Western University
Department of Psychology
PSYCHOLOGY 9545A
Psychometric Measurement Modeling
Fall 2024
Lecture: Thursday, 9:00AM – 12:00PM

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Course Information

Enrollment Restrictions

Enrollment in this course is restricted to graduate students in the Department of Psychology, as well as any student that has obtained special permission to enroll in this course from the course instructor as well as the Graduate Chair (or equivalent) from the student's home program.

Instructor and Teaching Assistant Information

Instructor: Dr. John Sakaluk ("Sack-uh-luck") (He/Him/His)
Office: SSC 6312
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Email: professor.sakaluk@gmail.com (for day-to-day class inquiries); jsakaluk@uwo.ca (for emergencies)

Course Description

Surveys designed to numerical quantify an individual's standing for some intrapsychic construct (e.g., attitudes, beliefs, motives, values) are ubiquitous in psychological and social science research.

The goal of this course is help students develop an understanding of classic and prevailing psychometric theories that attempt to explain how constructs become expressed in survey responses, and the measurement modeling techniques used on survey responses by researchers to understand the form and substance of the constructs they are attempting to study.

All analyses this semester will be taught using R, using a variety of available packages

Course Format

The course will be taught synchronously and in-person. Scheduled class time will be used for lectures, coding demonstrations, assessments, and/or progress on the final project.

Course Learning Outcomes/Objectives

Upon completion of this course, students should be able to:

1. Articulate the importance of (psychological) measurement in a healthy, generative psychological science, and or other social sciences using psychological variables
2. Describe the core features, assumptions, and implications of contemporary psychometric theories

3. Thoughtfully select between competing psychometric theories and measurement models on the basis of theoretical and empirical considerations, as well the goals of their research (e.g., test construction or refinement, construct interrogation, appraisals of meaning)
4. Conduct various forms of measurement modeling in R, including consistency tests of psychometric network structure, fitting and appraising a variety measurement models (psychometric networks, mixture models, factor analysis models), and apprasing the generalizability of measurement models over groups and individual differences
5. Accurately interpret and coherently report on a variety of measurement models, in a number of different reporting formats (text, tabular, visualization, poster, presentation, etc.,)
6. Develop capacity to help troubleshoot and/or explain for others the nature of particular problems in fitting/interpreting psychometric models (and their solutions)

Required Course Materials

Readings for the course will consist of a variety of peer-reviewed articles, book chapters, blog posts, and R vignettes and documentation for a variety of packages. You will also need to have access to a computer with R and R Studio or Positron installed.

Recommended (but Optional) Course Materials

This course focuses (eventually) on two contemporary psychometric theories and their analytic approaches: the psychometric network approach, and the reflective latent variable modeling approach. Below are a smattering of books that are high-quality resources (some, but not all are R-focused) for thinking about and carrying out these analyses, which you may want to consider based on the kind of data and/or psychometric approach(es) you will use in your Final Project (and/or your broader research program). However, none of these books are required (and any chapters I use from them for required course readings will be provided for you).

Please note, that although I have these books, I cannot loan them out for the class as I will both likely need them as teaching resources for myself, and because I will not be able to fairly loan a book to one interested student and not another who is interested in the same book. Many appear to be available in the library.

Also please note these are by no means the the only good books on these topics available. Rather, they are the ones I have read (in most cases) cover-to-cover and therefore to which I can reliably attest to their instructional value.

Psychometric Network Approach:

Isvoranu, A., Epskamp, S., Waldorp, L. J., & Borsboom, D. (2022). *Network psychometrics with R*. New York, NY: Routledge.

- A wonderful one-stop shop for both conceptual and coding considerations when estimating, visualizing, and comparing networks, as well as modeling them over time.

Reflective Latent Variable Modeling Approach:

Ruscio, J., Haslam, N., & Ruscio, A. M. (2006). *Introduction to the taxometric method: A practical guide*. New York, NY: Routledge.

- Niche, but if you are looking for a deep-dive on taxometrics (to distinguish between latent dimensions and latent categories), this is one of the only books available. Note the book largely

preceded the development of the RTaxometrics package for *R*, so coding help must be found elsewhere.

Collins, L. M., & Lanza, S. T. (2009). *Latent class and latent transition analysis*. Hoboken, NJ: Wiley.

- If you are modeling latent categories, this is a go-to, both cross-sectionally, across groups, and across time. Mostly focuses on the case with categorical indicators (hence latent classes and not latent profiles) but the wisdom is generalizable. Book is software agnostic for the most part.

Beaujean, A. A. (2014). *Latent variable modeling using R: A step-by-step guide*. New York, NY: Routledge.

- Very brief/to the point, but good introduction to the basics of CFA with a focus of application using the lavaan package for *R* (though some of its coding recommendations are outdated).

Brown, T. A. (2015). *Confirmatory factor analysis for applied research (2nd Edition)*. New York, NY: Guilford.

- If you need a comprehensive book on CFA, this is it. I have not read the 2nd edition, but I believe it has been expanded to include some R-related resources.

Fabrigar, L. R., & Wegener, D. T. (2011). *Exploratory factor analysis*. New York, NY: Oxford.

- Short and sweet, and not focused on R, but very good and accessible coverage re: exploratory factor analysis.

Little, T. D. (2013). *Longitudinal structural equation modeling*. New York, NY: Guilford.

- A book with very good coverage on some topics (cross-sectional CFA and multi-group CFA; longitudinal CFA and longitudinal invariance testing) and more mixed coverage on others. Mostly Mplus-focused (but this can be reasonable easily adapted for lavaan).

On the Use of R in the Course

This course will be using R, and you will need to download and install ***both*** R and one of either R Studio or Positron. In order to succeed in this course, you do not need extensive R knowledge, and we will spend some time reviewing basics in the first two weeks. Mainly, you will need to understand:

- How to import data
- How to create subsets of columns and/or rows within your data set
- How to create new variables and/or recode existing variable types and values
- The use of the following operators (separated by commas): <-, $, <%< (or |>)
- The core features of a reproducible R workflow (e.g., .Proj, .R,.Rmd , or Quarto files)

If, after the review in the first two weeks, you find yourself needing more support in navigating R, everything you will need to know can be found in the open-access book *R for Data Science* (Wickham & Grolemund, 2017), particularly in Chapters 1, 4, 5, 6, 8, 11, and 20. Please get in touch with me if you find yourself struggling with foundational R elements throughout the semester.

On the Use of AI-based Technologies in the Course

The use of AI-based Technologies like ChatGPT and Co-Pilot (for which you are eligible for a free license, through a free-to-join program offered [while you are a student] via GitHub Education) are changing the ways many courses are designed, and by which evaluation of course assessments occur.

In the statistics courses I teach (e.g., 9041, 9545), these technologies can provide incredible assistance for some of the more parsnickity tasks in coding, including function-writing, iteration, and parallelization; they are also useful to help with debugging (e.g., deciphering cryptic error messages). As such, I fully encourage students to make use of these technologies, *as appropriate*; it is one thing to use these technologies as but one tool in your toolbelt, and it is quite another to use them outsource all of your creative work. Further, I've found these technologies to be error-prone (laughably so) in other instances. However, I have little interest (at the graduate level) or ability (given fickleness of AI-detecting-AI tools) to police your judicious use of AI to a high degree. And so, my formal policy is this:

You, and you alone, are responsible for the coding products you submit. You commit to—if using ChatGPT and/or Co-Pilot or other LLMs to enrich your workflow—ensuring that a critical mass of your coding is originally generated through your own keystrokes and considerations. Further, you accept all liability of using AI technologies to any degree. This includes penalties as stark as:

- *a grade of "0", should you forego your commitment and depend entirely on AI to generate your code, and I find that your submission is mostly/entirely incorrect.*
- *conversely, should you instead feel inclined to plead that your grade should be considering because you used AI to generate most/all of your code, or I otherwise learn that your submission was generated by AI, I will consider this as evidence of academic misconduct, in the form of plagiarizing an AI-generated script and attempting to pass it off as your own work*

My bottom line advice: AI is a tool worth using in your *R* workflow, but make sure *you* remain in control of *its work* (and not the other way around). A heuristic I might recommend is to ensure you could independently (i.e., without AI) and at some other time:

- explain to me what each line of syntax is doing,
- explain to me why you made the coding choices you did, and
- you could reproduce most or all of the code, given the opportunity

Methods of Evaluation

Overview of Assessments

Assignment	Date of Evaluation (if known)	Weighting
Syllabus Quiz	Week 1	4%
Reading Quizzes (x13)	Weekly	11%
Reproducible Coding Assignments (x 6)	Throughout Semester	30%
Midterm	Oct. 18	20%

Assignment	Date of Evaluation (if known)	Weighting
Final Project	End of Week 13	35%
Total		100%

Syllabus Quiz

To ensure everyone understands the core elements of the syllabus, there will be an additional quiz on the first week. Format for this quiz will be multiple choice.

Reading Quizzes

There will be 11 quizzes on the readings assigned throughout the course—one for every week of the class. These quizzes will be short (one question per reading) and the questions will vary in format (e.g., multiple choice, matching, short answer). The portion of your grade from quizzes will be determined by your highest 9 quizzes, meaning that your lowest two will be dropped (and/or that you can be absent from/late to two classes [and miss their quizzes] without official documentation and/or approved absence). Make-up quizzes will not be provided.

Reproducible Coding Assignments

You will be asked to complete a set of 6 shorter assignments focused on the application and interpretation of a particular statistical technique to exemplar data. These will be graded as complete or incomplete based on whether a reproducible and substantive attempt at the assignment's contents has been submitted. A "key" (i.e., a script that yields the correct information) will be shared with the class in the week(s) after, for those wishing to verify (and/or strengthen) their understanding and application.

Midterm

There will be a Midterm covering lecture content from the first (approximate) half of the course, focusing on the introductory content as well as the core content pertaining to reflective dimensional latent variable models (i.e., the factor analysis family of models). The questions will vary in format (e.g., multiple choice, matching, short answer), and you will have the whole class to complete the Midterm. You will *not* be asked to write R code for the midterm, but you may be asked to interpret R code and/or visualizations and/or output. You may also be asked to perform some simple calculations, and so you will be permitted the use of a calculator and/or calculator smarphone app* (*and no other digital supports). Rescheduling of the Midterm will require a formally excused absence, or a verified conference commitment, otherwise a grade of 0 will be given.

Final project

The Final Project for the course consists of an original reproducible psychometric analysis

You are *strongly* recommended to use your own data for this project, but (A) it is ultimately your responsibility to ensure that you have access to (a sufficient amount of) the data you want in time to complete the project, and (B) you are permitted to use pre-existing data (e.g., your

advisor's, open access data, etc.,) as long as the requisite permissions are secured (or deemed unnecessary). As student interests will vary, so too will final projects vary in terms of the designs, samples, number and kinds of variables measures, and analyses that they feature. As long as the kinds of analyses you use are defensibly and substantively psychometric in nature (and you are encouraged to confirm this with me well in advance of you beginning your work), then you are free to mould the final project to something that you deem interesting, important, and useful for your graduate training program.

Grading rubrics for the Final Project will be circulated, but all projects will be graded on four elements: (1) their coherence; (2) their correctness; (3) their reproducibility; and (4) their complexity. Of these elements, (1) – (3) will be assigned numeric grades, while (4) will serve as a multiplier of their sum (easy = 0.90x ; standard = 1.0x; difficult = 1.10x).

Course Schedule

Course Timeline

Week	Date	Topic	Required Readings
1	Thurs, Sept. 5	What is (psychological) measurement, and why and when do we care? + R review day #1	1. Stevens (1946) 2. Borsboom (2006) 3. Flake & Fried (2020) 4. Fried et al. (2022) 5. Hussey & Hughes (2020) 6. Maul (2017)
2	Thurs, Sept. 12	Fundamental Measurement Modeling Concepts and Processes	1. Borsboom (2005, Chp. 2) 2. Fried (2017) 3. Borsboom et al. (2022, Chp. 1) 4. Borsboom (2005, Chp. 3)] 5. Bollen & Diamantopoulos (2017)
3	Thurs, Sept. 19	Confirmatory Factor Analysis I (Overview)	1. Little (2013, Chp. 3) 2. MacCallum et al. (1999) 3. Rhemtulla et al. (2012) 4. Woods et al. (2021)
4	Thurs, Sept. 26	Confirmatory Factor Analysis II (Basics)	1. Hu and Bentler (1999) 2. McNeish et al. (2018) 3. McNeish & Wolf (2021)
5	Thurs, Oct. 3	Exploratory Factor Analysis • **#1 CFA CODING ASSIGNMENT DUE**	1. Sakaluk & Short (2017) 2. Snook & Gorsuch (1989) 3. Widaman (1993) 4. Browne (2001)

Week	Date	Topic	Required Readings
			5. Grice (2001)
6	Thurs, Oct. 10	**MIDTERM**	
7	Thurs, Oct. 17	**READING WEEK (No Class or Office Hours)**	
8	Thurs, Oct. 24	**JOHN AWAY AT CONFERENCE (No Class or Office Hours)**	
9	Thurs, Oct. 31	Item Response Theory • **#2 EFA CODING ASSIGNMENT DUE**	1. Cai et al. (2016) 2. Revelle (2009) 3. Raykov & Marcoulides (2016) 4. Singh (2004)
10	Thurs, Nov. 7	Consistency tests of psychometric structure	1. Ruscio et al. (2006, Chp. 2) 2. van Bork et al. (2021) 3. Rhemtulla et al. (2020) 4. VanderWeele & Vansteelandt (2020) 5. Sakaluk (2019, pp. 478-488) 6. Masyn et al. (2010)
11	Thurs, Nov. 14	Mixture modeling (latent classes and profiles) • **#3 Consistency Tests Assignment Due**	1. Masyn (2013) 2. Nylund-Gibson & Choi (2018) 3. Nylund et al. (2007) 4. Steinley & Brusco (2011) 5. van Lissa et al. (in press)
12	Thurs, Nov. 21	Psychometric networks • **#4 Mixture modeling assignment due**	1. Borsboom et al. (2021) 2. Neal et al. (2022) 3. Epskamp et al. (2022) 4. Blanken et al. (2022)

Week	Date	Topic	Required Readings
			5. Henry et al. (2021)
13	Thurs, Nov. 28	Evaluating the Generalizability of Psychometric Measurement Models • **#5 Network modeling assignment due**	1. Sakaluk (in prep) 2. Fried et al. (2022) 3. Jorgensen et al. (2018) 4. Counsell et al. (2019) 5. Kolbe & Jorgensen (2019) 6. Gunn et al. (2020)
14	Thurs, Dec. 5	Specialized Models and Advanced Use-Cases • **#6 Generalizability assignment due** • **Final Assignment assignment (due Dec. 6)**	1. Morin et al. (2016) 2. Bonifay et al. (2017) 3. Bauer et al. (2013) 4. Epskamp et al. (2018) 5. Little (2013, Chp. 5) 6. Skrondal & Laake (2001)

Suggestions and strategies for success in navigating the course readings

The required reading for this course is substantial, and for good reason: (1) the landscape of measurement modeling theory, application, and best practices has changed considerably in the last 10-15 years; and (2) measurement modeling is a technical skill, and therefore a greater degree of learning is required in order to enable you to deploy these skills successfully.
That said, I strongly suggest you consider some/all of the following suggestions and strategies that may make it easier to navigate the required readings in the course:

- New measurement modeling techniques are developed and the "performance" of new/old/competing techniques is evaluated typically using simulation studies, and many of the papers we will read report on simulations. While you could simply skip the technical elements of the simulation methodology in a given paper, understanding the basics of simulation studies—what they are, why people conduct them, what kinds of statistical information they return—would likely decrease any stress you might feel when encountering one and allow you to get more out of the reading. To that effect, the accessible primer by Morris et al. (2019) might be quite helpful to read early on in the semester.
- You are free to create one or more "reading groups" to divide and conquer readings, and share notes amongst yourselves. Be aware, however, that you are each individually responsible for the readings (i.e., nobody else is responsible for ensuring notes contain what you might need for a given quiz).
- Don't miss the forest for the (alebgraic) trees! You will occasionally see formulas, matrix alegrba, and simulations that can be technically complex. Do not fret if you are not a "math person"! (I am not a "math person"). The most (but not singularly) important thing is that you take from a reading whatever lesson(s) are important for how/how not to do something measurement-modeling related and, in concept, why that is the case. Deeper learning can be found in the formulas and simulation details, but don't let these become a barrier to you learning the applied pieces that you can put to work. Skip if they detract from joy, and consider returning when you know more to see if you can absorb their wisdom—strategic skimming can go a long way when you are starting out.
- Focus on what is useful/important for you in this course; preserve your attention and energy when discussion strafes into topics that you do not perceive as applicable.

Reading List

Week 1 (What is (psychological) measurement, and why and when do we care?)

1. Stevens, S. S. (1946). On the theory of scales of measurement. *Science*, *103*(2684), 677-680.
2. Borsboom, D. (2006). The attack of the psychometricians. *Psychometrika*, *71*(3), 425-440.
3. Flake, J. K., & Fried, E. I. (2020). Measurement schmeasurement: Questionable measurement practices and how to avoid them. *Advances in Methods and Practices in Psychological Science*, *3*(4), 456-465.
4. Fried, E. I., Flake, J. K., & Robinaugh, D. J. (2022). Revisiting the theoretical and methodological foundations of depression measurement. *Nature Reviews Psychology*, *1*, 358-368.

5. Hussey, I., & Hughes, S. (2020). Hidden invalidity among 15 commonly used measures in social and personality psychology. *Advances in Methods and Practices in Psychological Science*, *3*(2), 166-184.
6. Maul, A. (2017). Rethinking traditional methods of survey validation. *Measurement: Interdisciplinary Research and Perspectives*, *15*(2), 51-69.

Week 2 (Fundamental Measurement Modeling Concepts and Processes)

1. Borsboom, D. (2005). *Measuring the mind* (Chapter 2, "True Scores": pp. 11 - 48). Cambridge: Cambridge University Press.
2. Fried, E. I. (2017). What are psychological constructs? On the nature and statistical modelling of emotions, intelligence, personality traits and mental disorders. *Health psychology review*, *11*(2), 130-134.
3. Borsboom, D., Cramer, A. O. J., Fried, E. I., Isvoranu, A. M., Robinaugh, D. J., Dalege, J., & van der Maas, H. L. J. (2002). Network Perspectives. In Isvoranu, A. M., Epskamp, S., Waldorp, L. J., & Borsboom, D. (Eds). *Network psychometrics with R: Guide for behavioral and social scientists* (pp. 9 -27). New York, NY: Routledge.
4. Borsboom, D. (2005). *Measuring the mind* (Chapter 3, "Latent Variables": pp. 49 - 84). Cambridge: Cambridge University Press.
5. Bollen, K. A., & Diamantopoulos, A. (2017). In defense of causal-formative indicators: A minority report. *Psychological Methods*, *22*(3), 581–596.

Week 3 (Confirmatory Factor Analysis I [Overview])

1. Little, T. D. (2013). *Longitudinal structural equation modeling* (Chapter 3, "The Measurement Model", pp. 71-105). New York: Guilford.
2. MacCallum, R. C., Widaman, K. F., Zhang, S., & Hong, S. (1999). Sample size in factor analysis. *Psychological Methods*, *4*(1), 84–99.
3. Rhemtulla, M., Brosseau-Liard, P. É., & Savalei, V. (2012). When can categorical variables be treated as continuous? A comparison of robust continuous and categorical SEM estimation methods under suboptimal conditions. *Psychological Methods*, *17*(3), 354–373.
4. Woods, A. D., Davis-Kean, P., Halvorson, M. A., King, K. M., Logan, J. A. R., Xu, M., … Elsherif, M. M. (2021, November 3). Best Practices for Addressing Missing Data through Multiple Imputation. https://doi.org/10.31234/osf.io/uaezh

Week 4 (Confirmatory Factor Analysis II [Basics])

1. Hu, L. T., & Bentler, P. M. (1999). Cutoff criteria for fit indexes in covariance structure analysis: Conventional criteria versus new alternatives. *Structural equation modeling: a multidisciplinary journal*, *6*(1), 1-55.
2. McNeish, D., An, J., & Hancock, G. R. (2018). The thorny relation between measurement quality and fit index cutoffs in latent variable models. *Journal of personality assessment*, *100*(1), 43-52.

3. McNeish, D., & Wolf, M. G. (2021). Dynamic fit index cutoffs for confirmatory factor analysis models. *Psychological Methods.*Advance online publication. https://doi.org/10.1037/met0000425

Week 5 (Exploratory Factor Analysis)

1. Sakaluk, J. K., & Short, S. D. (2017). A methodological review of exploratory factor analysis in sexuality research: Used practices, best practices, and data analysis resources. *The Journal of Sex Research*, *54*(1), 1-9.
2. Snook, S. C., & Gorsuch, R. L. (1989). Component analysis versus common factor analysis: A Monte Carlo study. *Psychological Bulletin, 106*(1), 148–154.
3. Widaman, K. F. (1993). Common factor analysis versus principal component analysis: Differential bias in representing model parameters?. *Multivariate behavioral research*, *28*(3), 263-311.
4. Browne, M. W. (2001). An overview of analytic rotation in exploratory factor analysis. *Multivariate behavioral research*, *36*(1), 111-150.
5. Grice, J. W. (2001). Computing and evaluating factor scores. *Psychological Methods, 6*(4), 430–450.

Week 7 (Item Response Theory)

1. Cai, L., Choi, K., Hansen, M., & Harrell, L. (2016). Item response theory. *Annual Review of Statistics and Its Application*, *3*, 297-321.
2. Revelle, W. (2009). An introduction to psychometric theory with applications in R (Chapter 8, "The 'new psychometrics'—Item Response Theory, pp. 241-264). Retrieved from https://personality-project.org/r/book/Chapter8.pdf
3. Raykov, T., & Marcoulides, G. A. (2016). On the relationship between classical test theory and item response theory: From one to the other and back. *Educational and Psychological Measurement*, *76*(2), 325-338.
4. Singh, J. (2004). Tackling measurement problems with Item Response Theory: Principles, characteristics, and assessment, with an illustrative example. *Journal of Business Research*, *57*(2), 184-208.

Week 9 (Consistency tests of psychometric structure)

1. Ruscio, J., Haslam, N., & Ruscio, A. M. (2006). *Introduction to the taxometric method: A practical guide* (Chapter 2, "Why Latent Structure Matters"). New York: Routledge.
2. van Bork, R., Rhemtulla, M., Waldorp, L. J., Kruis, J., Rezvanifar, S., & Borsboom, D. (2021). Latent variable models and networks: Statistical equivalence and testability. *Multivariate behavioral research*, *56*(2), 175-198.
3. Rhemtulla, M., van Bork, R., & Borsboom, D. (2020). Worse than measurement error: Consequences of inappropriate latent variable measurement models. *Psychological Methods*, *25*(1), 30–45.
4. VanderWeele, T. J., & Vansteelandt, S. (2020). A statistical test to reject the structural interpretation of a latent factor model. *arXiv preprint arXiv:2006.15899*.

5. Sakaluk, J. K. (2019). Expanding statistical frontiers in sexual science: Taxometric, invariance, and equivalence testing. *The Journal of Sex Research*, *56*(4-5), 475-510.
6. Masyn, K. E., Henderson, C. E., & Greenbaum, P. E. (2010). Exploring the latent structures of psychological constructs in social development using the dimensional–categorical spectrum. *Social Development*, *19*(3), 470-493.

Week 10 (Mixture modeling (latent classes and profiles)

1. Masyn, K. E. (2013). Latent class analysis and finite mixture modeling. In T. D. Little (Ed.), *The oxford handbook of quantitative methods (Volume 2*. pp. 551-611). New York, Oxford.
2. Nylund-Gibson, K., & Choi, A. Y. (2018). Ten frequently asked questions about latent class analysis. *Translational Issues in Psychological Science*, *4*(4), 440-461.
3. Nylund, K. L., Asparouhov, T., & Muthén, B. O. (2007). Deciding on the number of classes in latent class analysis and growth mixture modeling: A Monte Carlo simulation study. *Structural equation modeling: A multidisciplinary Journal*, *14*(4), 535-569.
4. Steinley, D., & Brusco, M. J. (2011). Evaluating mixture modeling for clustering: recommendations and cautions. *Psychological methods*, *16*(1), 63-79.
5. van Lissa, C. J., Garnier-Villarreal, M., & Anadria, D. (in press). Recommended practices in latent class analysis using the open-source R-package tidySEM. https://psyarxiv.com/pruwd/download?format=pdf

Week 11 (Psychometric networks)

1. Borsboom, D., Deserno, M. K., Rhemtulla, M., Epskamp, S., Fried, E. I., McNally, R. J., ... & Waldorp, L. J. (2021). Network analysis of multivariate data in psychological science. *Nature Reviews Methods Primers*, *1*(1), 1-18.
2. Neal, Z., Forbes, M. K., Neal, J. W., Brusco, M., Krueger, R., Markon, K. E., … Wright, A. G. (2022, April 25). Critiques of network analysis of multivariate data in psychological science. https://doi.org/10.31234/osf.io/jqs3n
3. Epskamp, S., Haslbeck, J. M. B., Isvoranu, A. M., & Van Borkulo, C. D. (2022). Pairwise Markov random fields. In Isvoranu, A. M., Epskamp, S., Waldorp, L. J., & Borsboom, D. (Eds). *Network psychometrics with R: Guide for behavioral and social scientists* (pp. 93 -110). New York, NY: Routledge.
4. Blanken, T. F., Isvoranu, A. M., & Epskamp, S. (2022). Estimating network structures using model selection. In Isvoranu, A. M., Epskamp, S., Waldorp, L. J., & Borsboom, D. (Eds). *Network psychometrics with R: Guide for behavioral and social scientists* (pp. 111 -132). New York, NY: Routledge.
5. Henry, T. R., Robinaugh, D. J., & Fried, E. I. (2021). On the control of psychological networks. *Psychometrika*, *87*, 188-213.

Week 12 (Evaluating the Generalizability of Psychometric Measurement Models)

1. Sakaluk, J. K. (in prep). *Reimagining the measurement model*.

2. Fried, E. I., Epskamp, S., Veenman, M., & van Borkulo, C. D. (2022). Network stability, comparison, and replicability. In Isvoranu, A. M., Epskamp, S., Waldorp, L. J., & Borsboom, D. (Eds). *Network psychometrics with R: Guide for behavioral and social scientists* (pp. 133 -153). New York, NY: Routledge.
3. Jorgensen, T. D., Kite, B. A., Chen, P.-Y., & Short, S. D. (2018). Permutation randomization methods for testing measurement equivalence and detecting differential item functioning in multiple-group confirmatory factor analysis. *Psychological Methods, 23*(4), 708–728.
4. Counsell, A., Cribbie, R. A., & Flora, D. B. (2020). Evaluating equivalence testing methods for measurement invariance. *Multivariate Behavioral Research*, *55*(2), 312-328.
5. Kolbe, L., & Jorgensen, T. D. (2019). Using restricted factor analysis to select anchor items and detect differential item functioning. *Behavior Research Methods*, *51*(1), 138-151.
6. Gunn, H. J., Grimm, K. J., & Edwards, M. C. (2020). Evaluation of six effect size measures of measurement non-invariance for continuous outcomes. *Structural Equation Modeling: A Multidisciplinary Journal*, *27*(4), 503-514.

Week 13 Specialized Models and Advanced Use-Cases

1. Morin, A. J., Arens, A. K., & Marsh, H. W. (2016). A bifactor exploratory structural equation modeling framework for the identification of distinct sources of construct-relevant psychometric multidimensionality. *Structural Equation Modeling: A Multidisciplinary Journal*, *23*(1), 116-139.
2. Bonifay, W., Lane, S. P., & Reise, S. P. (2017). Three concerns with applying a bifactor model as a structure of psychopathology. *Clinical Psychological Science*, *5*(1), 184-186.
3. Bauer, D. J., Howard, A. L., Baldasaro, R. E., Curran, P. J., Hussong, A. M., Chassin, L., & Zucker, R. A. (2013). A trifactor model for integrating ratings across multiple informants. *Psychological Methods*, *18*(4), 475–493.
4. Epskamp, S., Waldorp, L. J., Mõttus, R., & Borsboom, D. (2018). The Gaussian graphical model in cross-sectional and time-series data. *Multivariate behavioral research*, *53*(4), 453-480.
5. Little, T. D. (2013). *Longitudinal structural equation modeling* (pp. 137 – 179). New York, NY: Guilford.
6. Skrondal, A., & Laake, P. (2001). Regression among factor scores. *Psychometrika*, *66*(4), 563-575.

Other Relevant Policies

My Policy on Late Submission of Work

One of the most important mechanisms I have under my control to ensure equality in grading is to hold everyone to the same standards with respect to deadlines. **I do not accept late work**, unless you either a) have an official documented/approved excuse, or b) have invoked some official process that overrides my application of this policy. Do not put yourself in a position where you are submitting work late; **I will not accept it**. Believe me that **submitting work on time—of any stage of completion—will be better than submitting it late and taking a 0**. Graduate students often feel that they cannot submit less-than perfect work (e.g., for fear of judgement of their potential/capacity, by an instructor). I can assure you of two things, however: 1) that **I will not judge anyone for submitting less than their best on occasion** (we all get busy, have competing priorities, want to get different things out of classes, etc.,); and 2) that **letting the "perfect" become the enemy of the "on time" will result in you damaging your grade**. I hope you will not take this policy personally; I care about your experience in the class, but I adopt this policy because there is good evidence that if instructors (like me) exercise their personal discretion to decide who does and doesn't get extensions for late work, there is a good chance of prejudicial biases (of one form and/or another) contaminating those decisions. **If you are feeling nervous about your ability to meet a deadline and/or the quality of work you may need to submit to meet a deadline, please get in touch** (as I may be able to alay your concerns and/or misunderstandings, and help you manage your expectations and strategize how to maximize the quality of your submission in the time remaining).

Respect for Diversity

It is my intent that students from all diverse backgrounds and perspectives be well-served by this course, that students' learning needs be addressed both in and out of class, and that the diversity that students bring to this class be viewed as a resource, strength and benefit. It is my intent to present materials and activities that are respectful of diversity: gender, sexuality, disability, age, socio-economic status, ethnicity, race, and culture. Your suggestions are encouraged and appreciated. Please let me know ways to improve the effectiveness of the course for you personally or for other students or student groups. In addition, if any of our class meetings conflict with your religious events, please let me know so that we can make arrangements for you.

Child Care and Child-Friendly Policy

The following text has been adapted from Dr. Melissa Cheyney (2018):

It is my belief that if we want women and other child-bearing folk in academia, that we should also expect children to be present in some form. Currently, the university does not have a formal policy on children in the classroom. The policy described here is thus, a reflection of my own beliefs and commitments to student, staff and faculty parents.

1. All exclusively breastfeeding babies are welcome in class as often as is necessary to support the breastfeeding relationship. Because not all women and child-bearing folk can pump sufficient milk, and not all babies will take a bottle reliably, I never want students to feel like they have to choose between feeding their baby and continuing their education. You and your nursing baby are welcome in class anytime.

2. For older children and babies, I understand that minor illnesses and unforeseen disruptions in childcare often put parents in the position of having to chose between missing class to stay home with a child and leaving him or her with someone you or the child does not feel comfortable with. While this is not meant to be a long-term childcare solution, occasionally bringing a child to class in order to cover gaps in care is perfectly acceptable.
3. I ask that all students work with me to create a welcoming environment that is respectful of all forms of diversity, including diversity in parenting status.
4. In all cases where babies and children come to class, I ask that you sit close to the door so that if your little one needs special attention and is disrupting learning for other students, you may step outside until their need has been met. Non-parents in the class, please reserve seats near the door for your parenting classmates.
5. Finally, I understand that often the largest barrier to completing your coursework once you become a parent is the tiredness many parents feel in the evening once children have *finally* gone to sleep. The struggles of balancing school, childcare and often another job are exhausting! I hope that you will feel comfortable disclosing your student-parent status to me. While I maintain the same high expectations for all student in my classes regardless of parenting status, I am happy to problem solve with you in a way that makes you feel supported as you strive for school-parenting balance. Thank you for the diversity you bring to our classroom!

Limits of Final Project Consultation/Reminder of APA-Authorship Guidelines

The intent of this class is for you to work towards a publishable analysis in a research area of your choice. Keep in mind, however, that my ultimate responsibility is to teach you foundations of measurement modeling, and not to ensure that your project advances to a state of publishable quality. There is a limit, in other words, to the extent that I can (and will) make analytic corrections, troubleshoot code, clarify interpretations, etc., in order to stay in the realm of instructor (my strong preference), and not enter that of the realm of coauthor. Please keep in mind the APA guidelines for determining authorship (and their authorship determination score card, in particular) when making decisions about the extent to which you rely on my guidance in your project. I will do my best to let you know when I think we are approaching this boundary, but you have a responsibility to be aware of this dynamic as well.

Statement on Academic Offences

Scholastic offences are taken seriously and students are directed to read the appropriate policy, specifically, the definition of what constitutes a Scholastic Offence, at the following Web site: http://www.uwo.ca/univsec/pdf/academic_policies/appeals/scholastic_discipline_grad.pdf

All required papers may be subject to submission for textual similarity review to the commercial plagiarism-detection software under license to the University for the detection of plagiarism. All papers submitted for such checking will be included as source documents in the reference database for the purpose of detecting plagiarism of papers subsequently submitted to the system. Use of the service is subject to the licensing agreement, currently between The University of Western Ontario and Turnitin.com (http://www.turnitin.com).

Health/Wellness Services

Students who are in emotional/mental distress should refer to Mental Health@Western http://www.uwo.ca/uwocom/mentalhealth/ for a complete list of options about how to obtain help.

Accessible Education Western (AEW)

Western is committed to achieving barrier-free accessibility for all its members, including graduate students. As part of this commitment, Western provides a variety of services devoted to promoting, advocating, and accommodating persons with disabilities in their respective graduate program.

Graduate students with disabilities (for example, chronic illnesses, mental health conditions, mobility impairments) are strongly encouraged to register with Accessible Education Western (AEW), a confidential service designed to support graduate and undergraduate students through their academic program. With the appropriate documentation, the student will work with both AEW and their graduate programs (normally their Graduate Chair and/or Course instructor) to ensure that appropriate academic accommodations to program requirements are arranged. These accommodations include individual counselling, alternative formatted literature, accessible campus transportation, learning strategy instruction, writing exams and assistive technology instruction.