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

SOWO 719  Structural Equation Modeling

Fall Semester, 2009

INSTRUCTOR

Natasha K. Bowen, Ph.D.
Room 402J
Tate Turner Kuralt Building
CB #3550,
School of Social Work, Chapel Hill, NC 27599-3550
Phone: (919) 843-2434
Email: nbowen@email.unc.edu

CLASS MEETING TIMES & OFFICE HOURS

Class meets on Fridays 9:00-11:50 am in TTK Rm 107
Office hours are Fridays 12:00 – 1:00 or by appointment

COURSE DESCRIPTION

This course was developed and is usually taught by Dr. Shenyang Guo. We will make heavy use 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 know 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 dealing with missing data.

*We will examine these concepts only if time allows.

**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 as the primary statistical software package for data management and non-SEM statistical analysis, though the classroom lectures and materials will be based on SPSS. The course will employ AMOS as the main software package for running SEM. Advantages of Mplus will also be taught.

**TEXTBOOKS**

Required:


Recommended:


READINGS ABOUT APPLICATIONS OF SEM TO SOCIAL WORK RESEARCH

A reading list of 139 articles, compiled by Shenyang Guo and Chung-Kwon Lee, will be made available to students. These articles are applications of SEM to social work research. We compiled the list by reviewing all articles in eight social-work or social-work-related journals published from January 1, 1999 to December 31, 2004. These articles will be used in classroom lectures as social work examples. They will also serve as a useful literature base for students to learn various applications of SEM to social work problems.

ASSIGNMENTS

<table>
<thead>
<tr>
<th>ASSIGNMENTS</th>
<th>GRADE PERCENTAGE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Assignment 1</td>
<td>10%</td>
</tr>
<tr>
<td>Assignment 2</td>
<td>10%</td>
</tr>
<tr>
<td>Assignment 3</td>
<td>10%</td>
</tr>
<tr>
<td>Assignment 4</td>
<td>10%</td>
</tr>
<tr>
<td>Attendance and Preparation</td>
<td>10%</td>
</tr>
<tr>
<td>Midterm Exam (take home)</td>
<td>25%</td>
</tr>
<tr>
<td>Final Exam (take home)</td>
<td>25%</td>
</tr>
</tbody>
</table>

GRADING SYSTEM

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

\[ H = 94-100 \]
\[ P = 80-93 \]
\[ L = 70-79 \]
\[ F = 69 \text{ and below} \]

POLICY ON CLASS ATTENDANCE

Class attendance is an important element of class evaluation, and 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. It is the student’s responsibility to inform the instructor in advance for missing a class session. Starting after the second absence, your course grade will be reduced by 10% for each session missed. This reduction may make it necessary for the student to drop the course to avoid an inadequate grade. Students who miss a class are responsible for obtaining all notes, announcements, handouts, and assignments from the missed class from their peers. 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 class does not meet on a due date, assignments are due at 5:00 pm on the 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. Late assignments will automatically be reduced 10 percent. An additional 10 percent grade reduction 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**

Students are absolutely expected to follow the UNC Honor Code. All graded assignments are to be completed independently. 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. Assignments are open book and take home; 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 email a question related to an assignment to a discussion board. All questions about assignments 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**

Students may discuss with the instructor the possibility of using laptops during class on the first day of class. Regardless of the decision made during this discussion, the use of electronic devices for non-class related activities (e.g. checking email, playing games) is
prohibited. If any such uses occur during class time, laptops will not be allowed for the remainder of the course.

**DESCRIPTION OF THE ASSIGNMENTS**

Assignment 1: Matrix algebra, basic statistics, and expectations. **Due 9/18/09.**

Assignment 2: Running AMOS to solve problems of path analysis and regression analysis; and solving problems related to the decomposition of direct and indirect effects. **Due 10/2/09.**

Midterm exam: Replicating a CFA study and testing an alternative factor model. **Due 10/30/09.**

Assignment 3: Evaluating, modifying, and comparing general SEM models. **Due 11/6/09.**

Assignment 4: Testing group differences. Appropriate strategies for problematic data. **Due 11/20/09.**

Final exam: Apply best practices in specification, estimation, evaluation of fit, and model modifications. **Due 12/11/09**
OUTLINE OF COURSE TOPICS AND READINGS

8/28/09: Introduction to SEM and course overview (class 1)
Required readings:
   Kline Chapter 1, Byrne Chapter 1 (~30 pages)

9/04/09: Preliminaries (Part I): Basic matrix algebra (class 2)
   1. Matrix operations
   2. Properties of matrix operations
   3. Applications of matrix algebra to statistical analysis
   4. The eight basic matrices of SEM
Required readings:
   Kline Chapter 1, Byrne Chapter 1
Optional reading:
   Guo & Bowen (in preparation), Chapters 1 and 2

9/11/09: Preliminaries (Part II): Covariance algebra, correlation, and regression (class 3)
   1. Variance, Covariance
   2. Expectations
   3. Standardization, covariance, and correlation
   4. Regression, partial correlation, multiple correlation
   5. Statistical assumptions of regression and diagnostics
   6. Centered variables
Required readings:
   Kline Chapters 2 & 3, Byrne pp. 102-106 (~50 pages)
   (Assignment 1 available on BB, due 9/18/09. Work independently.)

9/18/09: Path analysis & running AMOS (class 4)
   1. Path analysis
   2. Total, direct, and indirect effects
   3. Overview of running AMOS
Required readings:
   Kline Chapters 5 & 6, and pp. 66-69. Byrne Chapter 2 (~100 pages) Ask for guidance
   AMOS lab in Room 227
   (Assignment 1 due at beginning of class)
9/25/09: A second pass at model specification, identification, and estimation in SEM with latent variables, plus handling missing data

(class 5)

1. Steps and best practices in running SEM
2. The fundamental hypothesis
3. Missing data

Required readings:
Kline Chapter 4, Byrne Chapter 13 (~83 pages)

Optional readings:
Reread Kline Chapter 1, Byrne Chapter 1, Guo & Bowen Chapters 1 and 2

*(Assignment 2 available on BB, due 10/2/09. Work independently.)*

10/2/09: Confirmatory factor analysis (Part I)

(class 6)

1. Applications and best practices in CFA
2. Model specification
3. Identification
4. Equations and matrices
5. Three types of measurement models: parallel, Tau-equivalent, congeneric
6. Validity

Required readings:
Kline Chapter 7, Byrne Chapter 3 (especially up to p. 73) and Chapter 4 (~90 pages)

Optional reading:
Guo & Bowen (in preparation), chapter 4

*AMOS lab in Room 227
(Assignment 2 due at beginning of class)*
10/09/09:  Confirmatory factor analysis (Part II)  
(class 7)  
1. Evaluation and modification of models  
2. Second-order CFA models  
3. Correlated measurement errors  
4. Comparison of models (testing differences—1)  

Required readings:  
Byrne Chapter 5, up to p. 143 (~33 pages)  

Optional reading:  
(Midterm exam distributed, due 10/30/09 at beginning of class. Work independently.)

10/16/09:  General SEM (Part I): Structural and measurement models combined  
(class 8)  
1. Applications and best practices in general SEM  
2. Model specification  
3. Identification  
4. Equations and matrices  

Required readings:  
Kline Chapter 8, Byrne Chapter 6 (~55 pages)  

Optional reading:  
Guo & Bowen, chapter 5  
AMOS lab in Room 227

10/23/09: No Class. Happy Fall Break!

10/30/09:  General SEM (Part II): Other models  
(class 9)  
1. Nonrecursive models  
2. Mediation models  
3. Alternative models (testing differences—2)  
4. More on the evaluation and modification of models  

Required readings:  
Kline Chapter 9 (~49 pages)  

Optional reading:  
Reread Byrne, pp. 73-95
11/06/09: Multiple-group comparison  
(class 10)

1. Measurement invariance
2. Test moderating effects with SEM
3. MIMIC models

Required readings:
Byrne Chapters 7 & 9, Kline Chapter 11 (~65 pages)

Readings used in class (supplied by instructor)

Optional reading:
Guo & Bowen, chapter on multiple group analysis

11/13/09: Strategies for ordinal, clustered, and non-normal data, and power analysis  
(class 11)

1. Non-normality and strategies
2. Categorical and ordinal variables and strategies
3. Grouped data and strategies

Required readings:
Byrne pp. 143-160 and Chapter 12 (~59 pages)

Optional reading:
Guo & Bowen, TBA
11/20/09: Longitudinal analysis with SEM (I)  
(class 12)

1. Autocorrelated, cross-lagged models  
2. Latent growth curve modeling

Required readings:
Kline Chapter 10, Byrne Chapter 11 (~78 pages)  
J. M. (2002). Temporal and reciprocal relationship between IADL/ADL  
disability and depressive symptoms in late life. Journal of Gerontology,  
57B, 338-347.

Recommended readings:
correlates and predictors of individual change over time, Psychological  
Bulletin 116, 363-381.  
approaches to study growth curves: the multilevel model and the latent  
curve analysis, Structural Equation Modeling 5, 247-266.  
Aish, A., & Joreskog, K.G. (1990). A panel model for political efficacy and  
responsiveness: An application of LISREL 7 with weighted least squares,  
Quality & Quantity 24, 405-426  
wave panel analysis: A case study of Cleveland in the 1980s, Social Work  
Research 18, 83-96.  
for the study of developmental psychopathology, Development and  
Psychopathology 15, 581-612.

(Assignment 4 due at beginning of class.)  
(Final exam distributed, due 12/11/09)

11/27/09: No Class. Happy Thanksgiving!

12/4/09 Power, MPlus, Course summary  
(Class 13)

1. Power analysis  
2. Why MPlus?  
3. Parting words of wisdom

Required readings:
Kline Chapter 12 (~40 pages)  
determination of sample size for covariance structure modeling,  
Psychological Methods 1: 130-149. (Ask for guidance)

Reading on Mplus, TBA

Optional readings (for future reference):

12/11/08: Final exam due by 5:00, at instructor’s office, mailbox, or by email. Seek confirmation of receipt.