2021 Fall PSYC557 (Psychometric Methods)

2021 FALL
PSYCHOMETRIC METHODS (PSYC 557)

PROFESSOR: Philseok Lee, Ph.D.
LECTURES: T, TR: 12:00-1:15 pm
CLASSROOM: Horizon Hall 5001

OFFICE HOURS: Tues 1:30 pm - 2:30 pm or by appointment
OFFICE: 3056 David King Hall
EMAIL: plee27@gmu.edu

COURSE OBJECTIVES:
This course will cover the foundations of classical test theory and modern test theory, including reliability/validity theory, exploratory factor analysis (EFA), confirmatory factor analysis (CFA), item response theory (IRT), and their various applications. Lectures will introduce psychometric concepts and demonstrate psychometric data analysis using the R program. Note, it is vital that you not only attend lectures and do assignments, but also that you devote ample time and effort to readings so that you can acquire an in-depth understanding of the material. Although it is unlikely that you will “master” all of the material by the end of the semester, you should leave with some applied skills related to scale development and validation and an understanding of the theory needed for advanced study in related areas.

TEXTBOOK
   *Although this course has a textbook, I will not solely rely on this textbook. I will cover various topics from various reading materials.

OTHER USEFUL REFERENCES
SOFTWARE:
R is chosen as the statistical software for this course, recognizing the growing importance of R programming in psychometrics as well as its great utility in modeling. Sample R codes will be provided for most of the examples so that you can try R programming on your own and gain hands-on experience. You can download R (https://www.r-project.org/) and R studio (https://www.rstudio.com/products/rstudio/download/).

Here are some useful materials for R:
- Quick-R https://www.statmethods.net/
- Cookbook for R http://www.cookbook-r.com/

COURSE STRUCTURE, REQUIREMENTS, AND GRADING:

1. Participation, Attendance, and Attitude:
   It will count 10% toward your final grade.
   - I expect that you will attend every class meeting and engage during class sessions.
   - This is a subjective evaluation.

2. Homework:
   There will be 6 homework assignments. The homework assignments will count 60% toward your final grade. Each homework will count as 10% of your final grade.
   Submit your assignments by noon on the due date. Assignments received after noon will be late.
   - You will lose 10% for each day the assignment is late (with the first day beginning after 12:00 pm the day it was due).
   - Homework submitted more than a week late will not be accepted and a grade of zero will be given.
   - You are free to discuss the assignments with other students in the class. However, you MUST complete the work INDEPENDENTLY.

3. Quiz:
   Quizzes will count 10% toward your final grade.
   - There will be 10 quizzes (multiple-choice and/or short-answer)
   - Each quiz will count as 1% of your final grade.
   - Quizzes will be about concepts or applications from your class materials and reading materials.
   - Quizzes will be administered via Blackboard self-assessment. This should be an INDEPENDENT work. Thus, you SHOULD NOT discuss with other students.

4. Final Project:
   The group project will count 20% toward your final grade. The course culminates with a final project, completed throughout the semester in a small group. Students must craft a well-defined research question and then identify and analyze real datasets to answer that question. Please find
any dataset that suits your research interests. If you cannot find a real dataset, you can use an archived dataset from [https://openpsychometrics.org/_rawdata/](https://openpsychometrics.org/_rawdata/) for your final project.

**Project Overview**

The final Project will give you the chance to explore a topic of your choice and to expand your psychometric analytical skills. By working with real data of your choosing you can examine questions of particular interest to you. You will work in teams of 2 students to conceive of and carry out an analysis project.

The broad objectives for the project are to:

- Identify the problems and goals of a real situation and dataset.
- Choose an appropriate approach for formalizing and testing the problems and goals, and be able to articulate the reasoning for that selection.
- Implement your analysis choices on the dataset.
- Interpret the results of the analyses.
- Contextualize those results within a greater scientific and social context, acknowledging and addressing any potential issues related to psychometrics.
- Work effectively to manage a project as part of a team.

**Guidelines for Project Proposal**

The Project Proposal should be 1-2 pages (single-space, 12 pts). The Proposal template can be found in Appendix 1. Your proposal must include the following sections:

- **NAMES:** Be sure to include each member’s name
- **RESEARCH QUESTION:** What is your research question/hypotheses? Include the specific question you're setting out to answer. This question should be specific, answerable with data, and clear.
- **BACKGROUND AND/OR PRIOR WORK:** Present the background and context of your topic (i.e., a brief literature review) and question in a few paragraphs. Include a general introduction to your topic and then describe what information you currently know about the topic after doing your initial research. Include references to other projects who have asked similar questions or approached similar problems. Explain what others have learned in their projects.
- **DATA:** Describe the datasets you would like to explore.
  - What is the source?
  - What variables do you have?
  - How they were collected?
  - How many observations do you have?
  - What/who are the observations? Over what time period? etc.
- **TEAM EXPECTATIONS:** Include your group’s expectations of one another for the successful completion of your project. Discuss how your team will communicate throughout the semester.
Guidelines for Project Submission

- Students should choose their research topic of interest and found a dataset. Conduct various psychometric analyses. **You should submit the final paper by December 10th noon.** Follow the SIOP Poster Session format (A summary with a maximum of 3,000 words. But, references, tables, and figures do not count toward the limit). You can find detailed information from [https://www.siop.org/Annual-Conference/Registration-and-Resources/Call-for-Proposals/Preparing-and-Formatting-Your-Proposal-Document](https://www.siop.org/Annual-Conference/Registration-and-Resources/Call-for-Proposals/Preparing-and-Formatting-Your-Proposal-Document)
- The project submission includes all the codes used for all components of your project, as well as written final paper and data visualizations.
- Check Points
  - **ABSTRACT:** Summarizing your group’s project and results.
  - **NAMES:** See proposal specifications.
  - **RESEARCH QUESTION:** See proposal specifications.
  - **BACKGROUND & PRIOR WORK:** See proposal specifications.
  - **DATASET(S):** Describe your dataset
  - **DATA CLEANING:** Describe your process (if any)
  - **DATA ANALYSIS & RESULTS:** For examples:
    - What psychometric analyses did you use? Why?
    - What were the results?
    - What was your interpretation of these findings?
  - **DATA VISUALIZATION** - There must be appropriate data visualizations throughout these sections. Each visualization must include an interpretation of what is displayed and what should be learned from that visualization. Be sure that the appropriate type of visualization is generated given the data that you have, axes are all labeled, and the visualizations clearly communicate the point you’re trying to make.
  - **CONCLUSION & DISCUSSION:** Discuss your project. Summarize your data and question. Briefly summarize your results and conclusions. Be sure to discuss any theoretical and practical implications of your findings and mention any limitations of your project.

### Grading:

<table>
<thead>
<tr>
<th>Grading</th>
<th>Percentage (%)</th>
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<tbody>
<tr>
<td>Participation, Attendance, and Attitude</td>
<td>10%</td>
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<tr>
<td>Homework</td>
<td>60%</td>
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<td>Quiz</td>
<td>10%</td>
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<tr>
<td>Final Project</td>
<td>20%</td>
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<td>Total</td>
<td>100%</td>
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Letter grades will be determined according to the following scheme:

- A+ 98-100%
- A  93-97.9%
- A-  90-92.9%
- B+ 87-89.9%
- B  83-86.9%
- B-  80-82.9%
- C+ 77-79.9%
- C  73-76.9%
- C-  70-72.9%
- D+ 67-69.9%
- D  63-66.9%
- D-  60-62.9%
- F Below 60%
Failure to complete course requirements:
Students who miss a small portion of the course due to an excused absence may be given a grade of Incomplete (I). However, failure to complete the required work by the end of the following semester will result in a grade of F.

Missing class due to religious observances:
Students who anticipate the necessity of being absent from class due to the observation of a major religious observance must provide notice of the date(s) to the instructor, in writing.

ACADEMIC INTEGRITY

Homework: You can discuss and work on assignments as a group, but each student must turn in his/her own results and interpretation. For example, when analyzing data, students might discuss how to approach a problem, run their own analyses, and independently write up the results. Simply copying someone else’s answers verbatim is unacceptable and will be subject to zero credit.

Quiz: Students must work alone on each quiz. If you have questions about problems or potential solutions, consult with your instructor only.

Failure to follow these guidelines may be viewed as evidence of academic dishonesty, which can result in a grade of FF for the course and other penalties through the University System.

DISABILITY SERVICES

Disability Services at George Mason University is committed to providing equitable access to learning opportunities for all students by upholding the laws that ensure equal treatment of people with disabilities. If you are seeking accommodations for this class, please first visit http://ds.gmu.edu/ for detailed information about the Disability Services registration process. Then please discuss your approved accommodations with me. Disability Services is located in Student Union Building I (SUB I), Suite 2500. Email: ods@gmu.edu | Phone: (703) 993-2474

IMPORTANT DATES
Please check Fall 2021 – Drop / Withdrawal Deadline Changes from this link
https://registrar.gmu.edu/calendars/fall_2021/

First day of fall classes: August 23
Last day to add a class: August 30
Last day to drop (with 100% tuition refund): September 7
Thanksgiving Recess: November 24 (Wed) – November 28 (Sun)
Last day of classes: December 4
Reading Day(s): December 6 – December 7
COURSE SCHEDULE, QUIZ, ASSIGNMENT

*Note: Reading materials will be provided for each class.
*While we certainly will try to adhere to this schedule, we may need to rearrange things a bit during the semester.

<table>
<thead>
<tr>
<th>Week</th>
<th>Date</th>
<th>Topic</th>
<th>Reading</th>
<th>Quiz/Homework</th>
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<tr>
<td>1</td>
<td>24-Aug</td>
<td>Course Orientation</td>
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<td></td>
<td>26-Aug</td>
<td><strong>Introduction to Psychometrics</strong></td>
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<td>26-Aug</td>
<td>Non-required reading (of potential interest)</td>
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<td>2</td>
<td>1-Sep</td>
<td><strong>Basic Understanding of Linear Algebra, Correlations, Covariance 1</strong></td>
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<td>Furr, CH3, CH11</td>
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<td>Non-required readings (of potential interest)</td>
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<td>2. Orrù, G., Monaro, M., Conversano, C.</td>
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<td>Date</td>
<td>Topic</td>
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<td>2-Sep</td>
<td>Basic Understanding of Linear Algebra, Correlations, Covariance 2</td>
<td>Furr, CH3, CH11</td>
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<td>Non-required readings (of potential interest)</td>
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<td>1. Glass &amp; Hopkins, CH.7</td>
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<td>2. Glass &amp; Hopkins, CH.8</td>
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<td>3. Glass &amp; Hopkins, CH.14</td>
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<td>7-Sep</td>
<td>Basic Understanding of Linear Algebra, Correlations, Covariance 3</td>
<td>Furr, CH5</td>
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<td>Quiz 1</td>
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<td>3. Glass &amp; Hopkins, CH.14</td>
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<td>3-Sep</td>
<td>Reliability: Reliability Models and Estimation</td>
<td>Furr, CH6</td>
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<td>Non-required readings (of potential interest)</td>
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<td>1. Allen &amp; Yen, CH3</td>
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<td>known but poorly understood. Organizational Research Methods,</td>
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<td>18(2), 207-230.</td>
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<td>to reliability coefficients. Organizational Research Methods.</td>
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<td>First published on July 4, 2016.</td>
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<td>of theory and application. Journal of Applied Psychology, 78,</td>
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<td>J. L. Farr, &amp; N. T. Tippins (Eds.). Handbook of</td>
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### 14-Sep

**Reliability2: Empirical Estimates of Reliability**

Non-required readings (of potential interest)

1. Allen & Yen, CH4
2. APA IO Handbook CH2

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### 16-Sep

**Reliability3: The Importance of Reliability**

Non-required readings (of potential interest)

1. McDonald, CH6-7
3. Crocker & Algina, CH14

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**Quiz 2**

H1 Out (Classical Test Theory, Reliability)


<table>
<thead>
<tr>
<th>Date</th>
<th>Exploratory Factor Analysis 1</th>
<th>Furr, CH4</th>
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<tr>
<td>21-Sep</td>
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<td></td>
<td>1. Exploratory and Confirmatory Factor Analysis, Kline, Chapter 6.</td>
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<td>2. APA IO Handbook CH5</td>
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<td>3. Crocker &amp; Algina, CH13</td>
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<tr>
<th>Date</th>
<th>Exploratory Factor Analysis 2</th>
<th>Furr, CH4</th>
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<tbody>
<tr>
<td>23-Sep</td>
<td>Non-required readings (of potential interest)</td>
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</table>
### Exploratory Factor Analysis 3

**Data Analysis Example**

**Non-required readings (of potential interest)**


<table>
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<tr>
<th>Date</th>
<th>Reading Details</th>
<th>Assignments</th>
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<tbody>
<tr>
<td>30-Sept</td>
<td><strong>Validity1: Conceptual Basis</strong></td>
<td>Furr, CH8</td>
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<td></td>
<td>Non-required readings (of potential interest)</td>
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<td>3. Allen &amp; Yen, CH5</td>
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<td>4. Crocker &amp; Algina, CH10</td>
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<td>5. APA IO Handbook CH4</td>
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<tr>
<td>5-Oct</td>
<td><strong>Validity2: Estimating and Evaluating Validity</strong></td>
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<td>Non-required readings (of potential interest)</td>
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<td></td>
<td>1. Crocker &amp; Algina, CH11</td>
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<tr>
<td>7-Oct</td>
<td><strong>Validity3: Estimating and Evaluating Validity (cont’)</strong></td>
<td>Quiz 4 H2 Due</td>
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<td>Non-required readings (of potential interest)</td>
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| 8 | **12-Oct** | **Confirmatory Factor Analysis 1**  
Non-required readings (of potential interest)  
1. McDonald CH9  
2. McDonald CH10  
**H3 Out**  
(Validity) |
| 9 | **19-Oct** | **Confirmatory Factor Analysis 2**  
Non-required readings (of potential interest)  
1. McDonald, CH11  
**H3 Due** |
| 10 | **27-Oct** | **Applications of CFA 1: Omega Coefficient, Factorial Validity, Multifactor**  
Non-required readings (of potential interest)  
**H3 Due**  
Quiz 5 |


### Applications of CFA 2: Higher-order, bifactor, Schmid-Leiman models, exploratory structural equation modeling (ESEM)

### Non-required readings (of potential interest)


### 10  26-Oct  Applications of CFA 3: Test-level Measurement Invariance Testing  Furr, CH11  H4 Due
### (Multigroup CFA)

**Non-required readings (of potential interest)**


<table>
<thead>
<tr>
<th>Applications of CFA 4: Item-level Invariance Testing (MACS and/or MIMIC)</th>
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<td><strong>28-Oct</strong></td>
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<td>Non-required readings (of potential interest)</td>
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### Quiz 7

H4 Due

Proposal Due

<table>
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<tr>
<th>Applications of CFA 5: Further topics</th>
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<tr>
<td><strong>11 2-Nov</strong></td>
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<tr>
<td>Non-required readings (of potential interest)</td>
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<tr>
<th>Item Response Analysis 1: IRT Models</th>
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<tr>
<td><strong>4-Nov</strong></td>
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<tr>
<td>Furr, H5 Out</td>
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</table>
### Non-required readings (of potential interest)

4. Embretson & Reise, CH 1-5
5. Drasgow & Hulin, Intro to IRT

### Item Response Analysis 1: Estimation & Calibration

Non-required readings (of potential interest)


### Item Response Analysis 3: Item & Test Information & Model Fit & Parallel Test

Non-required readings (of potential interest)

1. Embretson & Reise, CH 7-10
2. APA IO Handbook CH6 & CH7

### Quiz

- **Quiz 8**: CH14
- **Quiz 9**: H6 Due
# Differential Item Functioning (DIF) 1

**Non-required readings (of potential interest)**


4. Crocker & Algina, CH16

5. APA IO Handbook CH8

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# Differential Item Functioning (DIF) 2

**Non-required readings (of potential interest)**


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# Further topics of IRT: Computerized Adaptive Testing

**Organizational Psychology and Organizational Behavior, 3, 469-490.**


<table>
<thead>
<tr>
<th>Date</th>
<th>Event</th>
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<tbody>
<tr>
<td>25-Nov</td>
<td><strong>Thanksgiving Recess (No Class)</strong></td>
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<tr>
<td>15 Nov</td>
<td><strong>Class Presentation 1</strong></td>
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<tr>
<td>2-Dec</td>
<td><strong>Class Presentation 2</strong></td>
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<tr>
<td>16 Dec</td>
<td><strong>Reading Day (No Class)</strong></td>
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<tr>
<td>9-Dec</td>
<td><strong>Final Project Paper Due (by Noon)</strong></td>
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</tbody>
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Appendix 1: Project Proposal

Names and G-number:
- Student A
- Student B

Research Question:
- Fill in your research question here

Background and Prior Work:
- Fill in your background and prior work here. Be sure to specify which statements are from which references.

Data:
- Explain the ideal dataset you would want to answer this question. (This should include: What variables? How many observations? Who/what/how would these data be collected? How would these data be stored/organized?)

Team Expectations:
- Team Expectation 1
- Team Expectation 2
Appendix 2: Final Project Checklist
You can use this checklist to help guide your thinking on the final project. If you check off all the boxes below, you should be in good shape to get a perfect score on your final project.

Abstract:
- Write a clear summary of what you did
- Briefly describe the results of your project

Research Question:
- Include a specific, clear psychometric research question
- Make sure what you're measuring (variables)

Background & Prior Work:
- Include a general introduction to your topic
- Include an explanation of what work has been done previously
- Include citations or links to previous work

Dataset(s):
- Include an explanation of dataset(s) used

Data Visualization:
- Include data visualizations
- Clearly label all axes on plots
- Type of all plots appropriate given data displayed
- Interpretation of each visualization included in the text

Data Analysis & Results:
- Clearly describe your psychometric methods
- Report and interpret your results.

Conclusion & Discussion:
- Make a clear conclusion
- Discuss theoretical and practical implications of your findings
- Discuss limitations of the analysis and future research topic