

Psychological and Quantitative Foundations (PSQF) 6249 Fall 2020: Factor Analysis and Structural Equation Models

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Zoom Link: <https://uiowa.zoom.us/my/lesahoffmaniowa>
Meeting ID: 504 435 6512; Mobile Access: +13126266799,,5044356512#

Course Time: Tuesdays and Thursdays 2:00–3:15 PM at zoom link

Office Hours: Tuesdays and Thursdays 3:15–4:45 PM at zoom link or by appointment

Schedule of Topics and Events:

This course will meet synchronously on zoom. The planned schedule of topics and events given here may need to be adjusted throughout the course. The online syllabus at the web address below will always have the most current schedule and corresponding due dates: <http://www.lesahoffman.com/PSQF6249/index.html>

Course Objectives, Pre-Requisites, and Materials:

This course will address contemporary approaches to measurement, expanding from classical test theory into measurement models for latent traits (i.e., confirmatory factor models, item response models), and their use within structural equation models. In addition to these statistical models, the course will also focus on the measurement concepts behind these models and how they relate to each other with respect to scale construction and evaluation. Participants should be comfortable with the general linear model (e.g., regression) prior to enrolling. Auditors and visitors are always welcome to attend class.

Class time will be devoted primarily to lectures, examples, and spontaneous review, the materials for which will be available for download at the course website. Attendance via zoom is encouraged but not required; I intend to make video recordings of each class available online, and supplemental videos for specific topics (e.g., software demos) may be posted as well. Readings have been suggested for each topic and may be updated later. There will be no required sessions held outside the regular class time noted above (i.e., no additional midterm or final exam sessions). However, because the course will have an applied focus requiring the use of statistical software, participants are encouraged to attend group-based office hours, in which multiple participants can receive immediate assistance on homework assignments simultaneously.

Course Requirements:

Participants will have the opportunity to earn **up to 100 total points** in this course. Up to **88 points** can be earned from **homework assignments** (approximately 6 in total)—these will be graded for accuracy. Homework assignments that involve **individual writing** will have the opportunity to be **revised once** to earn the maximum total points. **Written assignments must be at least $\frac{3}{4}$ complete to be accepted.** Please use “track changes” and retain all original instructor comments (unless otherwise instructed) so that I can easily see how your revisions address the comments.

Up to **12 points** may be earned from submitting **outside-of-class formative assessments** (approximately 6 in total); these will be graded on effort only—incorrect answers will not be penalized. Please note there will also be an opportunity to earn up to **3 points of extra credit** (labeled as homework 0; see the online syllabus for more information). There may be other opportunities to earn extra credit at the instructor’s discretion.

Policy on Late Assignments, Formative Assessments, and Grades of Incomplete:

In order to provide participants with prompt feedback, **homework assignments submitted any time after the deadline will incur a 1-point penalty. Late revisions will also incur a 1-point penalty;** no late points will be returned through the revision process. However, extensions will be granted as needed for extenuating circumstances (e.g., conferences, comprehensive exams, family obligations) if requested **at least two weeks in advance of the due date. Late or incomplete outside-of-class formative assessments will incur a 0.5-point penalty.** A final grade of “incomplete” will only be given in dire circumstances and entirely at the instructor's discretion. **All work must be submitted by Friday, December 18, 2020 at 11:59 PM.**

Final grades will be determined by the *proportion* earned out of the total possible points:

>96 = A+, 93–96 = A, 90–92 = A–, 87–89 = B+, 83–86 = B, 80–82 = B–,
77–79 = C+, 73–76 = C, 70–72 = C– (**PASS**), 67–69 = D+, 63–66 = D, 60–62 = D–, <60 = F

Course Software:

Participants will need to have access to statistical software that can estimate the models presented. Although the course will feature *Mplus* primarily, other software programs (e.g., STATA, R) could also be used to complete homework assignments. All of these are freely available to participants enrolled in the course through the Ulowa Virtual Desktop: <https://virtualdesktop.uiowa.edu/Citrix/VirtualDesktopWeb/>; STATA was previously not available off-campus but it is currently available due to the need for remote work. A second option that allows many software packages off-campus is the Research Remote Desktop here: <https://its.uiowa.edu/rrds>. As a third option, student *Mplus* licenses can be purchased for \$195 (for the base version) here: <https://www.statmodel.com/orderonline/categories.php?category=Mplus-Software/>

Course Textbook (available electronically through the University of Iowa library):

Brown, T. A. (2015). *Confirmatory factor analysis for applied research* (2nd ed). New York, NY: Guilford.
Library link: https://search.lib.uiowa.edu/permalink/f/9i2ftm/01IOWA_ALMA51519239840002771

Other Course Readings (all available via "Files" in Icon):

Note—I know this is A LOT of readings, but we are covering a lot of material! I have included these sources to give you some additional background and/or exposure to current best-practices in each topic. I encourage you to read as much as possible, but your priority should be to participate in class and complete course work first!

- Asparouhov, T. & Muthén, B. (2014) Multiple-group factor analysis alignment. *Structural Equation Modeling*, 21(4), 495-508.
- Bauer, D. J., & Hussong, A. M. (2009). Psychometric approaches for developing commensurate measures across independent studies: Traditional and new models. *Psychological Methods*, 14(2), 101-125.
- Bollen, K. A., & Diamantopoulos, A. (2017). In defense of causal-formative indicators: A minority report. *Psychological Methods*, 22(3), 581-596.
- Chen, F., F., West, S. G., & Sousa, K. H. (2006). A comparison of bifactor and second-order models of quality of life. *Multivariate Behavioral Research*, 41, 189-225.
- Cole, D. A., & Preacher, K. J. (2014). Manifest variable path analysis: potentially serious and misleading consequences due to uncorrected measurement error. *Psychological Methods*, 19(2), 300-315.
- Curran, P. J. Cole, V. T., Bauer, D. J., Rothenberg, W. A., & Hussong, A. M. (2018). Recovering predictor–criterion relations using covariate-informed factor score estimates. *Structural Equation Modeling*, 25(6), 860-875.

- Curran, P. J., McGinley, J. S., Bauer, D. J., Hussong, A. M., Burns, A., Chassin, L., Sher, K., & Zucker, R. (2014). A moderated nonlinear factor model for the development of commensurate measures in integrative data analysis. *Multivariate Behavioral Research*, *49*(3), 214-231.
- Davidson, C. A., Hoffman, L., & Spaulding, W. D. (2016). Schizotypal personality questionnaire – brief revised (updated): An update of norms, factor structure, and item content in a large non-clinical young adult sample. *Psychiatry Research*, *238*, 345-355.
- Edwards, M. C., & Wirth, R. J. (2009). Measurement and the study of change. *Research in Human Development*, *62*(2-3), 74-96.
- Embretson, S. E., & Reise, S. T. (2000). *Item response theory for psychologists*. Mahwah, NJ: Erlbaum.
- Enders, C. K. (2010). *Applied missing data analysis*. New York, NY: Guilford.
- Ferrando, P. J. (2009). Difficulty, discrimination, and information indices in the linear factor analysis model for continuous item responses. *Applied Psychological Measurement*, *33*(1), 9-24.
- Hu, L., & Bentler, P. M. (1999). Cutoff criteria for fit indexes in covariance structure analysis: Conventional criteria versus new alternatives. *Structural Equation Modeling*, *6*, 1–55.
- Huggins-Manley, A. C., Algina, J. & Zhou, S. (2018). Models for semiordeed data to address not applicable responses in scale measurement. *Structural Equation Modeling*, *25*(2), 230-243.
- John, O. P., & Benet-Martinez, V. (2014). Measurement: Reliability, construct validation, and scale construction. In H. T. Reis & C. M. Judd (Eds.), *Handbook of research methods in social and personality psychology* (pp. 473-503, 2nd ed.). New York, NY: Cambridge University Press.
- MacKinnon, D. P. (2008). *Introduction to statistical mediation analysis*. New York, NY: Routledge Academic.
- Maydeu-Olivares, A. (2015). Evaluating the fit of IRT models. In S. P. Reise & D. A. Revicki (Eds.), *Handbook of item response theory modeling* (pp. 111-127). New York, NY: Taylor & Francis.
- Maydeu-Olivares, A., & Coffman, D. L. (2006). Random intercept item factor analysis. *Psychological Methods*, *11*, 344-362.
- McDonald, R. P. (1999). *Test theory: A unified treatment*. Mahwah, NJ: Erlbaum.
- McNeish, D. (2018). Thanks coefficient alpha, we'll take it from here. *Psychological Methods*, *23*(3), 412-433.
- 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.
- McNeish, D. & Wolf, M G. (2020). Thinking twice about sum scores. Forthcoming in *Behavior Research Methods*. <https://doi.org/10.3758/s13428-020-01398-0>
- Mungas, D., & Reed, B. R. (2000). Application of item response theory for development of a global functioning measure of dementia with linear measurement properties. *Statistics in Medicine*, *19*, 1631-1644.
- Paek, I., Cui, M., Gübes, N. O., & Yang, Y. (2018). Estimation of an IRT model by Mplus for dichotomously scored responses under different estimation methods. *Educational and Psychological Measurement*, *78*(4), 569-588.
- Preacher, K. J., & MacCallum, R. C. (2003). Repairing Tom Swift's electric factor analysis machine. *Understanding Statistics*, *2*(1), 13-43.
- Reise, S. P. (2012). The rediscovery of bifactor measurement models. *Multivariate Behavioral Research*, *47*, 667-696.
- Revuelta, J., Maydeu-Olivares, A., & Ximénez, C. (2020). Factor analysis for nominal (first choice) data. *Structural Equation Modeling*, *27*(5), 781-797.
- Savalei, V. (2020): Improving fit indices in structural equation modeling with categorical data. Forthcoming in *Multivariate Behavioral Research*. <https://doi.org/10.1080/00273171.2020.1717922>
- Shi, D., Lee, T., & Maydeu-Olivares, A. (2019). Understanding the model size effect on SEM fit indices. *Educational and Psychological Measurement*, *79*(2), 310-334.

- Sterba, S. K. (2019). Problems with rationales for parceling that fail to consider parcel-allocation variability. *Multivariate Behavioral Research*, 54(2), 264-287.
- Tay, L., & Jebb, A. T. (2018). Establishing construct continua in construct validation: The process of continuum specification. *Advances in Methods and Practices in Psychological Science*, 1(3), 375-388.
- Vandenberg, R. J., & Lance, C. E. (2000). A review and synthesis of the measurement invariance literature: Suggestions, practices, and recommendations for organizational research. *Organizational Research Methods*, 3(1), 4-69.
- Wirth, R. J., & Edwards, M. C. (2007). Item factor analysis: Current approaches and future directions. *Psychological Methods*, 12(1), 58-79.
- Xia, Y. & Yang, Y. (2018) The influence of number of categories and threshold values on fit indices in structural equation modeling with ordered categorical data. *Multivariate Behavioral Research*, 53(50), 731-755.
- Zhang, X. & Savalei, V. (2020) Examining the effect of missing data on RMSEA and CFI under normal theory full-information maximum likelihood, *Structural Equation Modeling*, 27(2), 219-239.

Academic Misconduct:

As a reminder, the University of Iowa College of Education has a formal policy on academic misconduct, which all students in this course are expected to follow. Please consult the instructor if you have questions.

Accommodating Students with Disabilities:

Students with disabilities or who have other special needs are encouraged to contact the instructor for a confidential discussion of their individual needs for academic accommodation.

Respect for Diversity:

It is the instructor's intent that students from ALL backgrounds and perspectives feel welcome and encouraged to participate in this course. There is no such thing as a "stupid" question (or answer). All course participants—enrolled students and auditing visitors—should always feel welcome to ask whatever questions will be helpful in helping them understand and follow the course content. You may do so during class, in office hours, over email, or in individual appointments with the instructor (available by request).

With respect to zoom class sessions, please provide the name you wish for me to call you inside your zoom account (i.e., so that it appears on your window while in use) along with a picture—it can be a real picture, an avatar, or a cartoon—just something I can use to help differentiate you. Student use of cameras and microphones during class is also encouraged but not required (out of respect for your privacy and/or limited bandwidth). Please note that class video recordings streamed to YouTube will NOT include any video from course participants (only the zoom audio and screen share from the instructor will be captured).

The University of Iowa is committed to making the classroom a respectful and inclusive space for people of all gender, sexual, racial, religious, and other identities. Toward this goal, students are invited in MyUI to optionally share the names and pronouns they would like their instructors and advisors to use to address them. The University of Iowa prohibits discrimination and harassment against individuals on the basis of race, class, gender, sexual orientation, national origin, and other identity categories set forth in the University's Human Rights policy. For more information, contact the Office of Equal Opportunity and Diversity (<https://diversity.uiowa.edu/eod>; 335-0705 or diversity.uiowa.edu).

Respect for The Rest of Your World:

The instructor realizes that this course is not your only obligation in your work or your life. If work or life events (expected or unexpected) may compromise your ability to succeed in this course, PLEASE contact

the instructor for a confidential discussion so that we can work together to make a plan for your success. Please do not wait to do so until you are too far behind to catch up!

Planned Schedule of Events for Weeks 1–9:

Week	Date	Topics	Suggested Readings for Each Topic
1	8/24	NO HOMEWORK (HW) OR FORMATIVE ASSESSMENT (FA) DUE	
	8/25	Lecture 1: Introduction to this Course and to Latent Trait Measurement Models	John & Benet-Martinez (2014) Tay & Jebb (2018) Davidson et al. (2016)
	8/27	Lecture 1, continued	
2	8/31	NO HW OR FA DUE	
	9/1	Watch video on your own: Introduction to the Online Homework System Lecture 1, continued Lecture 2: Exploratory Factor Analysis and Principal Components Analysis	Brown (2015) ch. 1-2 Preacher & McCollum (2003) Bollen & Diamantopoulos (2017)
	9/3	Lecture 2, continued Lecture 3: Classical Test Theory for Scale Reliability	McDonald (1999) ch. 5-7
3	9/7	HW0 (for 3 points extra credit) DUE ONLINE BY 11:59 PM	
	9/8	Lecture 3, continued	McNeish (2018)
	9/10	Watch video on your own: Using Mplus on the Ulowa Virtual Desktop Lecture 3, continued Example 3: Classical Items Analysis in SPSS and SAS	
4	9/14	FA1 DUE VIA ICON BY 11:59 PM	
	9/15	Lecture 4: Confirmatory Factor Analysis Example 4: Confirmatory Factor Models in Mplus and SAS MIXED	Brown (2015) ch. 3-5 Ferrando (2009)
	9/17	Lecture 4 and Example 4, continued	Hu & Bentler (1999) McNeish et al. (2018) Shi et al. (2019)
5	9/21	HW1 DUE VIA ICON BY 11:59 PM: Instrument Background	
	9/22	Lecture 4 and Example 4, continued	McNeish & Wolf (2020)
	9/24	Lecture 4 and Example 4, continued	Enders (2010) ch. 3-5
6	9/28	FA2 DUE VIA ICON BY 11:59 PM	
	9/29	Lecture 4 and Example 4, continued	Zhang & Savalei (2019)
	10/1	Lecture 4 and Example 4, continued	
7	10/5	NO HW OR FA DUE	
	10/6	Lecture 4 and Example 4, continued	
	10/8	NO CLASS, BUT OFFICE HOURS AS SCHEDULED Supplemental material for PCA and EFA to review on your own	
8	10/12	HW2 DUE ONLINE BY 11:59 PM: Practice with CFA OPTIONAL REVISION TO HW1 DUE VIA ICON BY 11:59 PM	
	10/13	Lecture 5: Latent Trait Measurement Models for Binary Responses Example 5: Binary Item Response Models in Mplus	Embretson & Reise (2000) ch. 3-4, 7-8
	10/15	FA3 DUE VIA ICON BY 11:59 PM WED 10/14 Lecture 5 and Example 5, continued	Mungas & Reed (2000)
9	10/19	HW3 DUE VIA ICON BY 11:59 PM: CFA on Your Own Data	
	10/20	Lecture 5 and Example 5, continued	Wirth & Edwards (2007) Paek et al. (2018)
	10/22	Lecture 5 and Example 5, continued	Maydeu-Olivares (2015)

Planned Schedule of Events for Weeks 10–17:

Week	Date	Topics	Suggested Readings for Each Topic
10	10/26	FA4 DUE VIA ICON BY 11:59 PM	
	10/27	Lecture 5 and Example 5, continued	
	10/29	Lecture 6: Latent Trait Measurement Models for Other Item Responses Example 6a: Graded Response Models for Ordinal Responses in Mplus	Embretson & Reise (2000) ch. 5
11	11/2	NO HW OR FA DUE	
	11/3	Lecture 6 and Example 6a, continued	Xia & Yang (2018)
	11/5	Lecture 6 and Example 6a, continued	Savalei (2020) Brown (2015) ch. 9
		Example 6b: Measurement Models for Semi-Ordered (Not Applicable) Responses in Mplus Example 6c: Measurement Models for Other Non-Normal Outcomes in Mplus	Revuelta et al. (2020) Huggins-Manley et al. (2017) Bauer & Hussong (2009)
12	11/9	NO HW OR FA DUE	
	11/10	Lecture 7: Measurement Invariance in CFA and Differential Item Functioning in IRT/IFA Example 7a: Multiple-Group Measurement Invariance in CFA using Mplus	Brown (2015) ch. 7 Vandenberg & Lance (2000)
	11/12	HW4 DUE ONLINE BY 11:59 PM: Practice with IRT/IFA Lecture 7 and Example 7a, continued	Asparouhov & Muthén (2014)
13	11/16	OPTIONAL REVISION TO HW3 DUE VIA ICON BY 11:59 PM	
	11/17	Example 7b: Longitudinal Measurement Invariance in CFA using Mplus	Edwards & Wirth (2009)
	11/19	FA5 DUE VIA ICON BY 11:59 PM Lecture 7, continued Example 7c: Multiple-Group Measurement Invariance in IFA using Mplus WLSMV Example 7c: Multiple-Group Measurement Invariance in IFA using Mplus ML	Curran et al. (2014)
14	11/23	NO HW OR FA DUE	
	11/24	NO CLASS, but office hours will be held from 12:30–4:45 PM	
	11/26	NO CLASS OR OFFICE HOURS	
15	11/30	HW5 DUE VIA ICON BY 11:59 PM: IRT/IFA on Your Own Data	
	12/1	Lecture 8: Higher-Order and Method Factor Models Example 8: Higher-Order CFA and IRT Models in Mplus	Brown (2015) ch. 8
	12/3	Lecture 8 and Example 8, continued	Maydeu-Olivares & Coffman (2006); Chen et al. (2006) Reise (2012)
16	12/7	FA6 DUE VIA ICON BY 11:59 PM	
	12/8	Lecture 9: Path Modeling and Structural Equation Modeling Example 9: Structural Equation Modeling in Mplus	MacKinnon (2008) ch. 6 Cole & Preacher (2014)
	12/10	Lecture 9 and Example 9, continued	Curran et al. (2018) Sterba (2019)
17	12/15	NO CLASS, but office hours will be held from 12:30–4:45 PM	
	12/17	NO CLASS, but office hours will be held from 12:30–4:45 PM HW6 DUE ONLINE BY 11:59 PM: Practice with Invariance	
	12/18	OPTIONAL REVISION TO HW5 DUE VIA ICON BY 11:59 PM ALL MUST BE COMPLETED BY 11:59 PM	