The University of North Carolina at Chapel Hill
School of Social Work

SOWO 916 Structural Equation Modeling

Spring Semester, 2013

INSTRUCTOR

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CLASS MEETING TIMES & OFFICE HOURS

Class meets on Wednesdays 9:00-11:50 am in TTK Room 102
Office hours are Wednesdays 12:00 – 1:00 or by appointment

COURSE DESCRIPTION

This course was originally developed by Dr. Shenyang Guo. We will use much of his syllabus, materials, and assignments throughout the semester.

*Structural equation modeling* (SEM) is a general statistical method that can be employed to test theoretically derived models. It is “a class of methodologies that seeks to represent hypotheses about the means, variances, and covariances of observed data in terms of a smaller number of ‘structural’ parameters defined by a hypothesized underlying model” (Kaplan, 2000). In this course, students will learn fundamental concepts and skills to conduct SEM, and how to apply these techniques to social work research.

COURSE OBJECTIVES

At the completion of the course, students will be able to:

- Understand the fundamental hypothesis of SEM and its relationship to the specification, identification, and estimation of a structural equation model;
- Run path analysis and test mediating hypotheses using SEM;
- Conduct confirmatory factor analysis to evaluate measurement validity;
- Conduct structural equations with latent variables and apply the method to test/confirm a theoretically derived model;
- Understand statistical indices measuring goodness-of-fit of a model;
- Conduct multiple group comparisons with SEM to test moderating effects;
- Perform power analysis with SEM and know how to determine minimum sample size needed;
• Understand basic concepts and skills to deal with interactions and quadratics in latent variables, and categorical variables;
• Understand the linkage between SEM and hierarchical linear models, and conduct multilevel analysis and latent growth curve analysis with SEM;
• Understand strategies for dealing with missing data.

PRE-REQUIREMENT

Students are assumed to be familiar with descriptive and inferential statistics. A solid understanding of multiple regression analysis is a key. They should have statistical and statistical software background at least equivalent to that provided by SOWO919 (applied regression analysis and generalized linear models), SOCI209, PSYC282, EDUC284 (linear regression), or SOCI211 (categorical data analysis).

SOFTWARE PACKAGES

Students may choose to use SAS, SPSS, or Stata for data management and matrix calculations. Class examples in these areas will be in Stata. The course will employ Mplus for running SEM. Mplus is available through the university’s Virtual Computer Lab. Students are expected to use the Lab’s help resources to learn how to establish connections with the Lab.

TEXTBOOKS

Required:

Recommended for students who will be conducting SEM’s in their futures:

ASSIGNMENTS

<table>
<thead>
<tr>
<th>Assignments</th>
<th>Grade Percentage</th>
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<tbody>
<tr>
<td>2 peer evaluations</td>
<td>10%</td>
</tr>
<tr>
<td>5 IRATS</td>
<td>15%</td>
</tr>
<tr>
<td>5 TRATS</td>
<td>20%</td>
</tr>
<tr>
<td>Team Application Activities</td>
<td>20%</td>
</tr>
<tr>
<td>7 Homeworks</td>
<td>35%</td>
</tr>
<tr>
<td>TOTAL</td>
<td>100%</td>
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</tbody>
</table>
**Grading System**

The standard School of Social Work interpretation of grades and numerical scores will be used.

- **H** = 94-100
- **P** = 80-93
- **L** = 70-79
- **F** = 69 and below

**Policy on Class Attendance**

Class attendance is critical for team performance and individual learning. You are expected to attend all scheduled sessions. Each class session will cover a great deal of material, and you will fall behind in the course when you miss even one class. In addition, your team will be disadvantaged by your absences. It is your responsibility to inform the instructor in advance about missing a class session. Starting after the second absence, your course grade will be reduced by 10% for each session missed. This reduction will occur after the calculation of your final grade and will be in addition to the effects absences may have on your peer evaluations. If you miss a class, you are responsible for obtaining all notes, announcements, handouts, and assignments from the missed class from your classmates. If you miss three classes, you will be expected to meet with the instructor and Associate Dean of Student Services to discuss if further participation in the course is possible. A grade of incomplete will only be given under extenuating circumstances and in accordance with University policy.

**Policy on Incomplete and Late Assignments**

Assignments are to be turned in to the instructor at the beginning of class on the due date noted in the course outline if the class meets on a due date. If assignments are sent by email, do not assume they have been received until confirmation is received. Extensions may be granted by the professor given advance notice of at least 24 hours and extenuating circumstances. Unannounced late assignments will automatically be reduced 10%. An additional 10% grade reduction on the assignment will occur for each day late (including weekend days). A grade of incomplete will only be given under extenuating circumstances and in accordance with University policy.

**Policy on Academic Dishonesty**

In-class activities are designed to create a collaborative learning environment. However, graded assignments are to be completed totally independently. Once an assignment has been handed out, it is assumed that students will not discuss any aspect of the assignment together—not even general principles or topics related to the assignment. Such exploring or sharing of knowledge that is even peripherally related to class assignments gives an unfair advantage to students who have peers from the same department or school enrolled in the course. Violations constitute violations of the honor code and will be treated as such.
Please include the honor code statement along with your signature on all assignments:

“I have neither given nor received unauthorized aid on this assignment.”

This statement indicates to the instructor that you did not consult with students or other human sources on any aspect of the assignment. It also represents your pledge that you have not made use of information or materials related to graded assignments from last year’s course. For assignments that are open book and take home (such as homeworks), consulting **non-human** sources (text and online sources) is encouraged. For example, you may read existing SEMNET postings, articles and Powerpoints about topics that are posted online, and book chapters, but you may not post a question related to an assignment to a discussion board. All questions about assignments and these policies should be referred to the instructor.

Please refer to the APA Style Guide (6th edition), the SSW Manual, and the SSW Writing Guide for information on attribution of quotes, plagiarism and appropriate use of assistance in preparing assignments.

If reason exists to believe that academic dishonesty has occurred, a referral will be made to the Office of the Student Attorney General for investigation and further action as required.

**POLICY ON ACCOMMODATIONS FOR STUDENTS WITH DISABILITIES**

Students with disabilities that affect their participation in the course and who wish to have special accommodations should contact the University’s Disabilities Services and provide documentation of their disability. Disabilities Services will notify the instructor that the student has a documented disability and may require accommodations. Students should discuss the specific accommodations they require (e.g. changes in instructional format, examination format) directly with the instructor immediately after the first class session and before the second class session. Retroactive accommodations will not be implemented. The instructor is happy to make any necessary accommodations to ensure optimal learning for every student.

**POLICIES ON THE USE OF ELECTRONIC DEVICES IN THE CLASSROOM**

We will discuss the use of laptops for in-class activities on the first day. The use of electronic devices for non-class related activities (e.g. checking messages, playing games) is prohibited. If any such uses occur during class time, laptops will not be allowed for any students for the remainder of the course.
### Dates and Descriptions of Assessments and Homework Assignments

<table>
<thead>
<tr>
<th>Date</th>
<th>Assignment</th>
<th>Description</th>
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<tbody>
<tr>
<td>1/9</td>
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<tr>
<td>1/23</td>
<td><strong>Assessment 1</strong></td>
<td>Matrices, Intro to SEM</td>
</tr>
<tr>
<td>1/30</td>
<td><strong>Homework 1 Due</strong></td>
<td>Matrix algebra, basic statistics</td>
</tr>
<tr>
<td>2/6</td>
<td><strong>Homework 2 Due</strong></td>
<td>Path analysis with traditional regression</td>
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<tr>
<td>2/13</td>
<td><strong>Assessment 2</strong></td>
<td>Confirmatory factor analysis</td>
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<tr>
<td>2/20</td>
<td><strong>Homework 3 Due</strong></td>
<td>Running an Mplus CFA</td>
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<tr>
<td>2/27</td>
<td><strong>No HW or RAT!</strong></td>
<td></td>
</tr>
<tr>
<td>3/6</td>
<td><strong>Assessment 3</strong></td>
<td>General structural models</td>
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<tr>
<td>3/20</td>
<td><strong>Homework 4 Due</strong></td>
<td>Running an Mplus general structural model</td>
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<tr>
<td>3/27</td>
<td><strong>Assessment 4</strong></td>
<td>SEM with ordinal and non-normal data</td>
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<tr>
<td>4/3</td>
<td><strong>Homework 5 Due</strong></td>
<td>Running Mplus with WLSMV</td>
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<td>4/10</td>
<td><strong>Homework 6 Due</strong></td>
<td>Comparing analyses with Mplus’ clustered data options</td>
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<tr>
<td>4/17</td>
<td><strong>Assessment 5</strong></td>
<td>Latent growth modeling</td>
</tr>
<tr>
<td>4/23</td>
<td><strong>Homework 7 Due</strong></td>
<td>Running a Latent growth model in Mplus</td>
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Homework assignments are due at the beginning of class and must include the student honor pledge (*I have neither given nor received unauthorized assistance on this assignment*) to be accepted.
OUTLINE OF COURSE TOPICS AND READINGS

1/9/13: Introduction to SEM and Underlying Statistics
(class 1)
   1. Intro to TBL
   2. Intro to SEM
      Three types of SEMs
      Basic statistical concepts—IRAT, TRAT
      Path diagrams—Team Activity
   5. Underlying hypothesis in SEM

1/16/13: No class—Read and study for next week

1/23/13: Matrices and Matrix Algebra
(class 2)
   1. Many kinds of matrices
   2. Manipulation of matrices
   3. SEM specification—Path Diagrams and Matrices

Required readings and resources (recommended order, B & G, powerpoint, Bollen)
Bollen (1989), Appendix A: Matrix Algebra Review (focus on types of matrices, major features of matrices, special matrices, and simple manipulations)
Bowen & Guo Chapers 1 & 2, pp. 3-51 (you may pay less attention to the parts about equations)
Matrices Powerpoint

Recommended resources: Matrix operations review by Ender; Multivariate matrices; and matrix operations in Stata, SPSS, SAS by Ender (Ender’s pdf file on matrix algebra summarizes important matrix operations)

RAT1
Homework 1 assigned

1/30/13: Path Analysis I
(class 3)
   1. Specification—Path diagrams, matrices, equations
   2. Mediation
   3. Identification
   4. The concept of model fit

Required readings:
   Bowen & Guo, Return to chapter 2 and read the sections about equations

Homework 1 due at the beginning of class
Homework 2 assigned

2/6/13: Path Analysis II
(class 4)
1. Path analysis estimation in Mplus
2. More on the evaluation of fit ($\chi^2$)
3. Evaluation of parameters
4. Direct, indirect and total effects

Required readings: (recommended order—alphabetical)
Bowen & Guo, pp. 141 and 144 in Chapter 6 (on $\chi^2$)

Homework 2 due at the beginning of class

2/13/13: SEM with latent variables: Confirmatory Factor Analysis
(class 5)
1. Latent variables
2. Theory
3. Specification—path diagram, matrices, equations
4. Identification
5. More on model fit

Required readings (recommendation: read B&G, then Bollen):
Bowen & Guo, Chapter 4, pp. 73-108; and pp. 141-144 on $\chi^2$ in Chapter 6.
CFA Powerpoint
An optional (user-friendly) reading:

RAT2
Homework 3 assigned
2/20/13: Confirmatory Factor Analysis: A closer look (class 6)
1. Alternative models
2. Second-order CFA models
3. Correlated measurement errors
4. Improving and comparing models--Intro

Required readings:
Bowen & Guo, Chapter 6, pp. 135-166 (some parts are review)

Homework 3 due at the beginning of class
Midterm course feedback

2/27/13: Confirmatory Factor Analysis in Scale Development (class 7)
1. Theory
2. Validity
3. Reliability
4. MIMIC models
5. Method effects and Multi-method multi-trait models

Required readings:
Reliability article TBA

Midterm peer evaluations

3/6/13: General SEM: Structural and measurement models combined (class 8)
1. Theory
2. Specification-- path diagram, matrices, equations
3. Identification
4. Estimation
5. Improving models

Required readings:
Bowen & Guo, chapter 5, pp. 109-134 and review chapter 6, pp. 157-166.

RAT3
Homework 4 assigned

3/13/12: HAVE A GOOD SPRING BREAK!

3/20/12: Multiple Group Modeling
(class 9)
1. Path analysis
2. CFA
3. General structural models

Required readings:
Bowen & Guo, review Chapter 6, 149-157 and Chapter 7, pp. 180-186

Recommended:

Homework 4 due at the beginning of class
3/27/12: Appropriate SEM Approaches for Social Science Data I
(class 10)
1. Robust Estimators for Non-Normal Measures
2. What to do With Ordinal Data
3. A note on multiple group analysis with WLSMV

Required readings:
Bowen & Guo, pp. 57-65 in Chapter 2

RAT4
Homework 5 assigned

4/3/12: Appropriate SEM Approaches for Social Science Data II
(class 11)
1. Missing Data
2. Clustered Data
3. Power

Required readings:
Bowen & Guo, Chapter 3, pp. 52-72
Bowen & Guo Chapter 7, sections on power analysis and the problem of underidentification, pp. 167-179

Homework 5 due at the beginning of class
Homework 6 assigned
4/10/13: Longitudinal Analyses in SEM--ARCL  
(class 12)  
1. Autoregressive, cross-lagged models  
2. Specification  
3. Identification  

Required readings:  

Homework 6 due at the beginning of class  

4/17/13: Longitudinal Analyses in SEM--Latent growth models  
(class 13)  
Required readings:  
Latent growth modeling Powerpoint  
RAT5  
Homework 7 assigned  

4/23/13: Follow-up, Catch-up, Wrap-up  

Homework 7 due at the beginning of class