Department of Marketing and Consumer Studies
MCS*6070
Structural Equation Modelling (SEM)
Winter 2017

Instructor(s): Dr. Towhidul Islam, Professor
Room: MINS 206, Ext 53835
Email: islam@uoguelph.ca
Office Hours: Mondays 12:30 – 1:30 pm, 4:00 – 6:00 pm
Wednesdays 1:30 – 3:30 pm

Class Times and Location: **Lecture:** Tuesdays MINS 207: 9:30 -12:30 pm
Lab: Additional Lab support on Mondays in MACS 243: 2:45 – 3:45 pm

COURSE DESCRIPTION

This course is designed for those students (or any researchers) who want to gain a significant familiarity with a collection of statistical techniques that target the measurement of latent variables (i.e. variables that cannot be measured directly) as well as methods for estimating relationships among variables within causal systems. This course covers exploratory and confirmatory factor analysis, latent class and finite mixture models, latent growth curve and introduction to multi-level model. The course also covers counterfactual approach of causal inference in the presence of confounders, mediators and moderators. Data analysis examples will come from business and social science applications and practical implementation of all methods will be demonstrated using the Mplus software.

COURSE LEARNING OBJECTIVES

Students who successfully complete this course will be able to:

- Understand the latent variable measurement problems
- Be able to implement factor analysis models using software on real data and interpret results including checking model assumptions
- Understand the use of latent class and finite mixture models as methods for clustering individuals and be able to fully implement them using software including assessing model fit and interpreting results
- Understand the role of structural equation modeling (SEM) including making causal inference using counterfactual approach in the presence of confounders, mediators and moderators.
- Identify and be able to estimate using software the total, indirect, and direct effects within a SEM as well as assessing model fit and checking model assumptions.
- Critically read research articles that use the collection of methods learned in the course.

Course Materials and Resources:
This course uses a variety of materials and resources. One of your primary resources will be the course website (http://courselink.uoguelph.ca). All announcements, required and recommended readings, assignments and updates will be posted here. You will also be able to access any handouts you may have missed through this site.

Course Structure
Classroom experience will be a combination of traditional lecture with notes made available electronically before class and hands-on computer lab experience (using the free demo version of Mplus) in a designated computer lab or in class with laptops. Homework will be assigned approximately every two weeks and students may discuss their work with other class-mates but are expected to write-up results themselves.

Suggested Texts for Reading Selected Chapters

- Kline, R.B. (2015). Principles and Practice of Structural Equation Modeling, 4th Edition, Guilford.
- Muthen, B., Muthen, L. and Asparouhov, T. (2016). Regression and Mediation Analysis using Mplus. Los Angeles, CA. Muthen & Muthen.
- Grimm, K. J., Ram, N. and Estabrook, R. (2017). Growth Modeling: Structural Equation and Multilevel Modeling Approaches. Guilford Press. New York.
- Bollen, K. A. and Curran, P. J. (2006). Latent Curve Models: A Structural Equation Perspective. Wiley, New Jersey.
- Heck, R. H. and Thomas, S. L. (2015). An Introduction to Multilevel Modeling Techniques: MLM and SEM Approaches using Mplus, 3rd Edition, Routledge, New York.

Software: MPLUS

You will need access to a computer. I will be introducing how to implement all the techniques in the course using the **Mplus software** (www.statmodel.com). A FREE demo version of MPLUS 7.4 software and **Mplus user guide** (www.statmodel.com) are available for download from the Mplus website. Some very good resources (including full video lectures by the creator of Mplus, Bengt Muthen) are available on Mplus website. PDF version of Mplus software manual is available free to download from Mplus website.

Group Final Project:

The project will entail a substantive description and detailed statistical analysis of some data set in which the analysis utilizes any one of the following statistical modeling techniques learned in class.

- Option 1: Multilevel Latent Growth modeling
- Option 2: Multilevel Latent Class Model
- Option 3: Multilevel Mediation Analysis
- Option 4: Multilevel CFA
- Option 5: Latent Class and Latent Transition Analysis (LTA)

Depending on the size of the class groups for final projects will be of size 2 or 3 and will be formed by self-selection. For all projects, a written report (10-12 pages not including graphs) outlining the problem, describing the analysis and summarizing the results will be required. For Ph.D. students target will be to generate a manuscript for submission.

Evaluation Procedure:

	Modules	**Weight**
Assignments: Individual	Latent Variable Measurement, CFA and Measurement Invariance	20%
	Mediation and Moderation using Counterfactual Approach	20%
	Latent Growth Mixture Models	20%
Group	Final Project	40%

For each assignment, you will get at least 7 day time for submission from the assignment handover date. Extensions will only be granted on the basis of extenuating circumstances.

Class Schedule and Suggested Readings:

Week and Module (and Labs)	Lecture Topics & Readings
Module 1: Introduction and Fundamentals of Measurement Week 1 - 2 (Jan 10 and Jan 17) Lab Week 1: Introduction to Mplus and Data Import Lab Week 2: Fitting Simple Models including introduction to EFA	Learning Objectives: Survey the full range of latent variable and structural equation modeling methods that will be introduced in the course. Learn how to develop conceptual variables. Understand reflective vs. formative latent variables. Understand and know methods for assessing dimensionality, reliability, and validity of scales. Required Reading: Course Notes Related Reading: o Jarvis, Mackenzie and Podsakoff (2003). A Critical Review of Construct Indicators and Measurement Model Misspecification in Marketing and Consumer Research, *Journal of Consumer Research*, 30, 199-218 o Diamantopoulos and Siguaw (2006) Formative versus reflective indicators in organizational measure development: A comparison and empirical illustration, *British Journal of Management,* 17, 263-282.
Module 2: Factor Analysis: Exploratory (EFA) and Confirmatory (CFA) and Measurement Invariance Week 3 - 4 (Jan 24 and Jan 31) Lab Week 3: CFA and Model Fit Lab Week 4: Measurement Invariance	Learning Objectives: Understand, interpret and implement EFA, CFA and test measurement invariance. Required Reading: Course Notes Related Reading: o Kline (2015), Chapter 9: Specification and identification of confirmatory factor analysis models o Pett, M., Lackey, N. and Sullivan, J. (2003), Making Sense of Factor Analysis, Sage, Thousand Oaks, California. o Reise, Waller and Comrey (2000) Factor analysis and scale revision, *Psychological Assessment*, 12(3), 287-297. o Gregorich, S. E. (2006). Do Self-report instruments allow meaningful comparisons across diverse population groups? Testing measurement invariance using confirmatory factor analysis, Medical Care, 44 (11), S78-S94.
Module 3: Structural Equation Models including Mediation & Moderation Week 4-5 (Feb 7 and Feb 14): Lab Week 4: Mediation analysis using counterfactual approach Lab Week 5: Sensitivity Analysis, Treatment-Mediator Interactions	Learning Objectives: Identify and be able to estimate using software the total, indirect, and direct effects within a SEM. Be able to estimate and test for meditational effects and understand the meaning of effect modification and be able to test interactions within a SEM. Be familiar with theoretical language and ideas of statistical inference for causal modeling using counterfactual approach Required Reading: Course Notes Related Reading: o Neumark-Sztainer, D., Wall, M., Story, M and Perry, C. L. (2003), Correlates of unhealthy weight-control behaviors among adolescents: Implications for prevention programs*, Health Psychology*, 22 (1), 88-98. o Preacher, K. J. 2015. Advances in mediation analysis: A survey and synthesis of new developments. *Annual Review of Psychology* 66 825-852. o Valerie L, and Vanderweele T (2013). Mediation Analysis Allowing for Exposure–Mediator Interactions and Causal Interpretation: Theoretical Assumptions and Implementation with SAS and SPSS Macros, *Psychological Methods*, 18(2), 137-150. o Felix, E. (2013) Graphical Causal Models, p 245-273. In S. Morgan (ed.), *Handbook of Causal Analysis for Social Research*. Dodrecht: Springer.

Week 7 (starting Feb 20)	**Winter Break**
Module 4: Latent Growth Models (LGM) Week 8 - 9 (Feb 28, March 7) Lab Week 8: Linear Growth Curve Models Lab Week 9: Non-linear Growth Curve Modeling	Learning Objectives: Understand what growth curve modeling is and how it can be used for longitudinal data analysis. Be able to fit a growth curve model and a growth curve mixture model to data using Mplus. Required Reading: Course Notes Related Reading: o Grimm, K., Ram, N. and Estabrook, R. (2017), Chapter 3: Linear Growth Models; Chapter 7: Growth Mixture Modeling o Bollen, K. and Curran, P. (2006), Chapter 2: Unconditional Latent Curve Model; Chapter 4: Non-linear trajectories and the coding of time. o Curran PJ, Obeidat K, Losardo D (2010), Twelve Frequently asked questions about growth curve modeling. *Journal of cognition and development*, 11(2), 121-136.
Module 5: Latent Class (LC) and Latent Transition Analysis (LTA) Week 10-11 (March 14 and 21) Lab Week 10: Latent Class Analysis Lab Week 11: Introduction to Latent Transition Analysis	Learning Objectives: Understanding, interpret and implement LCA with multiple applications and investigate stability of latent classed using LTA Required Reading: Course Notes Related Reading: o Masyn, K. E. (2013). Latent Class Analysis and Finite Mixture Modeling. In P. Nathan and T. Little (Eds.), The Oxford Handbook of Quantitative Methods (pp. 551-611). New York, NY. Oxford University Press. o Jung T and Wickrama AS (2008) An introduction to latent class growth analysis and growth mixture modeling. Social and Personality Psychology Compass 2/1, 302-317. o Asparouhov, T. & Muthén, B. (2014) Auxiliary variables in mixture modeling: Three-step approaches using Mplus. Structural Equation Modeling: A Multidisciplinary Journal, 21:3, 329-341. o Nylund-Gibson, K., Grimm, R., Quirk, M., & Furlong, M. (2014): A latent transition mixture model using the three-step specification. Structural Equation Modeling: A Multidisciplinary Journal, 21, 439-454.
Module 6: Multi Level Models Week 12-13 (March 28 & April 4) Lab Week 12: Multilevel Modeling Lab 13: Final Project Review	Learning Objectives: Understand the usefulness and application of multilevel SEM Required Reading: Course Notes Related Reading: o Preacher, K. J., M. J. Zyphur, Z. Zhang. 2010. A general multilevel SEM framework for assessing multilevel mediation. *Psychological Methods* 15(3), 209-233. o Heck and Thomas (2015), Chapter 1: Introduction; Chapter 2: Getting started with multilevel modeling strategy. o Lüdtke, O., Marsh, H.W., Robitzsch, A., Trautwein, U., Asparouhov, T., & Muthén, B. (2008). The multilevel latent covariate model: A new, more reliable approach to group-level effects in contextual studies. Psychological Methods, 13, 203-229.

University Grading Scheme

This course follows the University grading scheme outlined in the University Calendar*:

A+	90-100%	**Excellent:** An outstanding performance in which the student demonstrates a superior grasp of the subject matter, and an ability to go beyond the given material in a critical and constructive manner. The student demonstrates a high degree of creative and/or logical thinking, a superior ability to organize, to analyze, and to integrate ideas, and a thorough familiarity with the appropriate literature and techniques.
A	85-89	
A-	80-84	
B+	77-79	**Good:** A more than adequate performance in which the student demonstrates a thorough grasp of the subject matter, and an ability to organize and examine the material in a critical and constructive manner. The student demonstrates a good understanding of the relevant issues and a familiarity with the appropriate literature and techniques.
B	73-76	
B-	70-72	
C+	67-69	**Acceptable:** An adequate performance in which the student demonstrates a generally adequate grasp of the subject matter and a moderate ability to examine the material in a critical and constructive manner. The student displays an adequate understanding of the relevant issues, and a general familiarity with the appropriate literature and techniques.
C	65-66	
F	0-64	**Fail:** An inadequate performance.