PSY 792F: Structural Equation Modeling
Spring 2018
Tuesday, 10:30am to 1:10 pm
Clark C68

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Office Hours:	By Appointment

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Office Hours:	By appointment

Office Hours and Contact Information
Office hours are by appointment, however, I will generally be available after class and often when I am in my office. If you let me know ahead of time that you would like to meet after class, I will make sure that I am available. If you need something at other times, come by my office, and knock, or come in if the door is open. Otherwise, you should contact me via email, which is the best way to reach me, and we can set up an appointment. If you have questions about the course that you need answered quickly, I also suggest that you email me. Students can expect a response to email within 24 hours. Calling me on either my mobile or office phones is not an effective way of contacting me.

Course Purpose
Structural Equation Modeling (SEM) is a commonly used and flexible statistical framework that encompasses many statistical methods. SEM is a valuable skill for conducting your own research and for statistical consulting. Learning SEM will open the door for many other statistical methods, as it is at the core of many modern approaches to analyzing complex datasets.

Course Objectives:
This is an applied course. The goal of this course is to provide you with a strong foundation in SEM methods. After taking this course you will be able to:

1. Select the appropriate analysis for a given data set and research question
2. Understand the assumptions for the selected analysis
3. Know how to write the code to run the analysis in MPlus
4. Know how to interpret the output
5. Know how to write up the analysis plan and results section of a manuscript.

Required Software and Readings
Data analyses will be conducted in Mplus. Data management can be conducted in SPSS, R, Stata, or any other software you like. You will be expected to have access to MPlus to complete assignments and prepare for the exams.

There will be many articles and book chapters available for this course. I will provide pdfs of the articles and chapters and recommend some books that you may or may not choose to buy to have as a reference in your library. You will be responsible to understand the content of the articles as they apply to the materials covered in lectures. There will not be quizzes or tests asking specifically about the articles, but you will be tested on the big themes in the articles. Some of the articles will be helpful to have as a resource for writing up papers on the topics and other articles will be helpful to gain a deeper understanding of each SEM method we discuss.

Grading and Assignments
Your grade in this course will be determined by scores on 3 exams and a final paper. There will be a total of **320 points** across the 3 exams and final paper.

Exams: There will be three exams.

1. Exam 1 (**80 pts**): Feburary 14th, will cover path analysis, moderation and mediation
2. Exam 2 (**80 pts**): March 28th, will cover latent variable modeling, latent growth curve modeling, and mixture modeling
3. Exam 3 (**80 pts**): May 2nd, will cover multilevel modeling, multilevel SEM, and Bayesian Inference*
   *if we run behind I will drop Bayesian inference and use the final class period to catch up

Final Paper (**80 pts**)**:** You will be asked to write an abbreviated manuscript on real data (ideally your own data).

The paper will include:

1. A brief introduction outlining the research question and a bit of background (1-2 pages)
2. A brief methods section (1 page)
3. A thorough analysis plan
4. A thorough results section with tables and figures a relevant
5. A brief discussion (1-2 pages)

Homework: I will not assign weekly assignments. However, I **STRONGLY** encourage you to practice running the models we learn each week. I recommend you work both in small groups and alone to be sure you have mastered the following skills:

1. How to structure your data for each analysis
2. How to write the code (and how to trouble shoot it)
3. How to interpret the output
4. How to write up the results

Grade Chart

Total Points	***Final Grade***
307-320	**A**
293-306	**A-**
279-292	**B+**
265-278	**B**
251-264	**B-**
236-250	**C+**
223-236	**C**
200-222	**C-**

Less than 200 points is considered a failing grade

Due Dates:

Exams: will be held in class on the indicated date. Exams will be essays and interpretation of output. Exams are closed book and closed notes. I expect you to learn the material and write your answers from memory. You will have the full class period to complete the exams.

Final paper: Is due by 5pm on the Tuesday of Finals week: May 8th.

Attendance and promptness: Students are expected to be present and on time for all class meetings. The required course readings will provide information on a range of topics, whereas the lectures and class discussions will focus on selected topics in more depth. Many students find that regular attendance enables them to learn assigned material more easily and therefore enhances their performance on exams and assignments. It is your responsibility to obtain information about any announcements, class notes, and handouts from other classmates in the event of an absence. It is also expected to that you will inform me of an absence prior to its occurrence whenever possible by emailing me.

Classroom Decorum: It is important to maintain a classroom environment that is respectful and conducive to learning. To this end, it is useful to set out some basic policies for classroom behavior:

1. Arrive on time and stay for the duration of the class. If you are going to be late or absent, get it excused by me prior to it happening.
2. Cell phones must be turned off during class. This is an absolute. No cell phone use during class.
3. Laptops may be used only for note-taking. Though you may be able to multitask, other uses are distracting to those around you and to me. This includes checking email, surfing the web, chatting with others (including those in this class), and checking social media.
4. No reading of newspapers, books or other material unrelated to the course during class time.
5. No side conversations with other students while I am lecturing or during class discussions.
6. No engaging in any behavior that distracts from anyone's ability to learn and participate in class.

Failing to exhibit these behaviors will result in deductions from your class participations grade.

Disability disclosure. Any student who has need for accommodations based on the impact of a disability should contact me privately as early in the course as possible and contact Resources for Disabled Students at 970-491-6385 or in person at 100 General Services Building to coordinate reasonable accommodations.

Statement on Academic Freedom. Freedom to teach and freedom to learn are inseparable facets of academic freedom. Colorado State University has adopted polices and guiding principles for these freedoms, which can be accessed through this link: http://catalog.colostate.edu/Content/files/2012/FrontPDF/1.6POLICIES.pdf.

Diversity Statement. Diversity is a shared vision for our efforts in preparing professional psychologists. Students are encouraged to investigate and gain a perspective of diversity issues (race, ethnicity, language, religion, culture, SES, gender, sexual identity, disability, ability, age, national origin, geographic location, etc.) related to their chosen fields. Students will also have the opportunity to examine critically how diversity issues apply to course topics. Students will be encouraged to examine their belief systems and to reexamine and develop more grounded beliefs and practices regarding diversity. Students can expect the class environment to be respectful to diverse perspectives, and are encouraged to contact me if such an environment is not achieved.

Weekly Schedule

The syllabus is seen as a fluid document that may change at any time.

1/16 Week 1 Course Introduction and baseline exam (not graded):

Content: Review syllabus, discuss expectations, introduce Mplus, take baseline exam

Readings:

Muthén, L.K. and Muthén, B.O. (1998-2012). Mplus User's Guide. Seventh Edition. Los Angeles, CA: Muthén & Muthén

References for Regression:

Cohen, J., Cohen, P., West, S. G., & Aiken, L. S. (2013). *Applied multiple regression/correlation analysis for the behavioral sciences*. Routledge.

Aiken, L. S., West, S. G., & Reno, R. R. (1991). Multiple regression: Testing and interpreting interactions. Sage.

Miles, J., & Shevlin, M. (2001). Applying regression and correlation: A guide for students and researchers. Sage.

1/23 Week 2 Path Analysis

Content: Introduction to statistical modeling; Path Analysis (i.e., SEM with all observed variables/Regression with more than one dependent variable)

Readings:

Note: These readings will be important for the next 3 weeks.

Preacher, K. J., Rucker, D. D., & Hayes, A. F. (2007). Addressing moderated mediation hypotheses: Theory, methods, and prescriptions. Multivariate behavioral research, 42(1), 185-227.

Hu, L. T., & Bentler, P. M. (1999). Cutoff criteria for fit indexes in covariance structure analysis: Conventional criteria versus new alternatives. Structural equation modeling: a multidisciplinary journal, 6(1), 1-55.

1/30 Week 3 Mediation

Content: Modeling in sequence, best practices for testing mediation in a SEM framework

Readings:

Preacher, K. J., & Kelley, K. (2011). Effect size measures for mediation models: quantitative strategies for communicating indirect effects. Psychological methods, 16(2), 93. Chicago

Fritz, M. S., & MacKinnon, D. P. (2007). Required sample size to detect the mediated effect. Psychological science, 18(3), 233-239.

Hayes, A. F., & Scharkow, M. (2013). The relative trustworthiness of inferential tests of the indirect effect in statistical mediation analysis does method really matter?. Psychological Science, 0956797613480187.

2/6 Week 4 Moderation

Content: Modeling interaction terms in an SEM framework

Readings:

McClelland, G. H., & Judd, C. M. (1993). Statistical difficulties of detecting interactions and moderator effects. *Psychological bulletin,* 114(2), 376.

*Review Aiken and West

*Review Preacher, Rucker, & Hayes (2007)

2/13 Week 5 Exam 1

2/20 Week 6 Latent Variable Modeling

Content: Introducting latent variables

References:

Kline, R. B. (1998). *Structural equation modeling.* New York: Guilford.

Brown, T. A. (2015). Confirmatory factor analysis for applied research. Guilford Publications.

Readings:

Schreiber, J. B., Nora, A., Stage, F. K., Barlow, E. A., & King, J. (2006). Reporting structural equation modeling and confirmatory factor analysis results: A review. *The Journal of educational research*, 99(6), 323-338.

2/27 Week 7 Latent Growth Curve Modeling

Content: Modeling change overtime using SEM

Readings:

Feingold, A. (2009). Effect sizes for growth-modeling analysis for controlled clinical trials in the same metric as for classical analysis. *Psychological methods*, 14(1), 43.

Preacher, K. J. (2010). *Latent growth curve models*. The reviewer's guide to quantitative methods in the social sciences, 199-208.

3/6 Week 8 Latent Profile Analysis

Content: Identifying latent profiles within your data

Reference for mixture models

McLachlan, G., Peel, D., 2000. *Finite Mixture Models*. Wiley, New York.

Readings:

Nylund, K.L., Asparouhov, T., Muthén, B.O., 2007. Deciding on the number of latent classes in latent class analysis and growth mixture modeling: a Monte Carlo simulation study. *Structural Equation Modeling*, 14, 535–569.

Muthén, B.O., Muthén, L.K., 2000. Integrating person-centered and variable-centered analysis: Growth mixture modeling with latent trajectory classes. *Alcohol Clinical and Experimental Research, 24, 882–891.*

Lo, Y., Mendell, N.R. & Rubin, D.B. (2001). Testing the number of components in a normal mixture. *Biometrika*, 88, 767-778.

Jung, T., & Wickrama, K. A. S. (2008). An introduction to latent class growth analysis and growth mixture modeling. *Social and Personality Psychology Compass*, 2(1), 302-317.

Asparouhov, T., (2007). *Wald Test of Mean Equality for Potential Latent Class Predictors in Mixture Modeling. Technical Appendix*. Muthén & Muthén, Los Angeles.

Asparouhov, T., & Muthén, B. (2014). Auxiliary variables in mixture modeling: Three-step approaches using M plus. *Structural Equation Modeling: A Multidisciplinary Journal*, 21(3), 329-341.

3/13 Week 9 Spring Break! (No Class)

3/20 Week 10 Growth Mixture Modeling

Content: Identifying latent trajectories in longitudinal data

Readings:

Nylund, K.L., Asparouhov, T., Muthèn, B.O., 2007. Deciding on the number of latent classes in latent class analysis and growth mixture modeling: a Monte Carlo simulation study. *Structural Equation Modeling*, 14, 535–569.

Lubke, G.H., Neale, M.C., 2006. Distinguishing between latent classes and continuous factors: resolution by maximum likelihood? *Multivariate Behavorial Research*, 41, 499–532.

3/27 Week 11 Exam 2

4/3 Week 12 Multilevel Modeling

Content: Modeling complex survey data/nested data

References:

Singer, J. D., & Willett, J. B. (2003). *Applied longitudinal data analysis: Modeling change and event occurrence.* Oxford university press.

Raudenbush, S. W., & Bryk, A. S. (2002*). Hierarchical linear models: Applications and data analysis methods* (Vol. 1). Sage.

Readings:

Gibbons, R. D., Hedeker, D., & DuToit, S. (2010). Advances in analysis of longitudinal data. *Annual review of clinical psychology*, 6, 79.

Hayes, A. F. (2006). A primer on multilevel modeling. *Human Communication Research*, 32(4), 385-410.

4/10 Week 13 Multilevel SEM

Content: MLM with more than one dependent variable

Readings:

Mehta, P. D., & Neale, M. C. (2005). People are variables too: multilevel structural equations modeling. *Psychological methods*, 10(3), 259.

Curran, P. J. (2003). Have multilevel models been structural equation models all along?. *Multivariate Behavioral Research*, 38(4), 529-569.

4/17 Week 14 MSEM Mediation

Content: Modeling mediation with nested data

Readings:

Preacher, K. J., Zyphur, M. J., & Zhang, Z. (2010). A general multilevel SEM framework for assessing multilevel mediation. *Psychological methods*, 15(3), 209.

4/24 Week 15 Writing Help (attendance is optional)

5/1 Week 16 Exam 3

5/8 Finals Week Final Paper Due by 5 p.m.

The report should be emailed to me at Mark.Prince@colostate.edu by 5 p.m.