Spring 2019 EDPS 63200: Applied Structural Equation Modeling (SEM)[1]

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Student Information

In order to get to know you better, I would like you to complete a short survey which you can find at the following link. This will allow me to target the course and the instruction to your needs and career goals. Copy and paste the following link into a web browser.
https://purdue.qualtrics.com/SE/?SID=SV_3ISxH418h0sKQEB

Welcome to EDPS 632 – Applied Structural Equation Modeling (SEM)

I'm excited to embark on this learning experience with you this semester! By the end of the semester, you will have acquired real data analytic skills and competencies allowing you to run and interpret a variety of SEM models. These are important data analytic skills in our field and they will come in very handy to you as well. By the end of the semester, and perhaps sooner, you will be able to take your own data set and apply SEM procedures to analyze your own data, perhaps for your dissertation or prelims! Let's begin!!

Course Description

This course is an introduction to structural equation modeling procedures. We will focus on various applications of SEM procedures. Students will develop skills to conduct SEM research and critically review use of SEM in research.

Course Goals

By the end of this course, students will be able to:

1) Understand the importance of screening and cleaning your data
2) Conduct Exploratory Factor Analysis
3) Basics of Structural Equation Modeling

[1] This course is built upon Dr. Chantal Levesque-Bristol's Structural Equation Modeling course.

4) Applications 1 and 2: Testing the factorial validity of a theoretical construct or [2]a measuring instrument
5) Present, interpret, and discuss the findings of CFA
6) Application 3: Testing the validity of a causal structure
7) Present, interpret, and discuss SEM findings
8) Applications 4 and 5: Testing for invariant factorial structure of a theoretical construct or a measuring instrument
9) Application 6: Testing for invariant causal structure
10) Final Project Presentation
11) Final Project

Specific Learning Objectives

By the end of the course, students will be able to reach each of these competencies

1.1 Screen and clean data according to specified procedure

2.1 Discuss instances and situations in which it is appropriate to run an EFA model
2.2 Understand the different components and elements of an EFA model
2.3 Understand the differences between EFA and CFA
2.4 Run EFA models using SPSS and R
2.5 Calculate factor reliabilities
2.6 Describe the appropriateness of the model

3.1 Generally understand the different SEM applications
    First-Order CFA
    Full Structural model
3.2 Understand the concept of model identification
3.3 Understand matrix elements
3.4 Understand model specifications
3.5 Successfully specify a CFA model using LISREL notations
3.6 Successfully specify a full SEM model using LISREL notations

4.1 Test the factorial validity of a measuring instrument (First-Order CFA model)
4.2 Evaluate the fit of the model and its appropriateness
4.3 Modify the model parameters to improve the fit of the CFA model
4.4 Test the factorial validity of a theoretical construct (First-Order CFA model)

5.1 Summarize and critically review a CFA article
5.2 Discuss CFA readings

6.1 Test the validity of a causal structure
6.2 Evaluate the fit of the model and its appropriateness

6.3 Modify the model parameters to improve the fit of the causal structure if necessary

7.1 Summarize and critically review an SEM article
7.2 Discuss SEM readings

8.1 Understand multi-group models and discuss instances and situations in which it is appropriate to run a multi-group model
8.2 Test a multi-group model and interpret results
8.3 Impose full LX equality constraints on the multi-group model and interpret results
8.4 Impose partial LX equality constraints on the multi-group model and interpret results
8.5 Impose PH equality constraints on the multi-group model and interpret results

9.1 Test the fully invariant causal structure (impose full BE and GA equality constraints) of the multi-group model and interpret results
9.2 Test the partial invariant causal structure (impose partial BE and GA constraints) of the multi-group model and interpret results

10.1 Final project presentation: Present your final project and key findings, and respond to questions.

11.1 Final project: With your own data, create, test, interpret, and write the results of a CFA in a report suitable for publication in a peer reviewed journal

Course Requirements

The course and your grade in this course will be based on the attainment of specific competencies related to the learning objectives specified above. Each competency will need to be achieved and demonstrated by a certain time during the course in order to get full mastery points. Please consult the course calendar for dates.

Required Text

Tabachnick, B. G. & Fidell, L. S. (2012). Using Multivariate Statistics, 5th Ed. Pearson.

Suggested Text

Byrne, B. M. (1998). Structural Equation Modeling with LISREL, PRELIS, and SIMPLIS. Lawrence Erlbaum Associates.

Optional Text

Brown, T. A. (2006). Confirmatory Factor Analysis for Applied Research. The Guilford Press.

Software for Course Exercises

Student edition of LISREL for Windows
Free version from http://www.ssicentral.com/lisrel/student.html has all features of full version, but limits number of variables.
The full version of LISREL is available in BRNG 3157 (version 9.2) and all ITaP computer labs (version 8.8).

R for Mac OS, Linux, or Windows

Free download from http://www.r-project.org

Grading
Each assignment addressing the course goals/competencies is worth 10 points each. The total number of points possible is equal to 110 points. You have two attempts for each assignment. The due dates posted on the syllabus and schedule are the due dates for the last attempts. If you would like to receive feedback on your assignment, you need to submit your first attempts 24 hours before the dues.

In addition to the attainment of the competencies there will be a final project which you will work on throughout the semester and which will be due during finals week. This project will involve running and interpreting either a CFA model or a full Structural Equation Model (SEM) depending on the type of data you have available. The final project is the only component of the class that will be solely based on your individual work. You will need to secure a data set of your own to complete the final project. The final project is worth 200 points and is divided into 3 parts: the mid-term check (50 points), the final project presentation (50 points), and the final project report (100 points).

Course Goals/Competencies	110 points	**Grading Scale**
		90 – 100% = A (279 pts.)
Mid-Term Check	50 points	80 – 89% = B (248 pts.)
Final project report	100 points	70 – 79% = C (217 pts.)
Final project presentation	50 points	60 – 69% = D (186 pts.)
Total	310 points	Below 60 = F (185 ≤ pts.)

Course Competencies: Evaluated through exercises, demonstrations, discussions, and reports. The competencies can also be achieved through the submissions of other evidences that you would have already produced (e.g. published papers).

Mid-Term Check: The mid-term will be a check on the progression of the final project. You will need to secure your own data to complete the final project.

Final Report: For the final project, you will be testing, running, and interpreting either a CFA model or a full Structural equation model (SEM) depending on the type of data you have available. If you do the final project seriously and appropriately and spend quality time thinking about your research questions before you embark on this project, you would have a paper to submit to a peer reviewed journal by the end of the semester. Yeah!!

Final Project Presentation: At the end of the semester, you will be given 10 minutes to present your final project and respond to questions from your peers.

Policies and Expectations

General Course Policies
I will be answering student questions sent via emails twice a week. During office hours or after class on Tuesdays, as well as Friday afternoons. I will also answer most of the questions you have in class as you work through exercises and analyze data.

I will not be taking attendance. It is your responsibility to come to class prepared and ready to work. Most of the class period will be dedicated to working on meeting the competencies through suggested activities and exercises. You will be working with data every class period, analyzing and critically evaluating data and models. You will miss a lot of valuable time you could be using to work on learning the material and demonstrating course competencies if you miss too many class periods and I will not spend time repeating a class period during office hours or outside of office hours. The time to work and get the most assistance from me will be during class periods.

The class sessions will be very interactive. I will not be lecturing in class. Some of the lecture segments will be recorded and you will need to watch those before you come to class. We will further discuss this concept in class. It has been documented through research, that students learn more when they can interact with others and test their new skills by teaching them to others. Most of what you will do in class and be graded on will be done in a collaborative environment, which will foster problem solving skills, communications skills, and team work.

Academic Dishonesty
In this class, you will be encouraged to work in groups and collaborate on the attainment of the competencies. Each student will need to demonstrate their own attainment of the competencies, but collaborative work is encouraged and valued. Please find below, Purdue Academic Dishonesty policy for your reference.

Purdue prohibits "dishonesty in connection with any University activity. Cheating, plagiarism, or knowingly furnishing false information to the University are examples of dishonesty." [Part 5, Section III-B-2-a, University Regulations] Furthermore, the University Senate has stipulated that "the commitment of acts of cheating, lying, and deceit in any of their diverse forms (such as the use of substitutes for taking examinations, the use of illegal cribs, plagiarism, and copying during examinations) is dishonest and must not be tolerated. Moreover, knowingly to aid and abet, directly or indirectly, other parties in committing dishonest acts is in itself dishonest." [University Senate Document 72-18, December 15, 1972]

Attendance
The class period will be highly interactive. During class, you will be analyzing data and actively working on various data analytic problems. Class discussions will be fostered and encouraged and will occur every single class period. Therefore, missing a class period will be damaging to your understanding and progress in the class.

As stated in Purdue University policies, it is expected that students attend all class session of courses in which they are enrolled. Attendance is thus very important. However, it is your choice whether or not to attend class. Students have a primary responsibility to attend class regularly and to be certain that they miss class only for special reasons beyond their control, such as personal illness, illness of a family member for whom the student is responsible, participation in University-sanctioned activities and programs, or compelling family circumstances. It is not necessary to inform me of the reason for your absence. However, regardless of the reason for your absence, it is your responsibility to access and view the material that was discussed and worked on in class by doing the following: watching the lectures, reading the relevant chapters in your textbook, completed the assigned demo and exercises. You are responsible for all material presented in class and in the recorded lectures, whether or not that material is presented in the textbook. You are also responsible for any announcements made in class concerning reading assignments or schedule changes. Attendance will not be a component of the final grade.

Missed or Late Work
You have to meet each competency in order to move on to the next competencies in the course, since most of them will build upon each other. If you meet a competency after the established deadline for that competency, you will not receive the points associated with the competency. However, meeting each of the competencies will allow you to perform better on the following competencies.

Students with Disabilities

Purdue University is required to respond to the needs of the students with disabilities as outlined in both the Rehabilitation Act of 1973 and the Americans with Disabilities Act of 1990 through the provision of auxiliary aids and services that allow a student with a disability to fully access and participate in the programs, services, and activities at Purdue University.

It is the student's responsibility to notify the Disability Resource Center of an impairment/condition that may require accommodations and/or classroom modifications.

Health and other emergencies

If you are unable to meet a competency by the deadline specified because of illness or a medical emergency, you are responsible to inform me in writing (email will work) and subsequently provide proof or evidence of the illness which prevented you from meeting the competency in a timely manner. The same applies for the mid-term check as well as the final project.

According to a memorandum by the Provost Office (August 11, 2009), special care has to be taken to minimize the effect of Pandemic Influenza A (H1N1). In the event of a major campus emergency, course requirements, deadlines and grading percentages are subject to changes that may be necessitated by a revised semester calendar or other circumstances beyond the instructor's control. Relevant changes to this course will be posted onto the course website or can be obtained by contacting the instructors or TAs via email or phone.

Class Schedule

Course Goal 1: Understand the importance of screening and cleaning your data
Materials Needed: Found on the Blackboard course site

Course Goals	Materials supporting the attainment of the competencies	Date by which competencies need to be reached	Evidence demonstrating the attainment of the course goals
Screen and clean data according to specified procedure	Video Cleaning up your Data – Descriptive Statistics Video Cleaning up your Data – Linearity and Homoscedasticity Video Cleaning up your Data – Multivariate Outliers Video Cleaning up your Data – Missing Data Video Cleaning up your Data – Normality SCREEN data set Tabachnick & Fidell (2007) – Chapter 4	Jan. 21	Submit exercise – Understand the importance of screening and cleaning your data 10 points

Course Goal 2: Conduct Exploratory Factor Analysis
Materials Needed: Found on the Blackboard course site

Course goals	Readings and Activities supporting the attainment of the competencies	Date by which competencies need to be reached	Evidence demonstrating the attainment of the course goals
Discuss instances and situations in which it is appropriate to run an EFA model	Tabachnick & Fidell (2007) – Chapter 13		
Understand the different components and elements of an EFA model	Tabachnick & Fidell (2007) – Chapter 13		
Understand the differences between EFA and CFA	Tabachnick & Fidell (2007) – Chapter 13		
Run EFA models using SPSS	Video Factor Analysis – Running the Analysis Video Factor Analysis – Achieving simple solution Handout Factor Analysis FACTOR data set		
Calculate Factor Reliabilities	Handout – Calculating Alpha Reliability FACTOR data set		
Describe the appropriateness of the model	Article describing a scale validation using EFA	Jan 28	Submit exercise – Basic EFA model exercise 10 points

Monday Jan. 21 MARTIN LUTHER KING JR. DAY (No Class)

Course Goal 3: Basics of Structural Equation Modeling
Materials Needed: Found on the Blackboard course site

Course Goals	Readings and Activities supporting the attainment of the competencies	Date by which competencies need to be reached	Evidence demonstrating the attainment of the course goals
Generally understand the different SEM applications First-Order CFA Second-Order CFA Full SEM	Byrne (1998) – Chapter 1: Structural Equation Models – The basics		In Class Discussions
Understand the concept of model identification	Byrne (1998) – Chapter 1: Structural Equation Models – The basics Video CFA Model Identification Part 1 Video CFA Model Identification Part II		
Understand matrix elements	Byrne (1998) – Chapter 1: Structural Equation Models – The basics Byrne (1998) – Chapter 2: Using LISREL, PRELIS, and SIMPLIS Video Creating a CFA Model – Matrix Elements		
Understand model specifications	Byrne (1998) – Chapter 2: Using LISREL, PRELIS, and SIMPLIS Video Creating a CFA Model – Model Specifications		
Successfully specify a CFA model using LISREL notations	Byrne (1998) – Chapter 1: Structural Equation Models – The basics	Feb 4	Submit exercise: CFA Model Notation and Identification Exercise 10 points
Successfully specify a full SEM model using LISREL notations	Byrne (1998) – Chapter 1: Structural Equation Models – The basics	Feb 4	Submit exercise: SEM Model Notation 10 points

Course Goal 4: Applications 1 and 2: Testing the Factorial Validity of a Theoretical Construct or a Measuring Instrument
Materials Needed: Found on the Blackboard course site

Course Goals	Readings and Activities supporting the attainment of the competencies	Date by which competencies need to be reached	Evidence demonstrating the attainment of the course goals
Test the factorial validity of a measuring instrument (First-Order CFA)	Byrne (1998) – Chapter 4: Application 2: Testing the factorial validity of scores from a measuring instrument (First-Order CFA Model) Handout CFA – WISCSEM SYNTAX		
Evaluate the fit of the model and it's appropriateness	Byrne (1998) – Chapter 3: Application 1: Testing the factorial validity of a theoretical construct (First-Order CFA Model) Byrne (1998) – Chapter 4: Application 2: Testing the factorial validity of scores from a measuring instrument (First-Order CFA Model) Handout –CFA Evaluating the fit of the model		
Modify the model parameters to improve the fit of the CFA model	Byrne (1998) – Chapters 3 and 4 Handout – CFA – Modifying WISCSEM Model Parameters to Improve Fit VFI data set	Feb 11	Submit Exercise: Testing the factorial validity of a measuring instrument First-Order CFA Model – LISREL syntax project – VFI 10 points
Test the factorial validity of a theoretical construct (First-Order CFA)	Byrne (1998) – Chapter 3: Application 1: Testing the factorial validity of a theoretical construct (First-Order CFA Model) BASIC NEEDS data set	Feb 18	Submit Exercise: Testing the factorial validity of a theoretical construct – LISREL syntax project BASIC NEEDS or Your Own Data 10 points

Course Goal 5: Present, interpret, and discuss CFA findings
Materials Needed: Found on the Blackboard course site

Course Goals	Readings and Activities supporting the attainment of the competencies	Date by which competencies need to be reached	Evidence demonstrating the attainment of the course goals
Summarize and critically review a CFA article	Select a CFA article to read – Conduct a critical review of the article. Must be approved by the instructor	Feb 25	Submit Exercise: Summarize and Critically Review a CFA article 10 points
Discuss the readings	CFA article	Feb 25	In class discussions

Feb 25: Mid-Term check: 50 pts - Under Course Goal 11

Course Goal 6: Application 3: Testing the Validity of a Causal Structure
Materials Needed: Found on the Blackboard course site

Course Goals	Readings and Activities supporting the attainment of the competencies	Date by which competencies need to be reached	Evidence demonstrating the attainment of the course goals
Test the validity of a causal structure	Byrne (1998) – Chapter 7: Application 5: Testing the validity of a causal structure Full SEM article: Levesque, Knapp, & Fisher (2010). SEM indicators for Service Learning full model time 2 (data file) Handout: Testing the Validity of a Causal Structure JEE paper – SEM model with notations		
Evaluate the fit of the model and its appropriateness	Byrne (1998) – Chapter 7: Application 5: Testing the validity of a causal structure		
Modify the model parameters to improve the fit of the causal structure if necessary	Byrne (1998) – Chapter 7: Application 5: Testing the validity of a causal structure	Mar 18	Submit Exercise: Testing the Validity of a Causal Structure 10 points

Course Goal 7: Present, interpret, and discuss SEM findings
Materials Needed: Found on the Blackboard course site

Course Goals	Readings and Activities supporting the attainment of the competencies	Date by which competencies need to be reached	Evidence demonstrating the attainment of the course goals
Summarize and critically review an SEM article	Select an SEM article to read – Conduct a critical review of the article. Must be approved by the instructor	Mar 25	Submit Exercise: Summarize and Critically Review an SEM article 10 points
Discuss the readings	SEM article – Levesque, Knapp, & Fisher (2010)	Mar 25	In class discussions

Course Goal 8: Applications 6 and 7: Testing for Invariant Factorial Structure of a Theoretical Construct or a Measuring Instrument
Materials Needed: Found on the Blackboard course site

Course Goals	Readings and Activities supporting the attainment of the competencies	Date by which competencies need to be reached	Evidence demonstrating the attainment of the course goals
Understand multi-group models and discuss instances and situations in which it is appropriate to run a multi-group model	Byrne (1998) – Chapter 8: Application 6: Testing for invariant factorial structure of a theoretical construct (First-Order CFA Model) Byrne (1998) – Chapter 9: Application 7: Testing for invariant factorial structure of scores from a measuring instrument (First-Order CFA Model) Example: CFA invariance article		
Test a multi-group model and interpret results	Handout Multi-group CFA – Running the Simultaneous Analysis Handout LISREL syntax: Example CFA simultaneous run 2 groups		
Impose full LX equality constraints on the multi-group model and interpret results	Handout LISREL syntax Example CFA LX invariant run 2 groups		
Impose partial LX equality constraints on the multi-group model and interpret results	Handout Multi-group CFA – Imposing Equality Constraints	Apr 8	Submit Exercise: Simultaneous and Invariance multi-group run with LISREL 10 points

Impose PH equality constraints on the multi-group model and interpret results	Handout LISREL syntax Example CFA LX partial invariance		

Course Goal 9: Applications 9: Testing for Invariant Causal Structure
Materials Needed: Found on the Blackboard course site

Course Goals	Readings and Activities supporting the attainment of the competencies	Date by which competencies need to be reached	Evidence demonstrating the attainment of the course goals
Test the fully invariant causal structure (impose full BE and GA equality constraints) of the multi-group model and interpret results	Example: Causal Structure Invariance article Handout Testing for Invariant Causal Structure – Simultaneous Run Handout Testing for Invariant Causal Structure – BE, GA Invariant		
Test the partial invariant causal structure (impose partial BE and GA constraints) of the multi-group model and interpret results	Handout Testing for Invariant Causal Structure – Partial Invariance	Apr 15	Exercise: Causal Structure – Simultaneous and Invariance multi-group run 10 points

Course Goal 10: Final Project Presentation– 50 points

Final project presentation: 10 minutes + Q & A		Apr 22	Final Project Presentation 50 points

Course Goal 11: Final Project – 100 points
Materials Needed: Found on the Blackboard course site

Final project: With your own data, create, test, interpret, and write the results for a CFA or a full SEM model. The report should be		Apr 29	Final Report

suitable for publication in a peer reviewed journal			

Final Project Due on Monday Apr 29th by midnight.

How to Succeed in this Course: Tools for Study and Learning

To succeed in this course, you will need to watch the lectures associated with each course goal before coming to class and become familiar with the course content material before the weekly class sessions. You want to keep a close watch on the deadline to achieve each course competencies. I will not lecture in class. Class time will be dedicated to active learning. In class, you will complete exercises leading to the achievement of the competencies if you have not already completed those competencies before coming to class. When competencies are achieved and completed, you can work ahead or "teach" others in the class who are working on achieving the competencies. This kind of collaboration will be strongly encouraged.

Start looking for an appropriate data set which you will use to complete your mid-term and final projects. Plan ahead! If you select the right data set and the right research question, you will end up with a publishable product at the end of the semester, or perhaps a portion of your dissertation work completed!