**EDUC 707(001) & PSYCH 803 (001): Psychometric Theory: Classical and Latent Trait Models
Fall 2021 Syllabus**

Course location: School of Education, #2328   Matthew A. Diemer, Ph.D
Course time: Wednesday, 1-4pm   Office: 4120 School of Education Building
diemerm@umich.edu *[best way to contact me]*   Phone: 734-647-7369

Course graduate student instructor (GSI): Andres (Andy) Pinedo, anpinedo@umich.edu
Teaching apprentices: Chi-Lin Yu, chilinyu@umich.edu & Carlos Quiroz, cquirozs@umich.edu

Course Overview

This course is designed to provide students with conceptual understanding of psychometric theory and guided analytic experience, using a powerful software package, MPlus. The emphasis in this course is more applied than technical. [Students interested in more technical aspects of and/or advanced extensions of psychometrics are encouraged to talk with the instructor and/or request suggestions for further study.] We will consider psychometric concepts and analyses from the perspective(s) of diversity, equity and social justice. My intent is to help students learn psychometric principles to advance principles of equity and justice in their work.

More specifically, this course provides conceptual understanding of psychometric theory – including classical test theory, latent variable perspectives, and item response theory (IRT) - and guided experience conducting analyses that evaluate the quality of measures. Selected topics, such as instrument validation, are also reviewed.

At the end of this course, students will have the conceptual and syntactic skills to conduct psychometric analyses. However, no single course can provide students with everything they would need to know to handle the inevitable complexities that arise during analyses (including but not limited to psychometric analyses). A second goal of the course is for students to have sufficient conceptual, technical, and syntactic understanding of psychometrics to solve the methodological problems that will come up in your future work by consulting the methodological literature, seeking training, and/or consulting.

Course Format
Every class meeting will be (roughly) split into two parts. In the first 60-75 minutes, we will go over conceptual issues. In the second 60-75 minutes, we will apply these concepts by conducting analyses with MPlus. The instructional team will provide data sets to students in advance.

Required text:
Furr, R. M. (2017). *Psychometrics: An introduction*. SAGE publications.

This user-friendly textbook will be complemented by relevant journal articles, as well as "empirical examples" that illustrate the analytic approach being covered that week.

In the event you want a refresher on a concept for any week, the "Research Methods Knowledge

Base" provides a clear & approachable review of many statistical and measurement concepts. I'd recommend it highly: Trochim, W.M. (2006). The Research Methods Knowledge Base, 2nd Edition. URL: http://www.socialresearchmethods.net/kb/

Finally, the Quantitude Podcast covers a number of psychometric and SEM topics. I'd encourage you to listen for reinforcement of core concepts in this course or exposure to other topics (e.g., mixture models).

Software Requirement
All students will be required to download the free demo version of the MPlus software program. The MPlus demo can be downloaded here. MPlus has become the dominant SEM software package and allows the user to conduct a dizzying variety of analyses – but the good news is that it has fairly intuitive and simple syntax. The MPlus demo version has no limitations on the kinds of analysis you can do, but allows no more than six dependent variables and two independent variables. As a reference, you will need to download the (free) Mplus users guide from the MPlus website: statmodel.com

Students who need the full version of MPlus (which has no restrictions on the number of variables) have four options; the first three assume access to on-campus computing resources. **Option #1:** One Mac and one PC machine in the Brandon Center, located on the 2nd floor of the School of Education, have a full copy of MPlus installed. These machines are available during the Brandon Center's regular business hours. **Option #2**: Room 2035 in East Hall has two machines that have the full version of MPlus installed. My understanding is that this room is open during normal business hours; yet it can only be accessed by Psychology students. **Option #3:** Students interested in purchasing the full version of MPlus may do so and can also use the full version for this course. You may purchase the student version of MPlus for $195 via statmodel.com. **Option #4:** Students can access the full version of MPlus via the University of Michigan's 'Virtual Sites' portal. [One caution: The Virtual Sites may not provide access to the most recent version of Mplus, which may mean your work on the take-home homework assignments may differ from those using the most current version.] The Virtual Sites portal will allow up to four users (on a first come, first served basis – **please keep this in mind close to assignment deadlines**) of MPlus from the UM campus at any one time, and can be accessed via: http://virtualsites.umich.edu

Some data preparation and descriptive analysis using SPSS will also be required. You are free to use Stata, R, or another package that you may be familiar with for these preliminary analyses. Our assignments and in-class work will use the MPlus package.

Course Requirements
- *Class Attendance.* Students should attend every class, except in cases of illness and/or extenuating circumstances.

- *Accommodations for Students with Disabilities.* If you need accommodation(s) for a disability, please speak with me at your earliest convenience. Some aspects of this course may be modified to facilitate your participation and progress. As soon as you make me aware

of your needs, we can work together with the Office of Services for Students with Disabilities (SSD) to help us determine appropriate academic accommodations. SSD (734-763-3000; www.ssd.umich.edu) typically recommends accommodations through a Verified Individualized Services and Accommodations (VISA) form. Any information that you provide is private and confidential and will be treated as such.

- ***Students' Rights and Responsibilities.*** Membership in the academic community that is the University of Michigan affords you a number of important rights, as well as a number of important responsibilities. Please see http://www.oscr.umich.edu/statement/ for information about these rights and responsibilities.

- Each course meeting will be video recorded, using lecture capabilities in the classroom, and made available to all students in this course, via Canvas. As part of your participation in this course, you may be recorded. If you have questions about this, please contact soe.it.support@umich.edu

Course Assignments and Grading
For all written course assignments, standard American Psychological Association (APA) formatting applies (double-spaced, 12 point font, 1 inch margins on all sides, single-sided pages. This excludes the title page, references, and **brief** appendices – although an appendix cannot be used to get around page limits). **Please note that I am strict about enforcing page limits, so that every student has an equal amount of page space to work with.**

Assignments and grading will be as follows, totaling 120 possible course points:

- ***Class Attendance and Participation*** (40 course points): This is a graduate seminar emphasizing critical discussion of course concepts and readings. Active, relevant, and regular participation in class discussions, small group activities, and other in-class exercises is the most important requirement of the class and a vital way for you to actively learn this material. Students should come prepared & attend every class, except in cases of illness and/or extenuating circumstances (please contact me in these instances, such as the need for asynchronous learning).

- ***Commentaries*** (25 course points): Every week that there are assigned readings (beginning in week two, excluding the first week), you will write a brief (2-3 paragraph) commentary on the readings. These commentaries can range from specific methodological questions to integration of concepts across weeks to specific analytic issues. Be sure that you say enough about each reading to demonstrate that you have read them all, but **please do not summarize the readings**. Your goal in this assignment is to say something insightful or novel, while assuming your reader (the instructor) has already read the articles and understands them quite well. A quick way to remember the 'core' of this assignment is to focus on comments, questions, critiques, connections, and concerns raised by the readings. You can "maximize the payoff" of the commentaries if you include one (or more) questions you have about what you've read for that week – something you found confusing or particularly interesting – that

you can raise during our class meeting for further discussion.

Post your commentary on Canvas no later than 3pm (EST) **the day before** (AKA Tuesday) class meets. Late submissions will be penalized.

- *Article Critique* (25 course points): A 3-5 page paper will critique **one** published empirical journal article that uses psychometric approaches to examine issues of diversity, equity, and/or justice. The article should align with your substantive area of interest, and must use a psychometric approach we've covered (e.g., CFA, instrument validation, IRT) as its primary analytic approach. You should select a paper that applies psychometrics to some substantive issue that is of interest to you, rather than a purely technical paper regarding psychometrics. If you'd prefer to review and critique a more technical paper (for example, something published in *Structural Equation Modeling* or *Educational & Psychological Measurement*) you are required to consult with the instructor first. **You may not critique one of the 'empirical examples' that are required readings for this class.**

  Your critique should resemble how peer-reviewed articles are critiqued in that the critique should begin with a **very brief** summary of the paper's intent, methods, major findings, and implications. Your critique **should focus on** (including but not limited to the following): the analyses carried out by the researchers, the strengths and weaknesses of their analytic approach, considering whether a different analytic approach would've been better or provided different answers, and whether the inferences drawn from the analyses are appropriate. In writing your critique, keep in mind that it is easy for you to establish that you've read the paper in a few sentences – so instead devote your (precious) page space toward evaluating the analysis of the paper. It's an obvious point – but be certain to select a paper with an analytic approach that you can understand and offer comments on.

  The critique of an empirical research paper will be **due on December 7th by 4pm EST.** A dropbox will be enabled for the submission of the critique papers on the course Canvas site. When submitting your Critique paper, you are also required to submit a copy of the article being critiqued (in .pdf or other easily accessible format).

- *Homework* (30 course points): At three points during the semester, each student will complete data analyses (outside of class) as 'homework.' A dataset will be provided to you. (I am very open to students applying techniques we are using in this class to their own sources of data for the homework assignments. Please communicate with me if you'd like to do so and we can work together to shape the assignment to your dataset.)

  In these assignments, you will be required to develop the needed Mplus code to carry out the assigned analysis, interpret the output, and complete a brief write-up of your analyses. More information about each of the three homework assignments will be provided, both in class and via the Canvas course management system. Please keep in mind that other students in the course will likely be accessing MPlus via Virtual Sites in the hours before assignment deadlines – so please plan to start assignments well in advance of the deadline.

Course Schedule & Topics

1. **Psychometrics: Why it Matters, How to Understand It & Its Problematic History**
                                                                September 1

2. **Individual Differences, Classical Test Theory & Dataset Prep**   **September 8**

3. **'Mplus Day'**   **September 15**

4. **Exploring Dimensionality: Exploratory Factor Analyses (EFA)**   **September 22**
       ---Homework Assignment #1 due by September 30---

5. **Known Factor Structures: Confirmatory Factor Analyses (CFA)**   **September 29**

6. **Reliability: Widely Known, Poorly Understood**   **October 6**
         ---Homework Assignment #2 due by October 7th---

7. **Instrument Development & Validation**   **October 13**

8. **Bias & Fairness**   **October 20**

9. **Measurement Invariance**   **October 27**

10. **Guest lecture: Dr. Nolan Cabrera**   **November 3**
          ---Homework Assignment #3 due by November 4th---

11. **Item Response Theory (IRT): Part I**   **November 10**

12. **Item Response Theory (IRT): Part II**   **November 17**

12. **CLASS CANCELLED – THANKSGIVING HOLIDAY**   **November 24**

14. **Psychometric Workshop**   **December 1**
          ---Article Critique due December 7th by 5pm EST---

Course Schedule & Readings
[Listed by suggested order of reading, for each week]
[All articles provided, many with instructor annotation, in Canvas]
[For approachable intro to many concepts, see: http://www.socialresearchmethods.net/kb/]

**1. Psychometrics: Why it Matters, How to Understand It & Its   September 1
    Problematic History**
- Furr, CHs 1 & 2
- Chapter 1, in Bonilla-Silva, E. & Zuberi, T. (2008). *White logic, White methods: Racism and methodology*. Rowman & Littlefield Publishers, INC. Access ebook here

2. Individual Differences, Classical Test Theory & Dataset Prep   September 8
- Furr, CH 3¶
- Guidance on importing datasets from SAS, SPSS or Stata into MPlus
- Also required: Brief guide on preparing datasets for MPlus, posted to Canvas

3. 'MPlus Day'   September 15
- Intro to MPlus syntax
- Odum Institute Mplus Syntax Handout, posted to Canvas
- 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),* 1-55.

4. Exploring Dimensionality: Exploratory Factor Analyses (EFA)   September 22
- Furr, CH 4
- Preacher, K. J., & MacCallum, R. C. (2003). Repairing Tom Swift's electric factor analysis machine. *Understanding statistics: Statistical issues in psychology, education, and the social sciences*, *2*(1), 13-43.
- Empirical example: Duffy, R.D., Diemer, M.A., Perry, J.C. & Laurenzi, C., Torrie, C. (2012). The construction and initial validation of the Work Volition Scale. *Journal of Vocational Behavior; 80(2)*, 400-411.¶
- Intro to Mplus EFA syntax & interpretation
- Sample Mplus EFA output, annotated
- Recommended (hyperlinked): Principal components or factor analysis?

5. Known Factor Structures: Confirmatory Factor Analyses (CFA)   September 29
- Furr, CH 12
- Empirical example: Diemer, M.A., Li, C., Gupta, T., Uygun, N., Sirin, S. & Rogers-Sirin, L. (2014). Pieces of the immigrant paradox puzzle: Measurement, level, and predictive differences in precursors to academic achievement. *Learning & Individual Development, 33,* 47-54. [*skim the measurement invariance section*]
- MPlus: CFA syntax and interpretation
- Recommended: Byrne, B.M. (2012). Testing the factorial validity of scores from a measuring instrument: First-order confirmatory factor analysis model. Chapter posted on Canvas as .pdf
- Recommended: Flora, D. B., & Flake, J. K. (2017). The purpose and practice of exploratory and confirmatory factor analysis in psychological research: Decisions for scale development and validation. *Canadian Journal of Behavioural Science / Revue canadienne des sciences du comportement, 49*(2), 78–88. https://doi.org/10.1037/cbs0000069

6. Reliability: Widely Known, Poorly Understood   October 6
- Streiner, D. L. (2003). Starting at the beginning: An introduction to coefficient alpha and internal consistency. *Journal of Personality Assessment, 80(1),* 99-103.
- Furr, CH 5 & CH 6 (skim section on difference scores, p. 175-185)
- McNeish, D. (2018). Thanks coefficient alpha, we'll take it from here. *Psychological Methods*, *23*(3), 412.

7. Instrument Development & Validation   October 13
- Worthington, R. L., & Whittaker, T. A. (2006). Scale development research: A content analysis and recommendations for best practices. *The Counseling Psychologist*, *34*(6), 806-838.
- Empirical example: Diemer, M.A., Rapa, L.J., Park, C. & Perry, J.C. (2017). Development and validation of the Critical Consciousness Scale. *Youth & Society, 49(4)*, 461-483.
- Recommended: Clark, L. A., & Watson, D. (1995). Constructing validity: Basic issues in objective scale development. *Psychological Assessment*, *7*(3), 309.
- Recommended: 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, 166-184.
- Recommended: Wetzel, E., & Roberts, B. W. (2020). Commentary on Hussey and Hughes (2020): Hidden invalidity among 15 commonly used measures in social and personality psychology. *Advances in Methods and Practices in Psychological Science, 3(4),* 505-508.

8. Bias & Fairness: MIMIC Models   October 20
- Furr & Bacharach, CH 10 & CH 11 (stop at p. 359)
- Helms, J. E. (2006). Fairness is not validity or cultural bias in racial-group assessment: A quantitative perspective. *American Psychologist*, *61*(8), 845-859.
- Empirical example: Diemer, M. A., Voight, A. M., Marchand, A. D., & Bañales, J. (2019). Political identification, political ideology, and critical social analysis of inequality among marginalized youth. *Developmental Psychology*, *55*(3), 538.
- Recommended: Helms, J. E. (1992). Why is there no study of cultural equivalence in standardized cognitive ability testing? *American Psychologist*, *47*(9), 1083.

9. Measurement Invariance   October 27
- Putnick, D. L., & Bornstein, M. H. (2016). Measurement invariance conventions and reporting: The state of the art and future directions for psychological research. *Developmental Review*, *41*, 71-90.
- Mplus code: Freeing and constraining parameters
- Recommended: Schmitt, N., & Kuljanin, G. (2008). Measurement invariance: Review of practice and implications. *Human Resource Management Review, 18(4),* 210–222.
- Empirical example: Diemer, M.A., Li, C., Gupta, T., Uygun, N., Sirin, S. & Rogers-Sirin, L. (2014). Pieces of the immigrant paradox puzzle: Measurement, level, and predictive differences in precursors to academic achievement. *Learning & Individual Development, 33¸* 47-54.
- Empirical example: Diemer, M.A., Wang, Q., Moore, T., Gregory, S., Hatcher, K. & Voight, A.M. (2010). Sociopolitical development, work salience, and vocational expectations among low-SES African American, Latin American, and Asian American youth. *Developmental Psychology*, *46(3)*, 619-635. [Read the MI testing and multi-group analysis sections that you skipped before!]

10. Guest lecture: [Dr. Nolan Cabrera]   November 3

- Cabrera, N. L., & Chang, R. S. (2019). Stats, social justice, and the limits of interest convergence: The story of Tucson Unified's Mexican American Studies litigation. *The Association of Mexican American Educators Journal, 13(3),* 72-96. (special issue Education, law and the courts: Communities in the struggle for equality and equity in public education)

11. Item Response Theory (IRT): Part I   November 10
- Furr, CH 14 *(skim Rasch modeling section)*
- Reeve, B.B. (2002). An introduction to modern measurement theory. *National Cancer Institute, p. 1-19; 55-67. (Skim: "A brief history of IRT" section)*

12. Item Response Theory (IRT): Part II   November 17
- De Champlain, A. F. (2010). A primer on classical test theory and item response theory for assessments in medical education. *Medical Education, 44 (1)*, 109-117. *(focus on IRT section)*
- Re-read: Furr section re: Graded Response Model – p. 393-5
- Empirical example: Diemer, M.A., Frisby, M.B., Pinedo, A., Bardelli, E., Elliot, E., Harris, E.M., McAlister, S. & Voight, A.M. (in press). Validation of the Short Critical Consciousness Scale (ShoCCS). *Applied Developmental Science.*
- Recommended: (Thissen, Ackerman, Ho, Wainer & Thissen articles) in *Journal of Educational and Behavioral Statistics* (2016), *41(1)*, ranging across pages 91-108.

12. Class cancelled - Thanksgiving Holiday   November 24

14. Psychometric Workshop   December 2