts, applications and programming*. New York: Routledge.

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.

Suggested Readings:
Chapter 6: Evaluating and Modifying Structural Equation Models (pp. 109-132). In Kaplan, D. (2009), Structural equation modeling: Foundations and extensions (2nd edition). Thousand Oaks, CA: Sage.

Homework 2:
You will be given a series of model fit indices and parameter estimates from real data. You will write a short paragraph telling me which models fit the best from a statistical and practical perspective and any potential problems you see.

Topic 5 – Measurement Models and Confirmatory Factor Analysis
R 10/1
Readings:
Chapter 9: Measurement Models and Confirmatory Factor Analysis (pp. 230-264). In Kline, R. B. (2010), *Principles and Practice of Structural Equation Modeling* (3rd Ed.). New York: Guilford Publications.

Lance, C.E., & Vandenberg, R.J. (2001). Confirmatory factor analysis. In F. Drasgow & N. Schmitt (Eds.), *Measuring and Analyzing Behavior in Organizations: Advances in Measurement and Data Analysis* (pp. 221-256), Volume in the *Organizational Frontier Series*. San Francisco: Jossey-Bass.

Hurley, A.E., Scandura, T.A., Schriesheim C.A., Brannick, M.T., Seers, A., Vandenberg, R.J., & Williams, L.J. (1997). Exploratory and confirmatory factor analysis: Guidelines, issues, and alternatives. *Journal of Organizational Behavior*. *18*, 667-683.

Suggested Readings:
Chapter 5: Confirmatory Factor Analysis and Structural Equation Modeling (pp. 55-80). In Muthén, L. K., & Muthén, B. O. (1998-2012), *Mplus user's guide.* Seventh Edition. Los Angeles, CA: Muthén & Muthén.

Homework 3:
You will be given data to conduct an EFA in SPSS, multiple 1st order CFAs, and a 2nd order CFA in M*plus* – compare and contrast results.

Topic 6 – Construct Validity: MTMM & Effects of Common Method Variance
R 10/8
Readings:
Podsakoff, P.M., MacKenzie, S. B., & Lee, J. (2003). Common method biases in behavioral research: A critical review of the literature and recommended remedies. *Journal of Applied Psychology, 88,* 879-903.

Kenny, D. A., & Kashy, D. A. (1992). Analysis of the multitrait-multimethod matrix by confirmatory factor analysis. *Psychological Bulletin, 112,* 165-172.

Homework 4:
Students will be assigned to groups and given data to investigate construct validity using one of the techniques discussed. We will then compare results of the various techniques.

R 10/15 – **Topic 6 Continued – Group presentations & Midterm Review**

R 10/22 – **MIDTERM EXAM (IN CLASS)**

Topic 7 – **Path Models & Latent Models with Structural and Measurement Components (Full Structural Models)**
R 10/29
Readings:
Rigdon, E.E. (1994). Calculating degrees of freedom for a structural equation model. *Structural Equation Modeling, 1*, 274-278.

Chapter 5: Specification (pp. 91-123) & Chapter 10: Structural Regression Models (pp. 265-294). In Kline, R. B. (2010), *Principles and Practice of Structural Equation Modeling* (3rd Ed.). New York: Guilford Publications.

Suggested Readings:
Chapter 6: Testing the Validity of a Causal Structure: Full Structural Equation Model (pp. 147-189). In Byrne, B. M. (2012), *Structural equation modeling with Mplus: Basics, concepts, applications and programming*. New York: Routledge.

Homework 5:
You will calculate degrees of freedom and run a full structural model.

Topic 8 – Testing for Mediation in SEM
R 11/5
Readings:
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.

Lau, R. S., & Cheung, G. W. (2012). Estimating and comparing specific mediation effects in complex latent variable models. *Organizational Research Methods, 15,* 3-16.

Suggested Readings:
MacKinnon, D. P., Lockwood, C. M., Hoffman, J. M., West, S. G., & Sheets, V. (2002). A comparison of methods to test mediation and other intervening variable effects. *Psychological Methods, 7,* 83-104.

Homework 6:
You will run a mediation SEM model and interpret the results.

Topic 9 – Testing for Moderation, Moderated Mediation, Mediated Moderation, and Beyond
R 11/12
Readings:
Marsh, H.W., Wen, Z. & Hau, K-T. (2004). Structural equation models of latent interactions: Evaluation of alternative estimation strategies and indicator construction. *Psychological Methods, 9,* 275-300.

Little, T. D., Bovaird, J. A., & Widaman, K. F. (2006). On the merits of orthogonalizing powered and product terms: Implications for modeling interactions among latent variables. *Structural Equation Modeling, 13,* 497-519.

Edwards, J. R., & Lambert, L. S. (2007). Methods for integrating moderation and mediation: A general analytical framework using moderated path analysis. *Psychological Methods, 12,* 1-22.

Preacher, K. J., Rucker, D. D., & Hayes, A. F. (2007). Addressing moderated mediation hypotheses: Theory, methods, and prescriptions. *Multivariate Behavioral Research, 42,* 185-227.

Suggested Readings & a Nighttime Video:
Edwards, J.R. (2009). Seven deadly myths of testing moderation in organizational research. In C.E. Lance & R.J. Vandenberg (eds.), *Statistical and Methodological Myths and Urban Legends: Received Doctrine, Verity, and Fable in the Organizational and Social Sciences* (pp. 143-164). New York, NY: Routledge.

"Moderated Mediation" CARMA video by Jose Cortina from Spring 2013. Found at http://carma.wayne.edu/VideoLibrary.asp and accessible by registering with your uta.edu email address.

Homework 7:
You will run a series of SEMs to test for moderation and interpret the results.

Topic 10 – Multisample Analyses, Tests of Mean Structures, & Measurement Invariance/Equivalence
R 11/19
Readings:
Vandenberg, R.J., & Lance, C.E. (2000). A Review and synthesis of the measurement invariance literature: Suggestions, practices and recommendations for organizational research. *Organizational Research Methods, 3,* 4-70.

Ployhart, R.E., & Oswald, F.L. (2004). Applications of mean and covariance structure analysis: Integrating correlational and experimental approaches. *Organizational Research Methods, 7,* 27-65.

Suggested Readings:
Meade, A. W., Johnson, E. C., & Braddy, P. W. (2008). Power and sensitivity of alternative fit indices in tests of measurement invariance. *Journal of Applied Psychology, 93,* 568-592.

Homework 8:
You will test for ME/I in a measurement model across groups and interpret the results.

Topic 11 – Considering Time Within & Between Individuals: Latent Growth Modeling, Latent Change Scores, & Introduction to Multilevel Modeling
R 12/3
Readings:
Chapter 8: Latent Growth Curve Modeling (155-180). In D. Kaplan (2009), *Structural equation modeling: Foundations and extensions*. 2nd Edition. Thousand Oaks, CA: Sage.

Selig, J. P., & Preacher, K. J. (2009). Mediation models for longitudinal data in developmental research. *Research in Human Development, 6,* 144-164.

Chapter 7: Multilevel structural equation modeling (pp. 133-154). In D. Kaplan (2009), *Structural equation modeling: Foundations and extensions*. 2nd Edition. Thousand Oaks, CA: Sage.

Chapter 9: Multilevel Modeling (pp. 185 – 224). In E. Kelloway (2015), *Using Mplus for Structural Equation Modeling.* 2nd edition. Thousand Oaks, CA: Sage.

R 12/17 – **COURSE PROJECT DUE IN MY BOX (2:30pm)**