University of Guelph

College of Management and Economics
Dept. of Marketing and Consumer Studies

MCS*6070 Introduction to Structural Equation Modeling

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Session: Fall 2011
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Office Hours: TBA

Lecture: Tues / Thurs
Lab: 1:00 pm to 2:30 pm

Room: MINS 106
Room: MACS 311a

Course Description

This course introduces students to the theory, concepts and application of structural equation modeling. Topics covered include path analysis, confirmatory factor analysis and measurement models, latent variable modeling, multi-group modeling, and measurement invariance testing. Emphasis is placed on applying the principles of SEM to the creation and testing of theoretically driven models using both categorical and continuous data.

Prerequisites

One graduate level research methods course (MCS*6050 or equivalent).

Note: although a multivariate analysis course is shown in the University calendar as a prerequisite, it is no longer required.

Course Objectives

By the end of this course students will:

1. Be familiar with the theory and statistical assumptions behind structural equation modeling.
2. Understand the language, techniques, and technical issues pertaining to structural equation modeling.
3. Be able to evaluate the pros and cons of structural equation modeling in comparison to other univariate and multivariate analysis methods.

4. Understand how to deal with complex sampling issues (such as non-independence and design effect).
5. Develop the ability to construct, test, and modify a variety of different theoretical models within the structural equation modeling framework.
6. Develop the skills required to critically evaluate published research reporting structural equation modeling results.

Reading List

Required:

We will be working from a number of different sources. However three textbooks that I would recommend are. The Byrne book should be available in the University Bookstore.

1. Byrne, Barbara M. (2011) *Structural Equation Modeling with Mplus.* NY: Routledge Academic.
2. Raykov, Tenko and Marcoulides, George A. (2006) *A First Course in Structural Equation Modeling, 2nd Edition.* NJ: Lawrence Erlbaum.
3. Bollen, Kenneth A. (1989). *Structural Equations with Latent Variables.* NY: John Wiley and Sons.
4. Additional reading material included in the schedule (see additional reading material list).

Not Required but Recommend as Resources:

While you are not required to purchase these books, some of the readings for this course come from them. Books marked with **[L]** are on 2 hour reserve at the library. These texts are very useful as additional resource material.

1. Kaplan, David. (2009). *Structural Equation Modeling: Foundations and Extensions, 2nd Edition.* LA: Sage Publications.
2. Kline, Rex B. (2005). *Principles and Practice of Structural Equation Modeling, 2nd edition.* NY: Guildford Press.
3. Schumacker, Randall E. and Lomax, Richard G. (2004). *A Beginner's Guide to Structural Equation Modeling, 2nd Edition.* NY: Taylor and Francis Group.**[L]**

Software:

We will be using the Mplus software package for this course. Most computers in the graduate lab have Mplus installed, however, you may wish to consider purchasing your own copy (from www.statmodel.com) or downloading the free demonstration version so that you are not dependent on the lab computers. If you buy the program, the Mplus Base Program will be sufficient for this course, but I would recommend buying at least the Mplus Base Program with the Mixture Add-On. Note: you are not required to purchase the software.

Evaluation

Weekly Assignments **50%**

[1] Path Analysis (5%)
[2] Confirmatory Factor Analysis (5%)
[3] Reliability and Validity Testing (5%)
[4] Complex Sampling (5%)
[5] Latent Variable SEM with Continuous Data (5%)
[6] Latent Variable SEM with Categorical Data (5%)
[7] Moderation and Mediation (5%)
[8] Multigroup CFA and Measurement Invariance(5%)
[9] Latent Growth Curve Modeling (5%)
[10] Multilevel Modeling (5%)

Student Presentation **10%**

Students will critically review a paper that employs structural equation modeling.

Major Project **40%**

This project will incorporate various latent variable modeling methods.

Grading Guidelines

This course follows the grading guidelines outlined in the Graduate Calendar: http://www.uoguelph.ca/GraduateStudies/calendar/genreg/genreg-as.shtml

90-100 (A+)	Outstanding. The student demonstrated a mastery of the course material at a level of performance exceeding that of most scholarship students and warranting consideration for a graduation award
80-89 (A)	Very Good to Excellent. The student demonstrated a very good understanding of the material at a level of performance warranting scholarship consideration.
70-79 (B)	Acceptable to Good. The student demonstrated an adequate to good understanding of the course material at a level of performance sufficient to complete the program of study.
60-69 (C)	Minimally Acceptable. The student demonstrated an understanding of the material sufficient to pass the course but at a level of performance lower than expected from continuing graduate students.
0-59 (F)	Fail: An inadequate performance

Lectures and Labs

The course consists of both lectures and labs and is scheduled for Tuesdays and Thursdays from 1:00

pm to 2:30 pm. While the lectures will be held in MINS 106, the labs will be held in the Graduate Student Lab in the MACS building. The labs will be conducted on selected Thursdays during the regular scheduled lecture time. The dates of the lectures and labs are outlined on Courselink.

Assignment Details

All assignments will be posted on Courselink at the beginning of the course. You are free to work ahead if you wish. Each assignment will be graded out of 10. Given the importance of providing students with timely feedback on assignments, there will be no extensions granted. Late assignments will receive a 2 mark penalty per day. You may use the referencing / citation method of your choice.

Major Project Details

The major project will be posted on Courselink at the beginning of the course. We won't cover all of the topics included in the project until week 10. This is project is meant to be a "take home exam" however you may hand it in before the due date if you wish. You may use the referencing / citation method of your choice.

Student Presentation Details

For the presentation, you are to select one paper, based on topic of interest to you, that uses a structural equation methodology. You will then create a 15 minute presentation (to the class) focusing on critically reviewing the structural equation methodology employed. Presentations will be schedule for the last week of the class.

Miscellaneous

1. The electronic recording of classes is expressly forbidden without the prior consent of the instructor. This prohibition extends to all components of the course, including, but not limited to, lectures, seminars, and lab instruction, whether conducted by the instructor or a seminar leader or demonstrator, or other designated person. When recordings are permitted they are solely for the use of the authorized student and may not be reproduced, or transmitted to others, without the express written consent of the instructor.

2. You are responsible for understanding your rights and responsibilities outlined in the University Calendar. You can find the University Calendar at:
http://www.uoguelph.ca/academics/calendars/.

3. All announcements, notes, datasets, etc. will be posted on Courselink (D2L), so please check the site regularly.

4. Please use only your University of Guelph email address when sending me an email. Other email addresses tend to get blocked. I will strive to return your email as quickly as possible. I normally check email between 8am and 5pm Monday to Friday.

5. Please make reliable back-up copies of your work at all times. Computer crashes can happen when you are just finishing assignments. Computer crashes are not a valid reason for late work.

Topic Schedule

The following is a detailed schedule of the topics and readings we will cover each week. It is highly recommended that you complete the readings before coming to class. Please consult Courselink for specific lecture and lab dates.

Week 1: Overview of Structural Equation Modeling and its Statistical Assumptions

1. An introduction to structural equation modeling (SEM)

   Reading: Byrne chapter 1 and 2

   Reading: Raykov and Marcoulides pg. 1–8.

Week 2: Path Analysis

1. Regression modeling versus path analysis

   Reading: Schumacker and Lomax chapter 6 and 7.

2. Recursive versus non-recursive models

3. Model identification rules

   Reading: Raykov and Marcoulides chapter 3.

4. Decomposition of covariance / correlation

5. Total, direct, and indirect effects

   Reading: Schumacker and Lomax chapter 6 and 7.

   Reading: Raykov and Marcoulides chapter 3.

Week 3: Model Specification, Estimation, and Evaluation

1. Specifying and estimating models

   Reading: Course Notes

2. Model evaluation

   Reading: Byrne chapter 6

   Reading: Bentler and Chou (1987)

   Reading: Hu and Bentler (1995)

Reading: Hu and Bentler (1999)

Week 4: Measurement Models and Confirmatory Factor Analysis

1. Measurement models and Confirmatory Factor Analysis (CFA)
2. Exploratory Factor Analysis (EFA) in a CFA framework
3. Hybrid models

Reading: Byrne Chapter 3, 4, and 5.
Reading: Edwards and Bagozzi (2000)
Reading: Little, Lindenberger, and Nesselroade (1999)

Week 5: Reliability and Validity Testing within the CFA Framework

1. Reliability

Reading: Raykov (1997)
Reading: Byrne Chapter 10.

2. Discriminant validity

Reading: Anderson and Gerbing (1988)
Reading: Fornell and Larcker (1981)

3. Convergent validity

Reading: Steenkamp and van Trijp (1991)

4. Common method variance and bias

Reading: Richardson, Simmering, and Sturman (2009)

Week 6: Issues in Complex Sampling

1. Complex sampling, design effects, and intraclass correlation
2. Problems with ignoring clustering

Reading: Asparouhov (2005)

3. Statistical inference in complex sampling

Reading: Stapleton (2002)
Reading: Chambers and Skinner chapter 1

Week 7: Latent Variable Structural Models with Continuous and Categorical Data

1. Specifying models with and without complex sampling

   Reading: Byrne Chapter 6

2. Longitudinal and repeated measure models

   Reading: Raykov and Marcoulides chapter 5

Week 8: Moderation and Mediation within a Structural Equation Modeling Framework

1. Testing moderation and mediation in path analysis

   Reading: Baron and Kenny (1986)
   Reading: Muller, Judd, and Yzerbyt (2005)
   Reading: MacKinnon, Lockwood, Hoffman, West, and Sheets (2002)

2. Bootstrapping methods for testing mediation

   Reading: MacKinnon, Lockwood, and Williams (2004)

Week 9: Multi-group Modeling and Measurement Invariance Testing

1. Multi-group modeling (including a discussion of alternatives to ANOVA and MANOVA)

   Reading: Byrne Chapter 7, 8, and 9.
   Reading: Muthén (1998)

2. Invariance testing (first order and second order)

   Reading: Chen, Sousa, and West (2005)
   Reading: Vandenberg and Lance (2000)

Week 10: Introduction to Latent Growth Curve Modeling

1. Latent Growth Curve Modeling

   Reading: Byrne Chapter 11.
   Reading: Muthén (1998)

Week 11: Introduction to Multilevel Modeling

1. Multilevel Modeling

   Reading: Byrne Chapter 12.

Week 12 Student Presentations

1. Student presentations – critical review of papers employing SEM

Additional Reading Material List

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

2. Armstrong, J.S., and Overton, T.S. (1977) Estimating nonresponse bias in mail surveys. *Journal of Marketing Research*, 14, 396–402.

3. Asparouhov, T. (2005) Sampling weights in latent variable modeling. *Structural Equation Modeling*, 12, 411–434

4. Bentler, P.M. and Chou, C.P. (1987) Practical issues in structural modeling, *Sociological Methods and Research*, 16, 78-117

5. Chambers, R.L. and Skinner, C.J. 2003. *Analysis of survey data.* Chichester: Wiley and Sons.

6. Chen, F.F., Sousa, K.H., and West, S.G. (2005) Testing measurement invariance of second-order factor models. *Structural Equation Modeling*, 12: 471–492.

7. Edwards, J.R., and Bagozzi, R.P. (2000) On the nature and direction of relationships between constructs and measures. *Psychological Methods*, 5, 155–174.

8. Fornell, C.D. and Larcker, D.F. (1981) Evaluating structural equation models with unobservable variables and measurement errors. *Journal of Marketing Research*, 18 (February), 39–50.

9. Hu, L.T., and Bentler, P.M. (1995) Evaluating model fit. In R.H. Hoyle (Ed.), *Structural Equation Modeling. Concepts, Issues, and Applications.* London: Sage.

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

11. Kline, R.B. (2005) *Principles and Practices of Structural Equation Modeling*, 2nd Edition. NY: The Guilford Press

12. Little, T.D., Lindenberger, U., and Nesselroade, J.R. (1999) On selecting indicators for multivariate measurement and modeling with latent variables: When good indicators are bad and bad indicators are good. *Psychological Methods*, 4, 192–211.

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

14. MacKinnon, D.P., Lockwood, C.M., and Williams, J. (2004) Confidence limits for the indirect effect: Distribution of the product and resampling methods. *Multivariate Behavioral Research*, 39, 99–128.

15. Muthén, B. (1989) Latent variable modeling in heterogeneous populations. *Psychometrika*, 54, 557–585.

16. Raykov, T. (1997) Estimation of composite reliability for congeneric measures. *Applied Psychological Measurement*, 21(2), 173–184

17. Richardson, H.A., Simmering, M.J, and M.C. Sturman. (2009) A tale of three perspectives: Examining post hoc statistical techniques for detection and correction of common method variance. *Organizational Research Methods* 12(4), 762–800.

18. Schumacker, R.E. and Lomax, R.G. (2004) *A beginners guide to structural equation modeling, 2nd edition.* NY: Taylor and Francis.

19. Stapleton, L. (2002) The incorporation of sample weights into multilevel structural equation models. *Structural Equation Modeling*, 9, 475–502.

20. Steenkamp, J.B., and van Trijp, H.C.M. (1991) The use of LISREL in validating marketing constructs. *International Journal of Research in Marketing*, 8, 283–299.

21. Vandenberg, R.J. and 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.