**Digital Module 05: Diagnostic Measurement: The G-DINA Framework**

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Available in the ITEMS Portal at https://ncme.elevate.commpartners.com

## Module Overview

In this ITEMS module we introduce the generalized deterministic inputs, noisy "and" gate (G-DINA) model, which is a general framework for specifying, estimating, and evaluating a wide variety of cognitive diagnosis models. The module contains a non-technical introduction to diagnostic measurement, an introductory overview of the G-DINA model as well as common special cases, and a review of model-data fit evaluation practices within this framework. We use the flexible GDINA R package, which is available for free within the R environment and provides a user-friendly graphical interface in addition to the code-driven layer. The digital module also contains videos of worked examples, solutions to data activity questions, curated resources, a glossary, and quizzes with diagnostic feedback.

*Key words: Diagnostic measurement, cognitive diagnosis models (CDMs), diagnostic classification models (DCMs), G-DINA framework, GDINA R package, model fit, model comparison, Q-matrix validation*

## Prerequisite Knowledge

This ITEMS module assumes no prior knowledge of cognitive diagnosis models. However, to get the most out of this module, it might be beneficial to have:

- basic knowledge of educational assessments (e.g., assessments, items)
- basic understanding of different variable types and scales (e.g., continuous, discrete, dichotomous, polytomous)
- basic understanding of the distinction between observed variables and latent variables
- working knowledge of the basic models and practices of item response theory
- practical experience with analyzing item response data using descriptive statistics
- practical experience with using R for data analysis (optional)

## Learning Objectives

Upon completion of this ITEMS module, learners should be able to:

- Understand the basic principles and ideas behind diagnostic measurement
- Understand the similarities and differences between IRT and diagnostic models
- Understand the structure and properties of the G-DINA model framework
- Specify various diagnostic models as special cases of the G-DINA model
- Investigate model diagnostics using various statistical procedures
- Conduct diagnostic analyses using the GDINA R package and interpret the results

After completion of this module, learners might wish to take additional ITEMS modules on other diagnostic measurement frameworks. Check out the ITEMS Portal webpage for up-to-date information on available ITEMS modules!

## Module Structure

The module is divided into the following sections, which can be reviewed sequentially or independently [*approximate completion times in parentheses*].

- Module Introduction [*10 Minutes*]
- Section 1: Conceptual Foundations [*15 Minutes*]
- Section 2: G-DINA Framework [*15 Minutes*]
- Section 3: Model Diagnostics [*15 Minutes*]
- Section 4: R Implementation [*20 Minutes*]
- Section 5: Data Activity [*30 Minutes*]
- Section 6: Quizzes [*10 Minutes*]

## Module Components

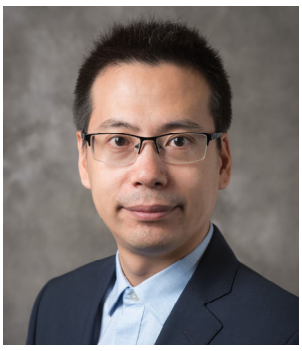
This ITEMS module includes the following components, which are delivered within a unified design shell that is compatible across platforms (i.e., laptops, desktops, tablets, cell phones) and was created with modern course development software (*Articulate 360*):

- integrated content slides that provide a structured walk-through of the content with suitable voice-over
- embedded didactic videos to demonstrate software implementations
- interactive quiz questions with diagnostic feedback
- data activity sample data, code, and annotated solutions
- glossary of key terms
- supplementary digital resources

Additional materials may be added over time so check back periodically!

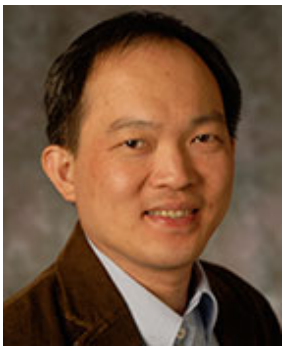
## Content Developers

**Wenchao Ma**, *Assistant professor at the University of Alabama*



Wenchao is an assistant professor in the Educational Research program in the Department of Educational Studies in Psychology, Research Methodology, and Counseling at the University of Alabama. He received his Ph.D. from Rutgers, The State University of New Jersey. His research interests lie in educational and psychological measurement in general, and item response theory and cognitive diagnosis modeling in particular. Wenchao was a recipient of the 2017 Bradley Hanson Award for Contributions to Educational Measurement given by the National Council on Measurement in Education as well as the 2018 Outstanding Dissertation Award given by the American Educational Research Association.

**Jimmy de la Torre**, *Professor at the University of Hong Kong*



Jimmy is a Professor at the Faculty of Education at The University of Hong Kong. His research interests include latent variable models for educational and psychological measurement and how to use assessment to improve classroom instruction and learning. His recent work includes the development of various cognitive diagnosis models, implementation of estimation codes for cognitive diagnosis models, and development of the G-DINA framework for model estimation, test comparison, and Q-matrix validation, which is the focus of this module. He is an ardent advocate of CDM, and, to date, has conducted more than a dozen national and international CDM workshops. Jimmy was a recipient of the 2008 Presidential Early Career Award for Scientists and Engineers given by the White House, the 2009 Jason Millman Promising Measurement Scholar Award, and the 2017 Bradley Hanson Award for Contributions to Educational Measurement awarded by the National Council on Measurement in Education (NCME).

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**Instructional Design Team**

**André A. Rupp**, *Research Director at the Educational Testing Service (ETS)*

André is a research director in the psychometrics, statistics, and data sciences area at ETS. He is the co-author and co-editor of two award-winning interdisciplinary books entitled *Diagnostic Measurement: Theory, Methods, and Applications* (2010) and *The Handbook of Cognition and Assessment: Frameworks, Methodologies, and Applications* (2016). His research synthesis- and framework-oriented work has appeared in a wide variety of prestigious peer-reviewed journals. Among other things, he is passionate about improving processes for interdisciplinary collaborations during the development and implementation of scoring solutions for digitally-delivered assessments. Consequently, he is very excited to serve as the associate editor / lead instructional designer of the ITEMS portal for NCME whose mission is to provide free digital resources to support self-directed learning and professional development.

**Xi Lu**, *Doctoral Candidate at Florida State University*

Xi is a doctoral candidate in the Instructional Systems and Learning Technologies program at Florida State University. Her current research interest focuses on designing and developing optimal learning supports to facilitate STEM learning in digital interactive environments. She also works as a research assistant with Dr. Val Shute on an NSF project targeted at designing various learning supports for a 2D physics game called *Physics Playground* to help middle school kids learn physics. Before coming to FSU, Xi taught Chinese for six years in Monterey Bay, California.

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