

# Psychometrics

## (Spring 2013)

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### Pre-requisites

**Proficiency in statistics and probability is required to follow the course 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.]

### Topics

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

### Textbooks

There is no set text, but almost all textbooks on Psychometrics cover the course topics adequately. The following books are all available in the library (or free to download). Crocker & Algina is your best pick as a reference book. The table under the list of textbooks enumerates relevant chapters in each book for each of the course topics.

- 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.]
- Furr, R.M. & Bacharach, V.R. (2008). *Psychometrics. An introduction*. Thousand Oaks, CA: Sage. [As of January 18, 2013, chapters 5, 9, and 13 of this book can be freely downloaded at <http://www.sagepub.com/booksProdDesc.nav?prodId=Book228888&#tabview=samples> ]

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.

(originally published in 1985). Free download at <http://echo.edres.org:8080/irt/baker/final.pdf>

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

	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				
Furr & Bacharach	ch. 1		pp. 46-60		ch. 5	ch. 6 & 7	ch. 8 & 9		ch. 13		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 (all in Spanish) are also available in the library and are a good source of exercises.

Barbero García, M.I. & García-Cueto, E. (1988). *Psicometría: Problemas*. Madrid: Universidad Nacional de Educación a Distancia.

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, A.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.

### ECTS break-down

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

- 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).

## Class sessions

Class attendance is expected but is not mandatory. I will present the course 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 under Microsoft Excel and other specialized, for-free software tools.

## Course materials

A booklet with printed copies of all the slides that I will show in class sessions is available at the copy shop (located on the ground floor in Pabellón Lateral I). 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 on the course website (where you got this document from) along the semester and each new posting will be announced in class.

## Assessment

Course 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. You must bring a calculator and statistical tables, and *you may bring up to five two-sided hand-written pages only including formulas*. You **must** bring a picture ID as proof of identity. The exam earns you a maximum of 6 points. A passing score of 2 points on the exam is required to pass this course.

You should keep in mind that successfully answering the questions in 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, which will consist of analogous exercises.

### 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. This activity is not mandatory but earns you an absolute maximum of 4 extra points, although some simple projects (see below) 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. 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 (10–15 pages long) and present your results to the rest of the class at the end of the semester. [maximum: 4 points.]
- b) Participation in the process of data collection for the instruments being developed by other classmates (if any). This only involves administering the instrument to members of the target population and handing in the response sheets. [maximum: 2 points.]

- c) Essay write-up. This involves preparing an essay paper (10–15 pages long) 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, ...). Suitable topics will become apparent during the first few class sessions. You must also give a presentation to the rest of the class at the end of the semester. [maximum: 3 points.]
- d) Software presentations. This involves getting acquainted with one of the many software tools that have been developed to address computational issues in psychometrics. You must also write a short report (4–6 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. [maximum: 3 points.]

Individuals or teams **must discuss their choice with me during the week starting on February 25**. I will understand that you give up on your option for these extra points if I do not hear from you by March 4. 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 subsequently brief me on your progress regularly so I can monitor your performance and give you feedback.

Subject to potential changes, project presentations are scheduled for May 27 and 28. The written report of your project is due on June 14 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.

### **Final course grade**

Your final course 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 final exam regardless of your score on the project/presentation. Note also that you cannot get a grade beyond AP if you decide against getting involved in a project/presentation.