

## PSYCHOMETRICS – Code 800158

Academic Year 2024-25

### COURSE INFORMATION

**Undergraduate Studies:** 0812 – Degree in Psychology (Studies Plan 2009-10)

**Type:** Compulsory

**ECTS:** 6.0

**Module:** Basic Psychological training

**Area:** Assessment and psychological diagnosis

**Year:** Second

**Semester:** 2

### INSTRUCTOR INFORMATION

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**Office number:** Room 2105-O

**Office hours:** Thursdays, 10:00 to 14:00

### SYNOPSIS

#### COMPETENCIES

##### General competencies

GC6: Know and understand research methods and data analysis techniques.

GC14: Prepare oral and written psychological reports in different areas of activity.

##### Transversal competencies

TC1: Analysis and synthesis.

TC2: Preparation and defence of properly reasoned arguments.

TC3: Problem solving and decision making in Psychology.

TC5: Looking for information and data interpretation on social, scientific and ethical topics related to the field of Psychology.

TC6: Team work and collaboration with other professionals

TC7: Critical thinking and self-analysis.

TC9: Communication skills, learning how to communicate ideas to both, professional and non-professional audiences.

##### Specific competencies

SC17: Be able to measure and obtain relevant data for the evaluation of interventions.

SC18: Know how to analyse and interpret results of evaluations.

SC19: Know how to appropriately and accurately provide feedback to recipients.

### TEACHING ACTIVITIES

#### CLASS SESSIONS

Class attendance is expected and useful for discussions not available elsewhere. I will present the topics in class with the help of slides. You will have copies of these slides (see below), which include text, formulas, and graphical displays. I will also illustrate the concepts and their implications with realistic exercises. Some practical class sessions will also involve computations with Microsoft Excel and other specialized software that is freely available.

#### MODULE MATERIALS

A booklet with printed copies of all the slides that I will use in class sessions is available at the copy shop (currently located in the Logopedia building; location may change). The booklet also includes a selected set of exercises with answers. These exercises are meant to help you practice and prepare for the exam. You are expected to complete the exercises over the

semester, but **they will not be graded**. I will also post additional materials in the Psychometrics site on Campus Virtual along the semester and each new posting will be announced in class.

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## ECTS BREAK-DOWN

This module is worth 6 ECTS, which implies 150 hours broken down as follows:

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- 60 hours for class sessions (40% of the time).
  - 75 hours for your own work (50% of the time).
  - 15 hours for assessment (10% of the time).
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## BRIEF DESCRIPTION:

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### PRE-REQUISITES

**Proficiency in statistics and probability is required to follow the module adequately.** If you need to brush up on your statistics, read Crocker & Algina's chapter 2 (*Statistical Concepts for Test Theory*) or Allen & Yen's chapter 2 (*A Review of Basic Statistical Concepts*). [Full references below.]

## OBJECTIVES

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### TOPICS

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Topics listed in [blue](#) are covered discretionarily:

1. Psychometrics: Goals and historical notes
2. Test types and item formats
3. Item scores, test scores, and score scales
4. The process of test construction
5. Classical Test Theory
6. Reliability, and factors affecting it
7. Validity, and factors affecting it
8. Classical item analysis
9. Item Response Theory. 1. Models
10. [Item Response Theory. 2. Parameter estimation](#)
11. [Response biases](#)
12. [Test equating](#)
13. [Test score bias and differential item functioning](#)
14. [Computerized adaptive testing](#)
15. [Generalizability theory](#)

## LEARNING GOALS

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The measurement of psychological attributes with suitable psychometric tests is key to valid and dependable psychological research and to effective and responsible psychological practice. The goal of this module is to raise your awareness of crucial aspects of psychometric measurement and test quality and to provide you with the formal (methodological and statistical) tools needed to develop new tests and to judge the appropriateness of existing tests to accomplish well-defined purposes. This breaks down into the following learning goals:

1. Get acquainted with the goals of psychological measurement and with the main difficulties and challenges that accompany the task of constructing and using psychometric tests for this purpose.
2. Become familiar with the different types of item that a test can be made of and the various formats under which the items can be administered.

3. Become familiar with different types of item scoring rules, test scoring rules, and types of reference norms for score interpretation.
4. Know all the steps that must be followed to construct a test.
5. Get acquainted with the statistical foundations of test development under Classical Test Theory and know the statistical tools used for the assessment of the psychometric properties of tests.
6. Get acquainted with the concepts of reliability and validity of measurement and know the statistical tools used of assess such properties of test scores.
7. Get acquainted with the psychometric properties of individual items and know the statistical tools used to assess them so as to take appropriate action.
8. Know the basics of Item Response Theory as an alternative to Classical Test Theory for the development of tests and the assessment of the psychometric properties of tests and items.

By the end of the semester you should be able to fully understand (almost) everything that is described (and the jargon used for that purpose) on the typical journal paper reporting the development and psychometric properties of a test that was newly created or modified in some way out of an existing test. For comparison, check out how much of that you understand at this point (i.e., when this course has just started) by glancing over the papers listed under "Sample papers on test development" in the Psychometrics site on Campus Virtual.

## ASSESSMENT

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Module grades arise from two sources: a final exam and a project/presentation that you will complete over the semester.

### Final exam

An open-note exam will be administered at the end of the semester. The exam will consist of practical exercises thoroughly analogous to those at the end of the booklet of slides. You must bring a calculator and statistical tables, and **you may bring around 10 hand-written sheets only including formulas**. You **must** bring a picture ID as proof of identity. The exam earns you a maximum of 6 points. A minimum score of 2 points on the exam is necessary (but not sufficient) to pass this module.

You should keep in mind that successfully answering the questions on the exam requires that you have developed specific problem-solving skills. You are unlikely to acquire such skills over a few crash study sessions right before the exam. Continued work throughout the semester is essential to develop those skills. Solving the exercises at the end of the booklet mentioned above should help you get in shape for the exam.

### Project/presentation

You will also be evaluated on the basis of a project that you will carry out throughout the semester, and for which you will give a presentation to the rest of the class at the end of the semester. Your active participation with questions or comments during the discussion that will follow each presentation is also required. This activity earns you an absolute maximum of 4 points, although some simple projects will not earn you that maximum. You may decide to carry out your project individually or in a team with other classmates, but I will impose limits on the size of each team according to the project you choose to carry out. I am open to hearing about project proposals of any suitable type but, in principle, you have a choice among:

- a) Development of a test or questionnaire for some attribute of your interest. Your instrument must be original, although other instruments may have already been developed to measure the same attribute. Development must follow all the steps in test construction, namely, creation of items, collection of data, reliability and validity studies, item analysis, and norming. You must also write a report (15–20 pages long, excluding figures) and present your results to the rest of the class at the end of the semester.

- b) Essay write-up. This involves preparing an essay paper (15–20 pages long, excluding references) on a selected topic (e.g., alternative scoring modes for multiple-choice tests, item-writing rules, response biases, research on the optimal number of choices per item, review of psychometric properties of some test across studies, ...). Suitable topics will become apparent during the first few class sessions but feel free to ask me about your own proposals. You must also give a presentation to the rest of the class at the end of the semester.
- c) Software presentation. This involves getting acquainted with one of the many freeware tools that have been developed to address computational issues in psychometrics. You must also write a short report (15–20 pages long) and give a presentation that should take the form of a practical class session similar to those that you will see me give. Some suitable software tools are listed in the booklet of slides, but others are also available and acceptable.

Individuals or teams **must discuss their project choice with me during the week that starts on February 10th, at the latest.** I will understand that you refuse continuous assessment if I do not hear from you by February 17th. I must approve the team size and I will notify you of the maximum number of points that your project will be worth. You must then brief me on your progress regularly during the semester so I can monitor your work and assess your performance. Completing your project will take time and it is advisable that you start early and work on it steadily throughout the semester. The number of times we have to meet is not predefined as this depends on the difficulties you encounter, but you must keep me up to date on your progress and discuss with me the decisions that you make along the way. **Without this regular interaction, your project will not be graded.**

Subject to potential changes, and pending assignment of final dates, project presentations will take place during the evening hours (3 pm to 7 pm) from May 5th to May 9th. Twenty-minute presentations will be arranged to fill up the four hours in each session. You must attend all the presentations given in the session where your own is scheduled, and you are expected to contribute to the ensuing discussion. **The written report of your project is due on May 16th** but it is advisable that you have it ready by the time of your presentation so you can easily make changes or additions according to the discussion that will follow your presentation. A tool will be made available in due time for you to upload your written report (and data file, if applicable) to the Psychometrics site on Campus Virtual.

#### **Final module grade**

Your final module grade will be based on the sum of the points earned on the exam (a maximum of 6) and the points earned on your project/presentation (a maximum of 4). If your score on the exam is at least 2 points, grades will be assigned according to your sum score (ranging from 0 to 10) on the following scale:

[0–5]: Suspenso (SS)

[5–7]: Aprobado (AP)

[7–9]: Notable (NT)

[9–10]: Sobresaliente (SB)

No passing grade is required on the project/presentation, but note that you will receive a failing grade (SS) if you do not earn at least 2 points on the exam regardless of your score on the project. Note also that you will not get a grade beyond AP if you do not carry out a project.

If you do not pass the module in May, there will be a resit examination in June but there is not a second chance for a project. However, if you did work on a project during the semester and gave a presentation but you did not get the maximum score it was worth, you have the option to improve your written report and upload the new version to the Psychometrics site on Campus Virtual by the date of the resit. An additional oral presentation is not required in these cases.

## Plagiarism and cheating

Plagiarism or cheating are breaches of academic integrity and are penalized. Cheating on the final exam results in dismissal from the exam and an automatic failing grade on the module. The penalty for copying word for word or cutting and pasting material from other sources into your written report is to fail the assignment, with no consequences on your score on the exam.

## RESOURCES

There is no set text, but almost all textbooks on Psychometrics cover the module topics adequately. The following books are all available in the library (or free to download). If you want to rely on a single source, Crocker & Algina's book is the best pick to my taste.

Crocker, L. & Algina, J. (1986). *Introduction to classical & modern test theory*. New York: Holt, Rinehart and Winston. [Reprinted by Cengage Learning, Mason, OH, 2006.]

Gulliksen, H. (1950). *Theory of mental tests*. New York: Wiley. [Reprinted by Erlbaum, Hillsdale, NJ, 1987.]

de Gruijter, D.N.M. & van der Kamp, L.J.Th. (2008). *Statistical test theory for the behavioral sciences*. Boca Raton, FL: Chapman & Hall.

Allen, M.J. & Yen, W.M. (1979). *Introduction to measurement theory*. Monterey, CA: Brooks/Cole. [Reprinted by Waveland Press, Long Grove, IL, 2002.]

Domino, G. & Domino, M.L. (2006). *Psychological testing: An introduction*, 2nd ed. Cambridge: CUP. <https://ebookcentral.proquest.com/lib/universidadcomlutense-ebooks/detail.action?docID=261147>

Furr, R.M. (2018). *Psychometrics. An introduction* (3rd edition). Los Angeles, CA: Sage.

McDonald, R.P. (1999). *Test theory: A unified treatment*. Mahwah, NJ: Erlbaum.

Baker, F.B. (2001). *The basics of item response theory* (2nd edition). College Park, MD: ERIC. Free download at <https://files.eric.ed.gov/fulltext/ED458219.pdf>

Hambleton, R.K. & Swaminathan, H. (1985). *Item response theory: Principles and applications*. Boston, MA: Kluwer-Nijhoff.

The following table lists chapters in each book that cover each of the module topics:

	Psycho-metrics	Test types & item formats	Scores & scales	Test construction	Classical test theory	Reliability	Validity	Item analysis	IRT models	IRT Parameter estimation	Response biases	Test equating	Test bias & DIF
Crocker & Algina	ch. 1		ch. 5, 17 & 19	ch. 4	ch. 6	ch. 7	ch. 10	ch. 14	ch. 15	ch. 15		ch. 20	ch. 16
Gulliksen			ch. 18		ch. 2, ch. 3	ch. 4, 6, 7, 8, 10, 15 & 16	ch. 9 & 11	ch. 21				ch. 19	
de Gruijter & van der Kamp					ch. 2	ch. 3 & 4	ch. 7	pp. 92–98	ch. 9	ch. 9		ch. 11	pp. 182–189
Allen & Yen		ch. 6	ch. 7	ch. 6	ch. 3	ch. 4	ch. 5		ch. 11				
Domino & Domino	ch. 1 & 19	ch. 2	ch. 2	ch. 2		ch. 3	ch. 3				ch. 16		ch. 11
Furr	ch. 1	ch. 1	pp. 58–71	pp. 208–216		ch. 5–7	ch. 8–9		ch. 14		ch. 10		ch. 11
McDonald		ch. 2	ch. 3 & 4		ch. 5	ch. 6 & 7	ch. 10	ch. 11	ch. 12 & 13			ch. 16	
Baker									✓	✓			
Hambleton & Swaminathan									✓	✓			

The following books (in Spanish) are available in the library and are a good source of exercises:

Barbero García, M.I. & García-Cueto, E. (1988). *Psicometría: Problemas*. Madrid: UNED.

García Cueto, E. (1993). *Introducción a la psicometría*. Madrid: Siglo XXI.

Hogan, T.P. (2004). *Pruebas psicológicas. Una introducción práctica*. México: Manual Moderno.

Martínez Arias, M.R. (1996). *Psicometría: Teoría de los tests psicológicos y educativos*. Madrid: Síntesis.

- Martínez Arias, M.R., Hernández Lloreda, M.J. & Hernández Lloreda, M.V. (2006). *Psicometría*. Madrid: Alianza.
- Muñiz, J. (1996). *Teoría clásica de los tests*. Madrid: Pirámide.
- Muñiz, J. (1990). *Teoría de respuesta a los ítems: Un nuevo enfoque en la evaluación psicológica y educativa*. Madrid: Pirámide.
- Muñiz, J. (1997). *Introducción a la teoría de respuesta a los ítems*. Madrid: Pirámide.
- Muñiz, J., Fidalgo, M., García-Cueto, E., Martínez, R. & Moreno, R. (2005). *Análisis de los ítems*. Madrid: La Muralla.
- Santisteban Requena, C. (1990). *Psicometría. Teoría y práctica en la construcción de tests*. Madrid: Norma.
- Santisteban Requena, C. (2009). *Principios de psicometría*. Madrid: Síntesis.

There is also relevant audiovisual material available online. The *National Council on Measurement in Education* (<https://www.ncme.org>) produces videos, "print modules", and "digital modules" some of which cover topics included in this course. Videos are plain and short (7–10 minutes each) audiovisual introductions to the topic that each addresses; print modules are printed material with exercises; and digital modules are video-narrated slides that also include practical demonstrations, exercises, and quizzes. This material is freely available on the ITEMS (I**n**structional T**o**pics in E**d**ucational M**e**asurement S**e**ries) portal at <https://www.ncme.org/itemsportal>. The following items from this source are useful (and recommended) for this course:

Video 2: Reliability, validity, and fairness  
 Video 3: Standardized test development  
 Video 4: Standardized test scoring

Module 04: Formula scoring for multiple-choice tests  
 Module 07: Comparison of 1-, 2-, and 3-parameter IRT models  
 Module 08: Reliability in Classical Test Theory  
 Module 09: Standard error of measurement  
 Module 16: Comparison of Classical Test Theory and Item Response Theory  
 Module 35: Polytomous Item Response Theory models

Digital Module 01: Reliability in Classical Test Theory  
 Digital Module 08: Foundations of operational item analysis  
 Digital Module 30: Validity and educational testing: Purposes and uses of educational tests