**PSYCHOLOGY 533**

**STRUCTURAL EQUATION MODELING**

**Fall 2021**

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| **Professor**  Kevin Grimm  Office Hours: By Appointment  [kjgrimm@asu.edu](mailto:kjgrimm@asu.edu) | **Teaching Assistant**  Molly Gardner  Office Hours: T 9-10am, Th 3-4pm  Zoom Meeting ID: 927 5330 1614  [pmanapat@asu.edu](mailto:pmanapat@asu.edu) |

**Meeting Times**

M/W 10:30-11:45am

**Readings**

Readings will be made available on the course website in PDF format

**Website**

The class website is available on Canvas (<https://asu.instructure.com/>)

Course videos will be available through links posted on Canvas or on the Longitudinal Research Institute Website (<https://longitudinalresearchinstitute.com/>)

Handouts for the lectures & other course materials (programming code/datasets) will be made available on Canvas or on the Longitudinal Research Institute Website (<https://longitudinalresearchinstitute.com/>)

**Overview**

This course is an introduction to linear structural equation modeling and its application to social and behavioral research. This course will cover various data analytic techniques ranging from simple regression, matrix algebra, and confirmatory factor analysis to measurement invariance, longitudinal growth models, and latent variable models with categorical outcomes. Within each technique we will examine algebraic and graphic model specification, estimation procedures, identification, goodness‑of‑fit criteria, and alternative model comparison approaches. The goals of this course are to develop an understanding of the conceptual and mathematical bases of structural equation modeling, to learn how to specify and estimate models using statistical software, and evaluate them in relation to alternative models using statistical and practical criteria.

**Software/Computers**

We will use several different software packages in this class. Primarily, we will use M*plus* and lavaan (latent variable analysis), which is a package in R. Additionally, we will discuss Lisrel (linear structural relations) because this program established a common notation for structural equation models that continues to be the dominant matrix notation used by researchers. R is available at <http://cran.us.r-project.org>, and the lavaan package can be installed by specifying install.packages(‘lavaan’). Please download the RStudio software (<https://rstudio.com/>), which provides a user-friendly front-end interface for R. Rmarkdown files can be written in RStudio, which is the recommended way to submit homework. A demonstration version of M*plus* is available at <http://www.statmodel.com/demo.shtml> and Lisrel will be made available through Vector Psychometric Group.

**Class Structure**

The course is delivered as a **flipped course**. Lectures are prerecorded and available on the Longitudinal Research Institute webpage (<https://longitudinalresearchinstitute.com/>). There are multiple videos to watch for each week. Videos will cover conceptual material as well as the specification and estimation of structural equation models using M*plus*, lavaan, and Lisrel. You will be provided with an access code for the structural equation modeling module on the website. Watch the videos prior to coming to class on Monday and write down any questions you have so that we can discuss in class.

We will discuss questions about the prerecorded videos and engage in data analysis projects during the in-class portion of our class. Bring your laptop to class with structural equation modeling software, data files, and basic data analysis software (e.g., SAS, R, SPSS). The goal for the in-class portion of the course is to become proficient in the specification, estimation, and interpretation of structural equation models.

**Data**

When learning any statistical approach, it is ideal to analyze data with which you are familiar. Homework assignments will often involve data analysis and you are encouraged to analyze your own data, if possible. I will provide data that can be used for the homework assignments, but it is ideal if you can analyze your own data. For most exercises, you only need a few variables.

**Grading Polices**

There are no exams. Your grade is based on the following: (1) Homework Assignments (50%), (2) Project Proposal (10%), (3) Final Project Report (25%), and (4) Class Participation (15%).

***Homework Assignments***

There will be several homework assignments that can involve computations, data augmentation, data analyses, and a brief report. You are encouraged to submit html files compiled using Rmarkdown. These reports should contain model specification, model results, and a **written** **description of the results**. Assignments are submitted through Canvas.

***Project Proposal & Final Project Report***

The final project has two components: (A) *Project Proposal* and (B) *Final Project Report*. The *Project Proposal* is a brief (~1 page) written description of your research questions, data, and proposed analytic model(s). The *Project Proposal* is due on **November 5, 2021**. The *Final Project Report* should conform to APA standards. The paper should be 7 to 10 pages in length, and is due on **December 3, 2021**.

***Class Participation***

You are expected to come to our zoom call having read the papers/chapters for the day, watched the videos for the day, prepared questions based on the reading and videos, and ready to discuss and answer questions. You should also have access to statistical software and R for class.

**Title IX**

Title IX is a federal law that provides that no person be excluded on the basis of sex from participation in, be denied benefits of, or be subjected to discrimination under any education program or activity.  Both Title IX and university policy make clear that sexual violence and harassment based on sex is prohibited.  An individual who believes they have been subjected to sexual violence or harassed on the basis of sex can seek support, including counseling and academic support, from the university.  If you or someone you know has been harassed on the basis of sex or sexually assaulted, you can find information and resources at <https://sexualviolenceprevention.asu.edu/faqs>.

As a mandated reporter, I am obligated to report any information I become aware of regarding alleged acts of sexual discrimination, including sexual violence and dating violence.  ASU Counseling Services, <https://eoss.asu.edu/counseling> is available if you wish to discuss any concerns confidentially and privately. ASU online students may access 360 Life Services, <https://goto.asuonline.asu.edu/success/online-resources.html>.

**Tentative Course Schedule**

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| **Week** | **Topics** | **Readings** |
| 1 | Correlation, Regression, Multiple Regression, & *RMarkdown* |  |
| 2 | Matrix Algebra, Using Matrix Algebra, Covariance Expectations, & Covariance Algebra |  |
| 3 | Path Diagrams, Path Diagram Notation, Path Tracing, & Lisrel Notation | Boker, McArdle, & Neale (2002);  Lomax (1982); Lisrel Handouts;  Jöreskog (1970a, 1970b) |
| 4 | RAM Notation, Lisrel *all-y* notation, M*plus* Notation | McArdle & McDonald (1984)  McArdle (2005) |
| 5 | SEM Software & Regression Analysis in SEM | Nachtigall et al. (2003) |
| 6 | Path Analysis & Model Specification | Boker & McArdle (2005);  Duncan (1975) - Chapter 3 |
| 7 | Confirmatory Factor Analysis | McArdle (1996), Brown (2006)  Chapters 3 & 4 |
| 8 | Model Fit & Latent Variable Path Analysis | Hooper, Coughlan, & Mullen (2008); Hu & Bentler (1999);  McArdle & Prescott (1992); Ponitz, Rimm-Kaufman, Grimm, & Curby (2009) |
| 9 | Mean & Covariance Structure Models | Grimm & McArdle (2005) |
|  | Growth Modeling | McArdle & Epstein (1987);  Ram & Grimm (2007) |
| 10 | Multiple Group Models –  Regression Analysis | Tucker-Drob & Salthouse (2008) |
| 11 | Multiple Group Models –  Factor Analysis | Horn & McArdle (1992);  Widaman & Reise (1997) |
| 12 | Missing Data | Enders (2001); McArdle (1994);  Wiggins & Sacker (2002) |
| 13 | Categorical Outcomes | Wirth & Edwards (2007);  Muthén (1983) |
| 14 | Finite Mixture Modeling | Muthén (2001); Ram & Grimm (2009) |
| 15 | Power Analysis | Muthén & Muthén (2002);  Satorra & Saris (1985) |

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