Western University
Department of Psychology
PSYCHOLOGY 9545A
Psychometric Measurement Modeling
Fall 2023
See Student Centre for course times and locations.

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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
Office Phone: 519-661-2111 ext. 87755
Office Hours: TBD (see Calendly link on OWL for booking an appointment)
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 appraising 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 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:**
  - 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:**
  - 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.
- 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.

- 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).

- 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.

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

- 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 R Studio (they are separate programs). 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): <-, $, <%
- The core features of a reproducible R workflow (e.g., .Proj, .R, and .Rmd 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.
Methods of Evaluation

Overview of Assessments

<table>
<thead>
<tr>
<th>Assignment</th>
<th>Date of Evaluation (if known)</th>
<th>Weighting</th>
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</thead>
<tbody>
<tr>
<td>Syllabus Quiz</td>
<td>Week 2</td>
<td>4%</td>
</tr>
<tr>
<td>Reading Quizzes (x13)</td>
<td>Weekly</td>
<td>11%</td>
</tr>
<tr>
<td>Reproducible Coding Assignments (x 6)</td>
<td>Throughout Semester</td>
<td>30%</td>
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<tr>
<td>Midterm</td>
<td>End of Week 13</td>
<td>20%</td>
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<tr>
<td>Final Project</td>
<td>End of Week 13</td>
<td>35%</td>
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<tr>
<td>Total</td>
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<td>100%</td>
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**Syllabus Quiz**
To ensure everyone understands the core elements of the syllabus, there will be an additional quiz on the second 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 (i.e., a knitable .Rmd file) 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 smartphone 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 one of two possible options:

*Reproducible Psychometric Analysis*

You may conduct and report on a reproducible psychometric analysis corresponding to your particular interests. 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.

*A Elaborated Psychometric Tutorial*
You may demonstrate an effort to develop and practice teaching skills with respect to psychometric measurement modeling. This should include either a *public* YouTube tutorial video (recommended min. 10 – 15) and/or a comprehensive blogpost and/or a “knowledge brokering” research paper—along with supporting R code—teaching others how to navigate some substantive element of psychometric modeling w/ code that was *not already covered extensively in class* (please confirm topic with me before moving ahead).

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 (for psychometric analyses) or their didactic “polish” (for psychometric tutorials); 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

<table>
<thead>
<tr>
<th>Week</th>
<th>Date</th>
<th>Topic</th>
<th>Required Readings</th>
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</table>
| 1    | Wed., Sept. 13 | What is (psychological) measurement, and why and when do we care? + R review day #1 | 1. Stevens (1946)  
3. Flake & Fried (2020)  
4. Fried et al. (2022)  
5. Hussey & Hughes (2020)  
2. Fried (2017)  
3. Borsboom et al. (2022, Chp. 1)  
4. Borsboom (2005, Chp. 3)]  
| 3    | Wed, Sept. 27 | 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    | Wed, Oct. 4  | Confirmatory Factor Analysis II (Basics)                              | 1. Hu and Bentler (1999)  
| 5    | Wed, Oct. 11 | Exploratory Factor Analysis  
- #1 CFA CODING ASSIGNMENT DUE | 1. Sakaluk & Short (2017)  
2. Snook & Gorsuch (1989)  
4. Browne (2001)  
5. Grice (2001) |
<table>
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<th>Week</th>
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<th>Topic</th>
<th>Required Readings</th>
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<tr>
<td>6</td>
<td>Wed, Oct. 18</td>
<td>MIDTERM</td>
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<td><strong>#2 EFA CODING ASSIGNMENT DUE</strong></td>
<td>2. Revelle (2009)</td>
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<td>8</td>
<td>Wed., Nov. 1</td>
<td>READING WEEK</td>
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<td>9</td>
<td>Wed., Nov 8</td>
<td>Consistency tests of psychometric structure</td>
<td>1. Ruscio et al. (2006, Chp. 2)</td>
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<td><strong>#3 Consistency Tests Assignment Due</strong></td>
<td>2. van Bork et al. (2021)</td>
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<td>3. Rhemtulla et al. (2020)</td>
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<td>4. VanderWeele &amp; Vansteelandt (2020)</td>
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<td>5. Sakaluk (2019, pp. 478-488)</td>
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<td>3. Nylund et al. (2007)</td>
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<td>4. Steinley &amp; Brusco (2011)</td>
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<td><strong>#4 Mixture modeling assignment due</strong></td>
<td>2. Neal et al. (2022)</td>
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<td>3. Epskamp et al. (2022)</td>
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<td>4. Blanken et al. (2022)</td>
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<td>5. Henry et al. (2021)</td>
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<td><strong>#5 Network modeling assignment due</strong></td>
<td>2. Fried et al. (2022)</td>
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<td>4. Counsell et al. (2019)</td>
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<td>Week</td>
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<td>Topic</td>
<td>Required Readings</td>
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<td>• #6 Generalizability assignment due</td>
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<td>• Final Assignment assignment (due Dec. 8)</td>
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<td>1. Morin et al. (2016)</td>
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<td>2. Bonifay et al. (2017)</td>
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<td>3. Bauer et al. (2013)</td>
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<td>4. Epskamp et al. (2018)</td>
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<td></td>
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<td>5. Little (2013, Chp. 5)</td>
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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 (alebraic) trees! You will occasionally see formulas, matrix algebra, 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?)


**Week 2 (Fundamental Measurement Modeling Concepts and Processes)**

**Week 3 (Confirmatory Factor Analysis I [Overview])**

**Week 4 (Confirmatory Factor Analysis II [Basics])**

**Week 5 (Exploratory Factor Analysis)**


**Week 7 (Item Response Theory)**


**Week 9 (Consistency tests of psychometric structure)**


12


**Week 10 (Mixture modeling (latent classes and profiles))**


**Week 11 (Psychometric networks)**


**Week 12 (Evaluating the Generalizability of Psychometric Measurement Models)**


Week 13 Specialized Models and Advanced Use-Cases


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 choose 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](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](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/](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.