

Quantitative Methods for Small Scale Interventions

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Access slides at
www.matthewmadison.com/workshop

Talk Overview

- A little about me and the QMC
- Designs and methods for interventions
 - » Empirical demonstration
 - » Survey design
- Scaling up
 - » Instrument validation and psychometrics
- Conclusions

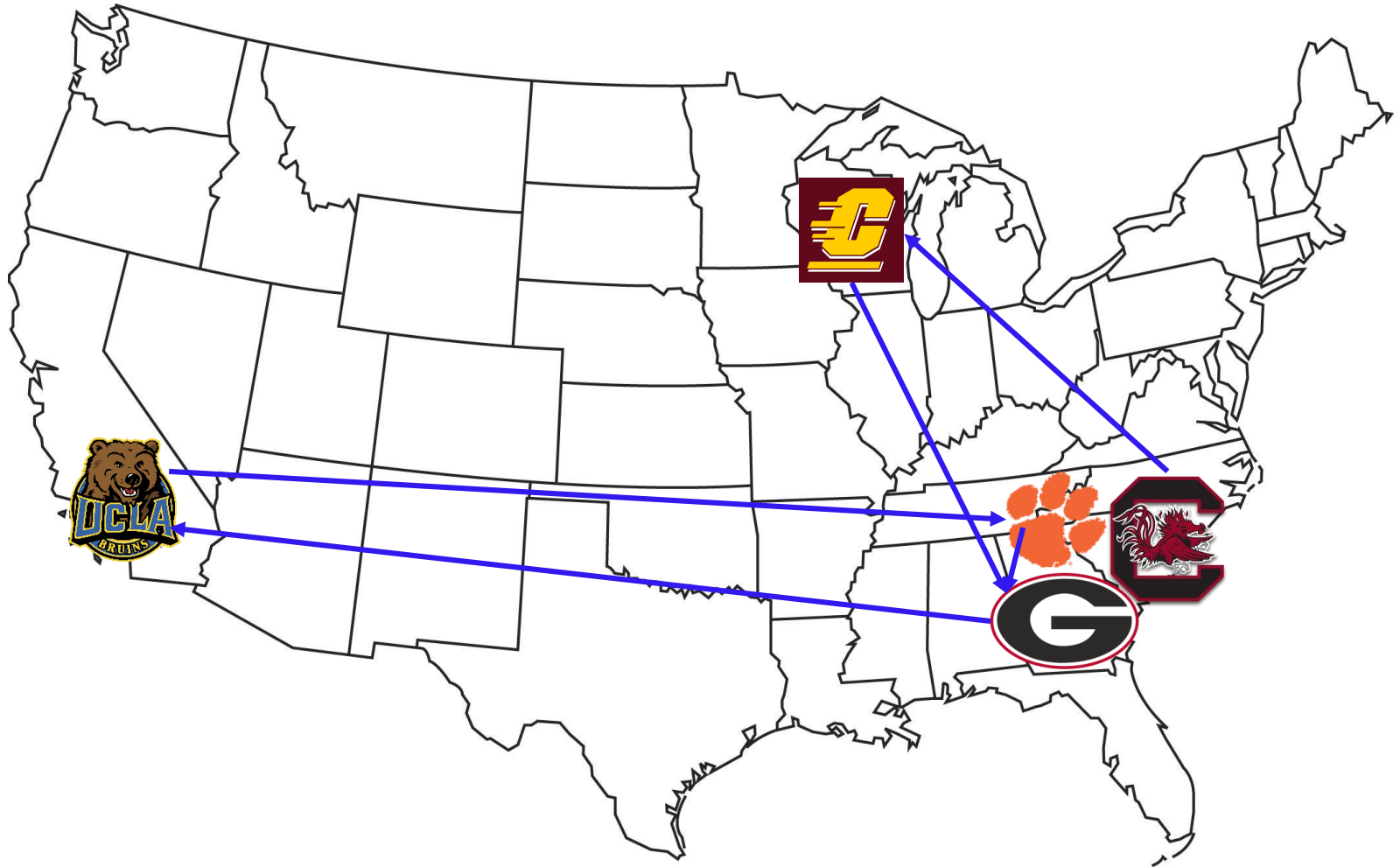


A Little About Me

- From Columbia, South Carolina
- Research interests: psychometrics
- Hobbies: sports (basketball, golf), true crime



My Journey Summary



Quantitative Methods Consulting Center (QMC)

- QMC purpose is to provide quantitative research support and training for members of the MFECO
- QMC Team



Matthew Madison

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Nancy Alila

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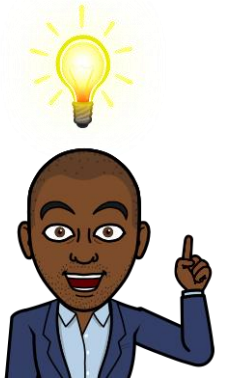
Ph.D. Student in
Quantitative
Methodology,
QMC Research
Assistant

Quantitative Methods Consulting Center (QMC)

- **Services include, but not limited to:**
 - Research design
 - Statistical analysis
 - Software support
 - Survey and assessment development
 - Grant proposal preparation
 - Manuscript preparation
 - Methods workshops
- Free for graduate students
- Five free hours of service for MFECOE and friends doing educational research

Evaluating Interventions

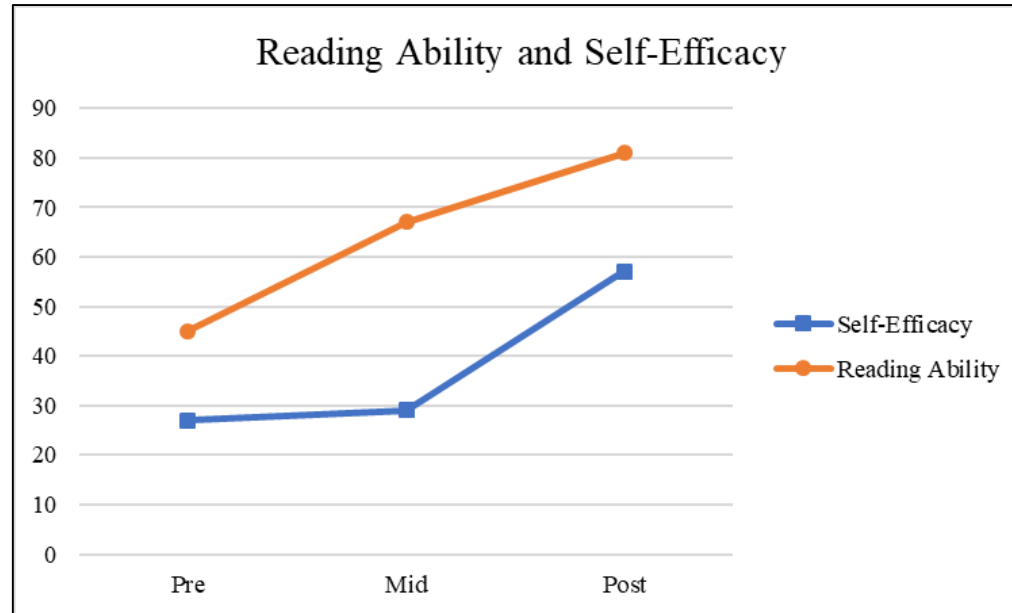
- Suppose you're interested in evaluating an instructional method or product
 - » Does the method improve student outcomes?
 - » How does the method compare to traditional methods?
- Potential designs:
 - » Observational, single-case design
 - » Quasi-experimental design



Quasi-Experimental Designs

- Manipulation of groups or conditions
- Pre-test post-test design
 - » Give pre-test
 - » After instruction, give post-test
 - » Evaluate the growth
- Statistical methods:
 - » Paired t-test or repeated measures ANOVA: compares pre-test scores to post-test scores
 - » Hypothesis test for time effect: did outcome change over time?
 - » Effect size: more meaningful interpretation of observed effects (small-medium-large thresholds)

Pre-test Post-test Design



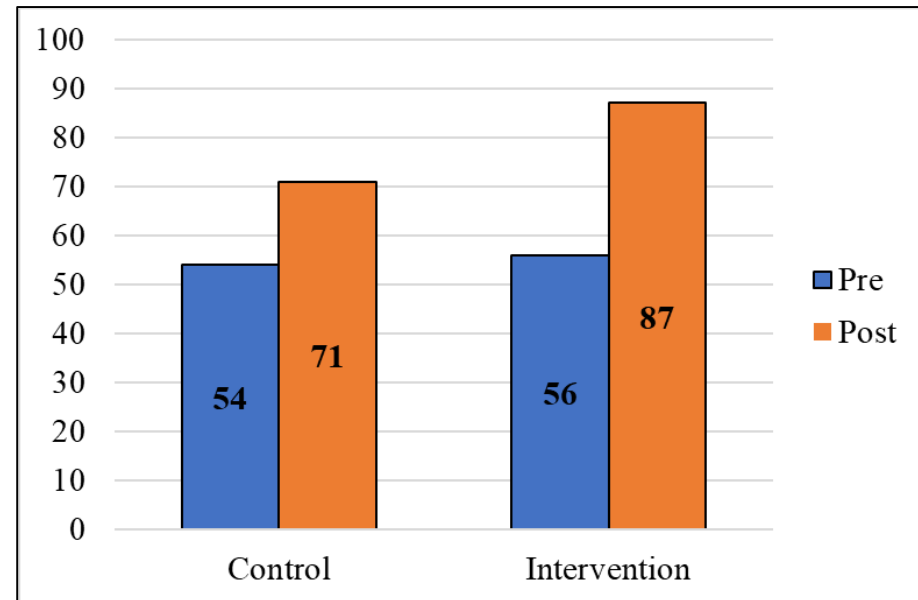
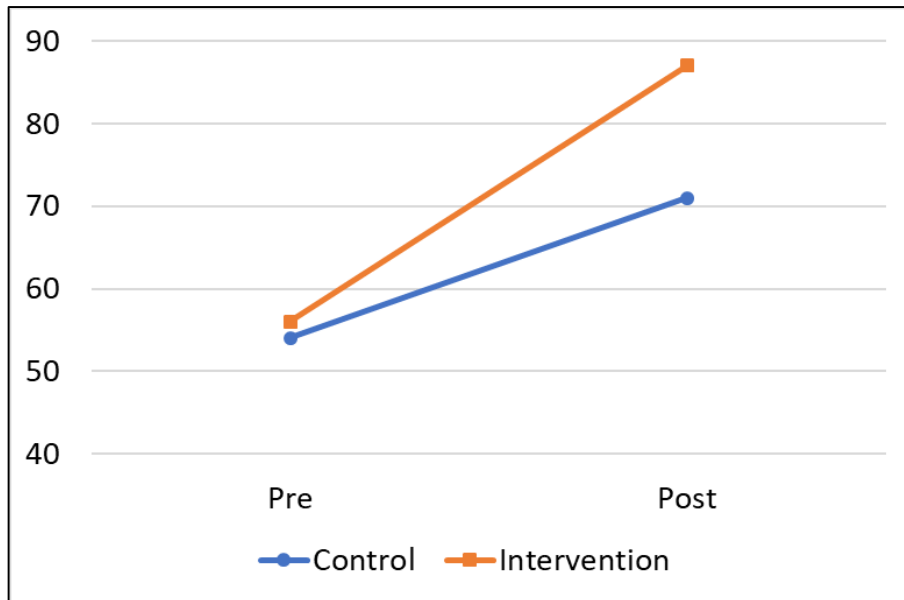
- Statistical methods:
 - » Hypothesis test for time effect: did SE increase? Did reading ability increase?
 - » Follow-up: Pre vs Mid? Mid vs Post?

Quasi-Experimental Designs

- **Control group** pre-test post-test design
 - » Give pre-test to both groups
 - » After instruction, give post-test to both groups
 - » Evaluate and compare the growth
- Statistical methods:
 - » Mixed ANOVA:
 - Hypothesis test for time: change over time?
 - Hypothesis test for groups: group mean difference?
 - **Hypothesis test for time*groups: were growth patterns the same for all groups?**

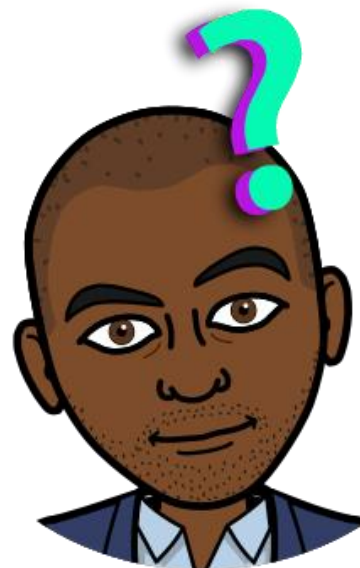
Quasi-Experimental Designs

- Hypothesis test for time: change over time?
- Hypothesis test for groups: group mean difference?
- Hypothesis test for time*groups: were growth patterns the same for all groups?
- Include an effect size estimate with hypothesis tests (Cohen's d)



Survey Design Basics

- Suppose you want to measure social-emotional outcomes
 - » Self-efficacy
 - » Engineering identity
 - » Mathematics anxiety

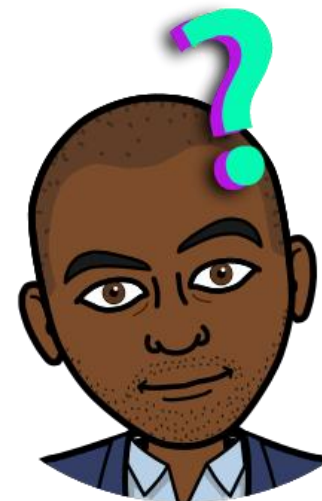


Survey Design Basics

- Define your constructs
 - » Outline objectives and population/sample
 - » Operationalize the construct
- Look for validated measures
- Design and adapt items
 - » Use simple and plain language
 - » Avoid double negatives or confusing language

Survey Design Basics

- Item types
 - » Likert items (strongly disagree – strongly agree)
 - » Multiple-choice
 - » Open-ended
- Pilot your survey and get feedback
 - » Subject matter experts
 - » Members of the population



Scaling Up

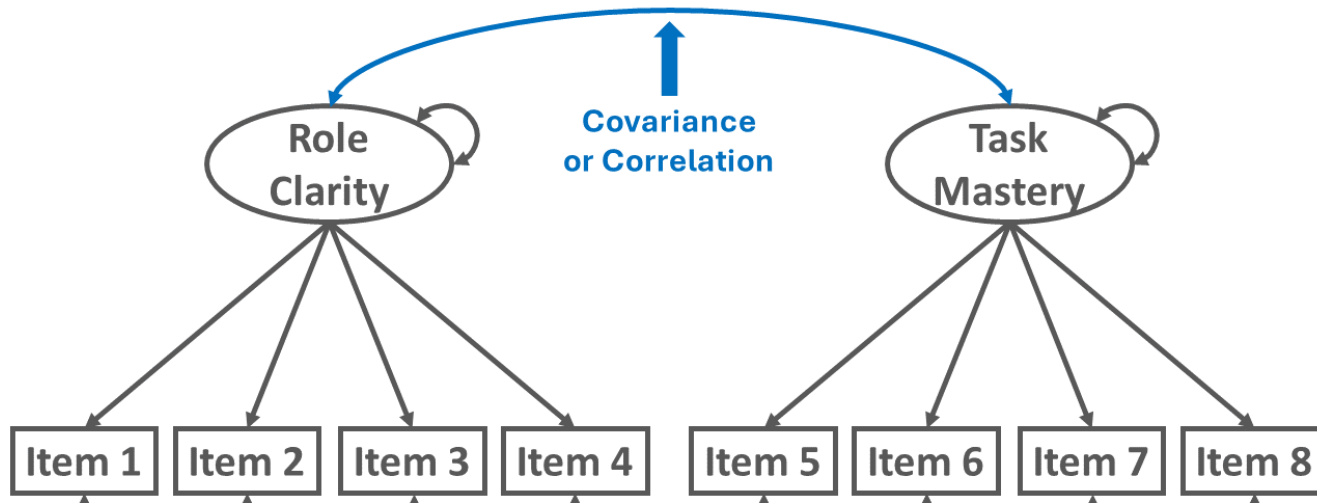
- You've finished a small scale evaluation
 - » Showed some positive results
- Now you want to scale up and conduct a larger study
 - » Apply for an external grant
 - » Larger sample – power analysis
 - » More data collection and nuance

Large Scale Educational Interventions

- With a larger sample, comes ability for more sophisticated methods
- Instrument validation:
 - » Develop a new instrument to measure a unique construct
- **Factor analysis:**
 - » **Latent variable analysis that supports instrument validation**

Factor Analysis

- Factor analysis:
 - » Latent variable analysis that supports instrument validation
 - » Indicate the number of factors, how they are related, and how they load onto items
 - » Assess reliability (consistency)



Large Scale Educational Interventions

- With a larger sample, comes ability for more sophisticated methods
- Instrument validation:
 - » Develop a new instrument to measure a unique construct
- Factor analysis:
 - » Latent variable analysis that supports instrument validation
- **Psychometric modeling:**
 - » **Latent variable analysis designed to evaluate educational assessments and estimate student knowledge**

Psychometric Models

- Two predominant frameworks:
 - » Item response theory (IRT): assumes continuous latent trait
 - » Diagnostic classification models (DCMs): assumes categorical latent traits

Item Response Theory

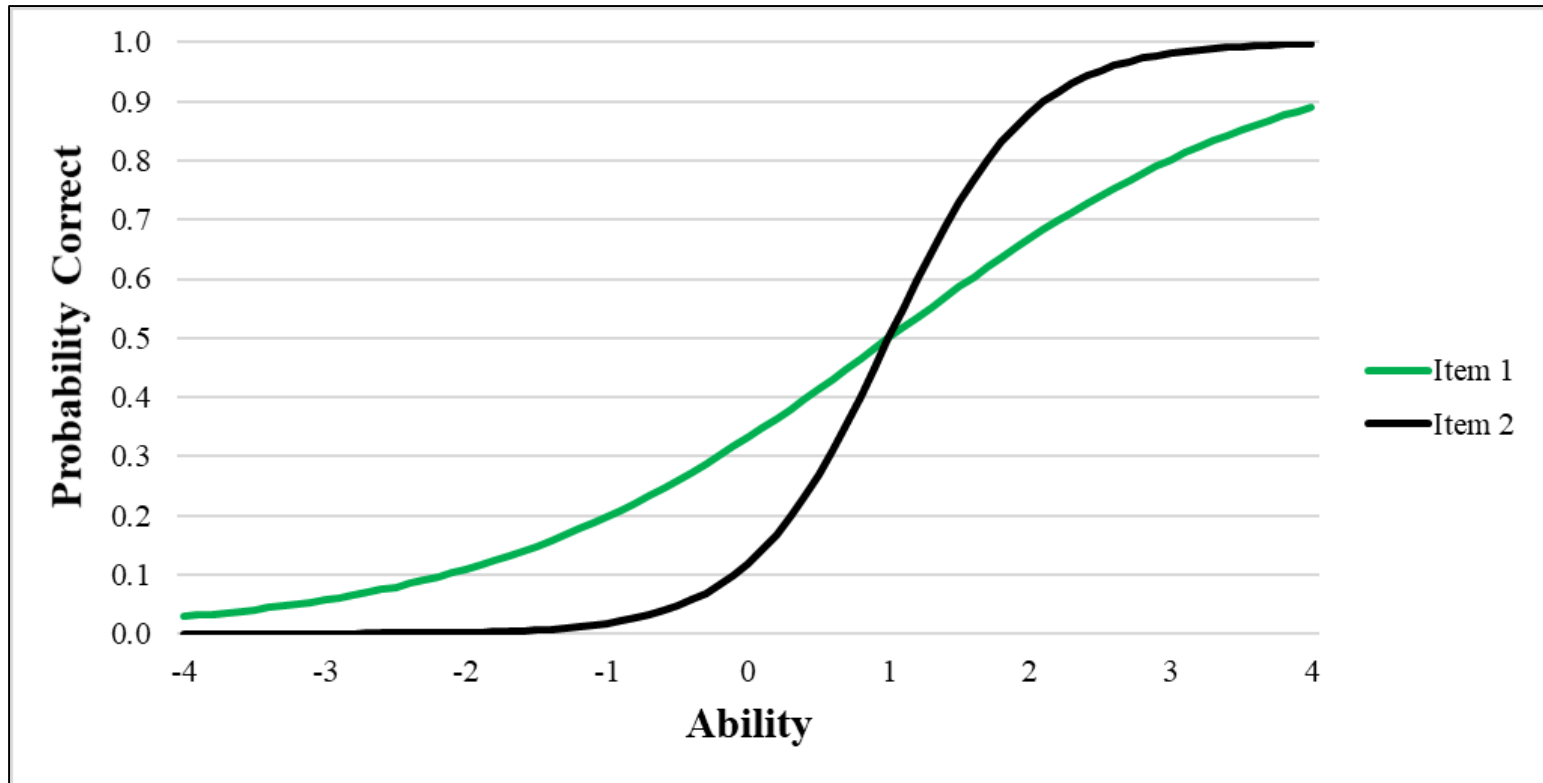
- All large scale assessments use IRT
 - » SAT, ACT, GRE, all K – 12 standardized tests
 - » Goal is to rank students (percentile ranking)
- IRT model serves two purposes
 - » Evaluate quality of items and tests
 - » Provide estimates of student ability

Item Response Theory



Basketball Ability

Item Response Theory



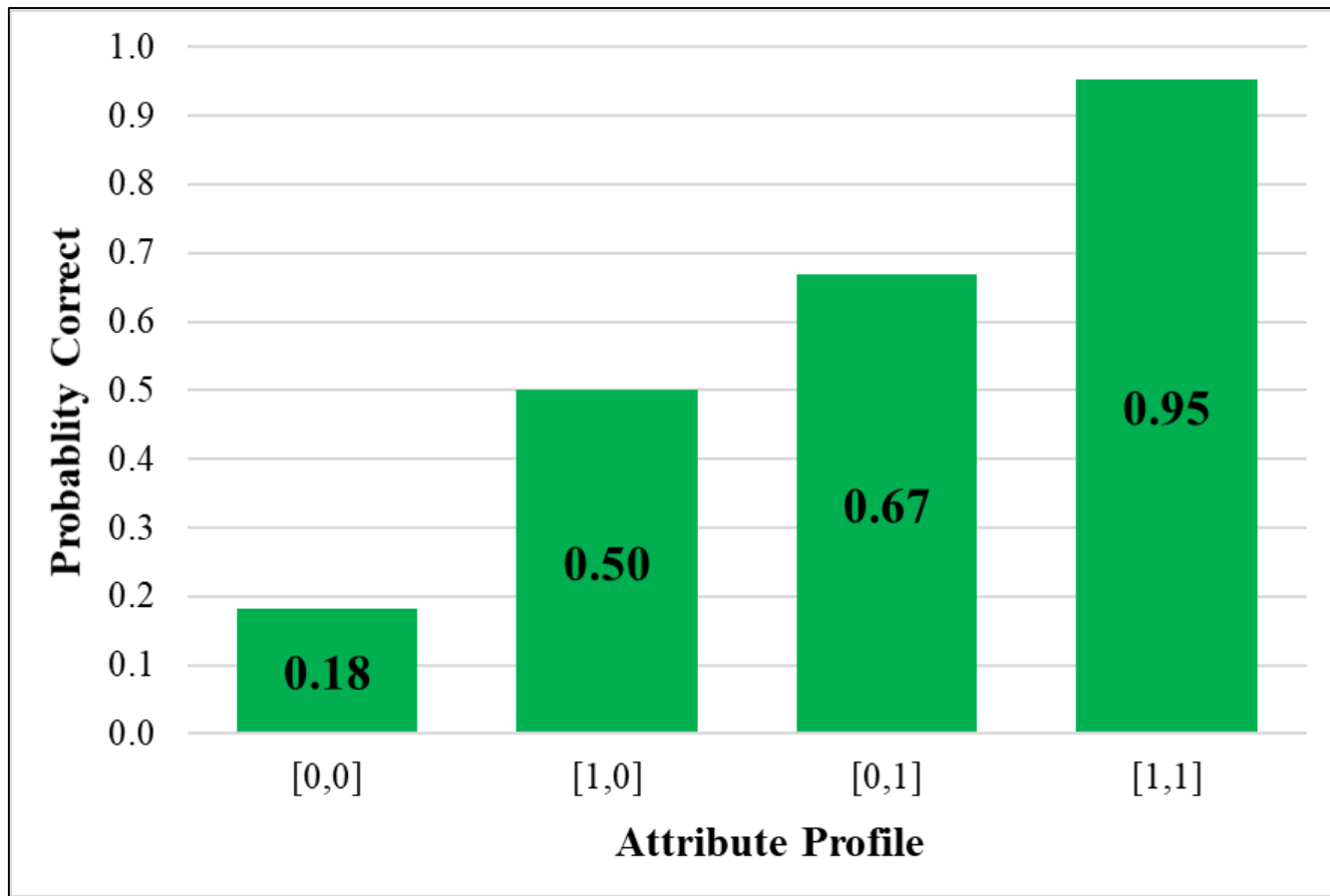
Diagnostic Classification Models

- DCMs serve two purposes
 - » Evaluate quality of items and tests
 - » Provide classifications of student ability in multiple areas

Diagnostic Classification Models

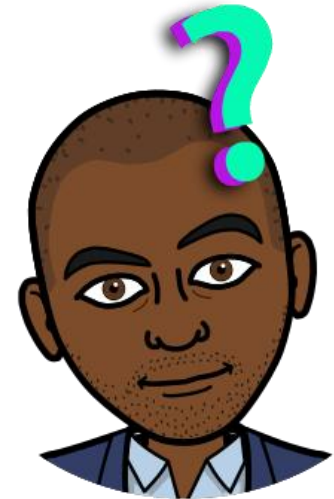
Player	Defense	Shooting	Clutch	Athleticism
	✓	✗	✗	✓
	✓	✗	✗	✓
	✓	✓	✓	✓

Diagnostic Classification Models



Conclusions

- Designs and methods for evaluating interventions
 - » Observational and quasi-experimental
 - » Effect sizes
 - » Survey design for non-academic outcomes
- Considerations for scaling up
 - » Instrument empirical validation
 - » Psychometric modeling options





If you have questions or comments, feel free to contact me:

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Submit a request to the QMC:

www.tinyurl.com/ugaqmc

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