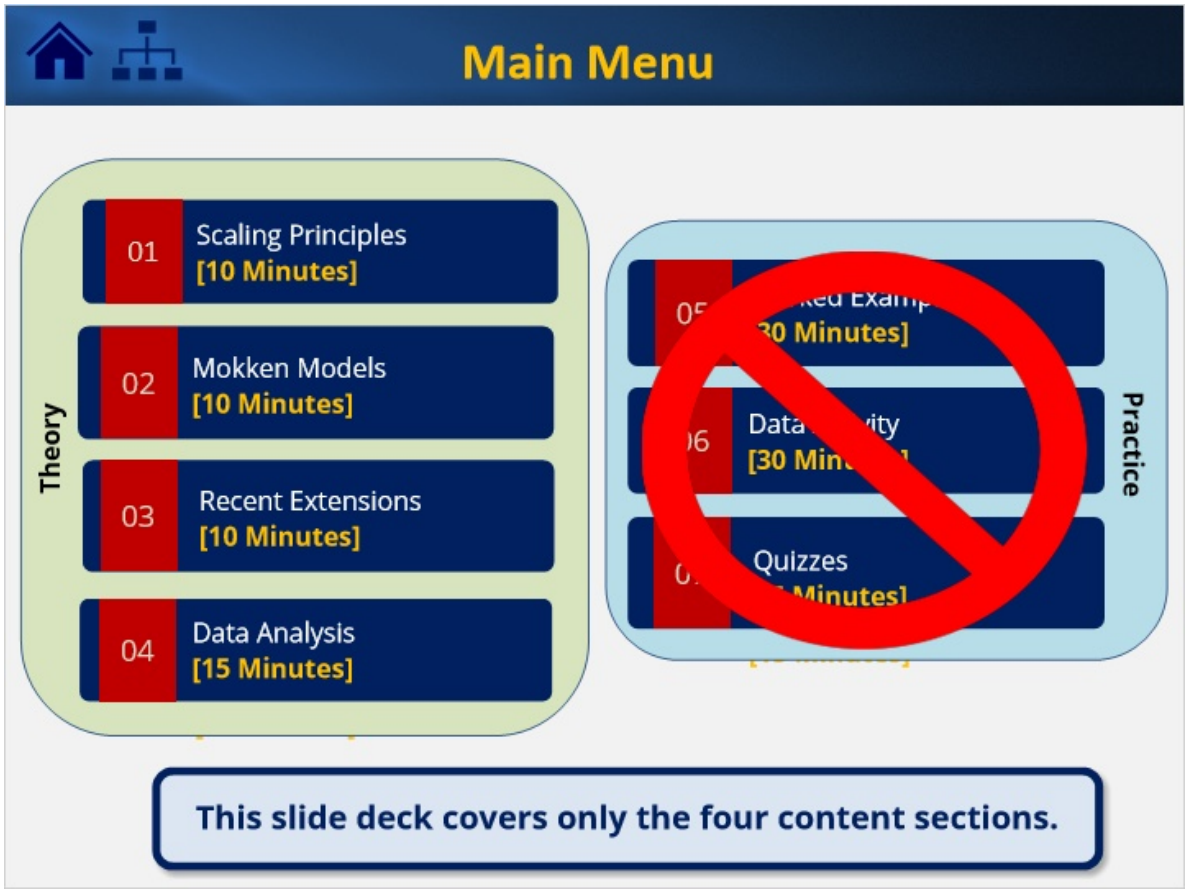
ITEMS Digital Module 03: Nonparametric Item Response Theory

This document contains all core content slides from sections 1-4 with the exception of slides that show video screens. In the digital module all slides can be accessed individually.

Module Organization

The module starts with an introductory section that leads to the main menu from which learners can select individual content and activity sections:



DM03 SLIDES (Version 1.3)

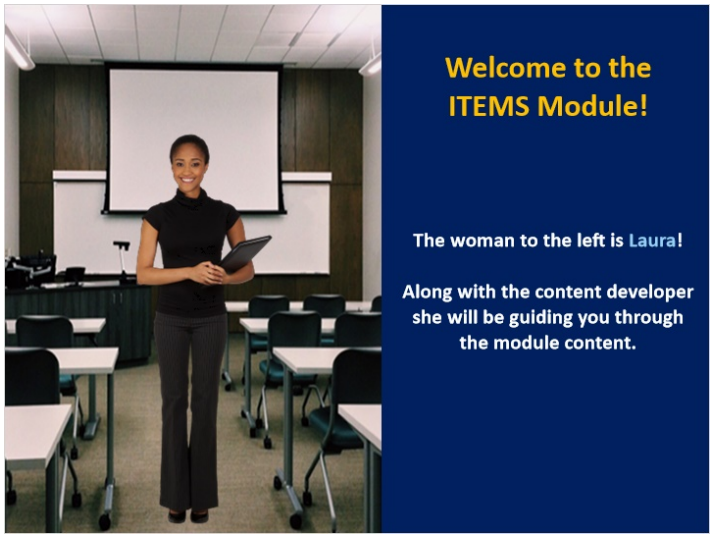
1. Module Overview

1.1 Module Cover (START)

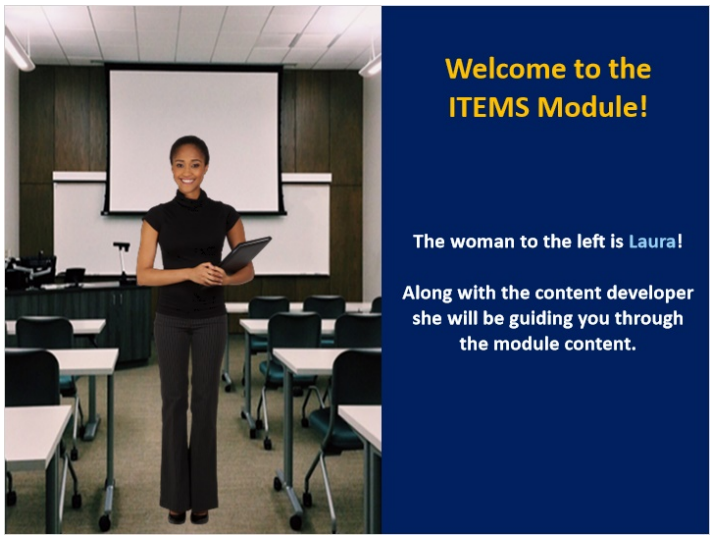
1.2 Instructor

1.3 Designers

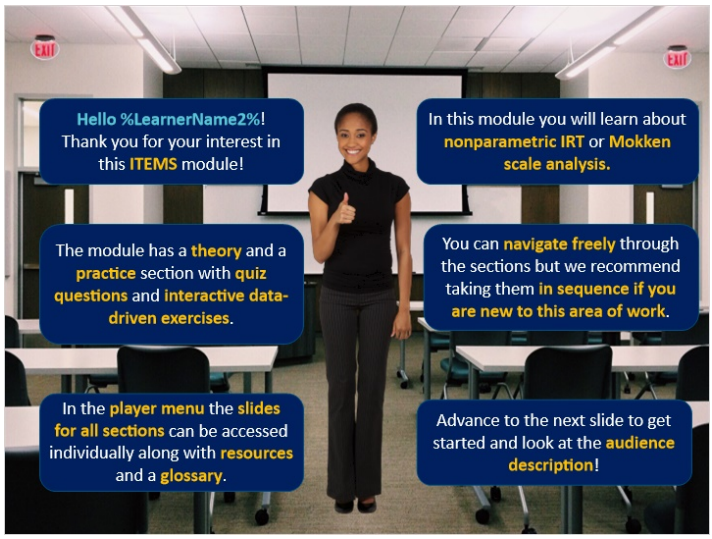
1.4 Welcome



Untitled Layer 1 (Slide Layer)



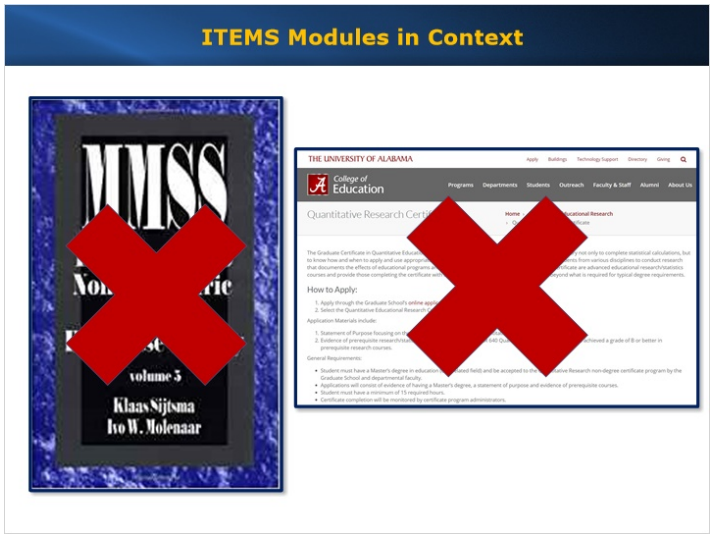
1.5 Overview



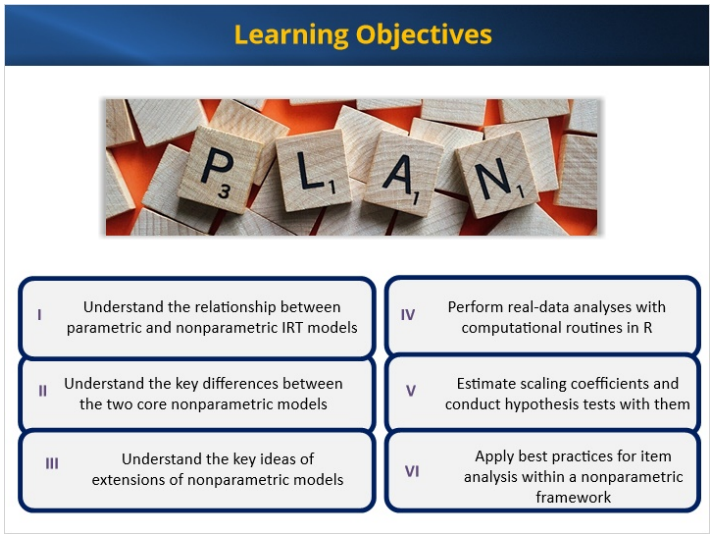
1.6 Target Audience

1.7 Expecations (I)

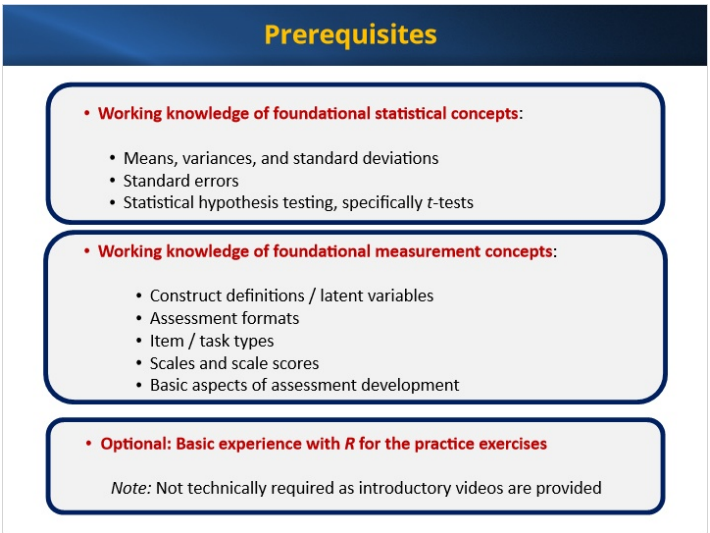
1.8 Expectations (II)



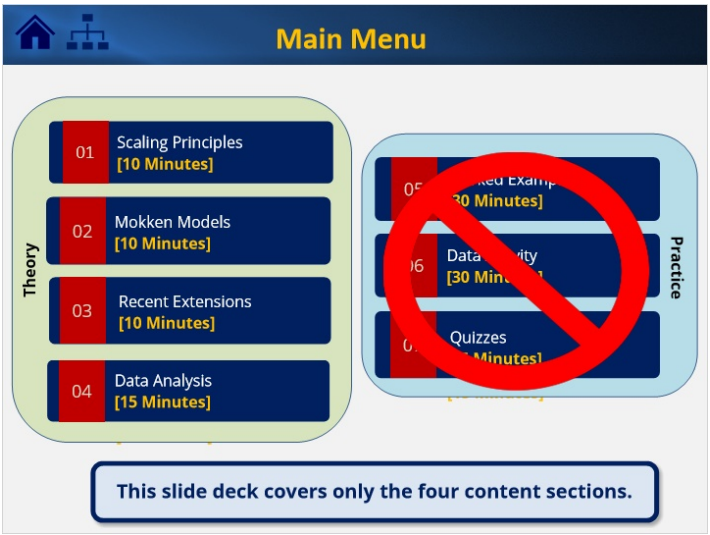
1.9 Learning Objectives



1.10 Prerequisites

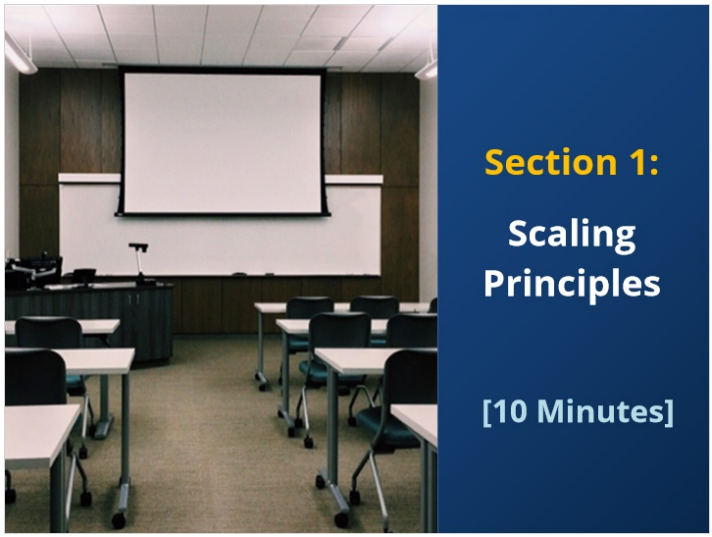


1.11 Main Menu

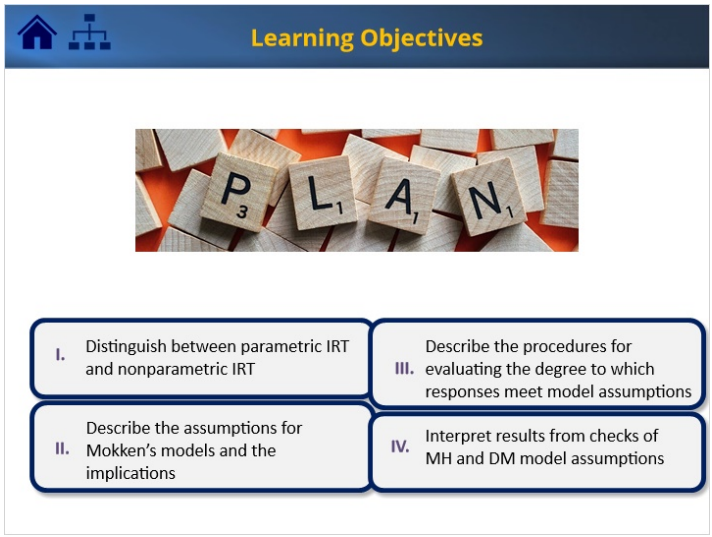


2. Section 1: Scaling Principles

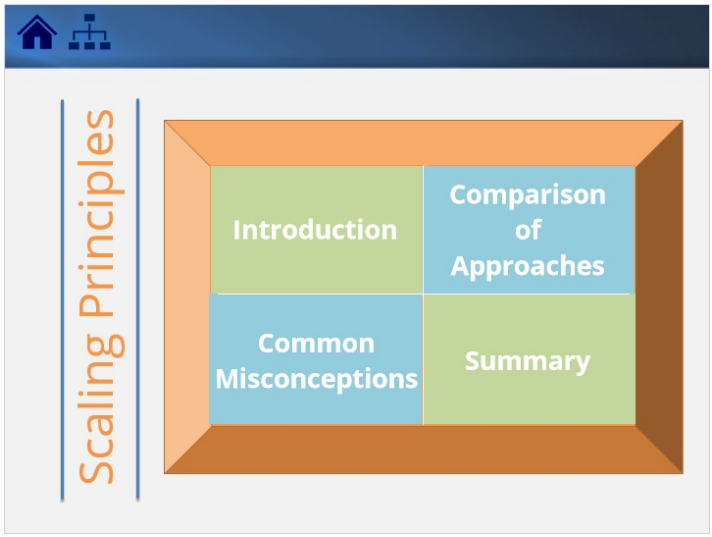
2.1 Cover: Section 1



2.2 Objectives: Section 1

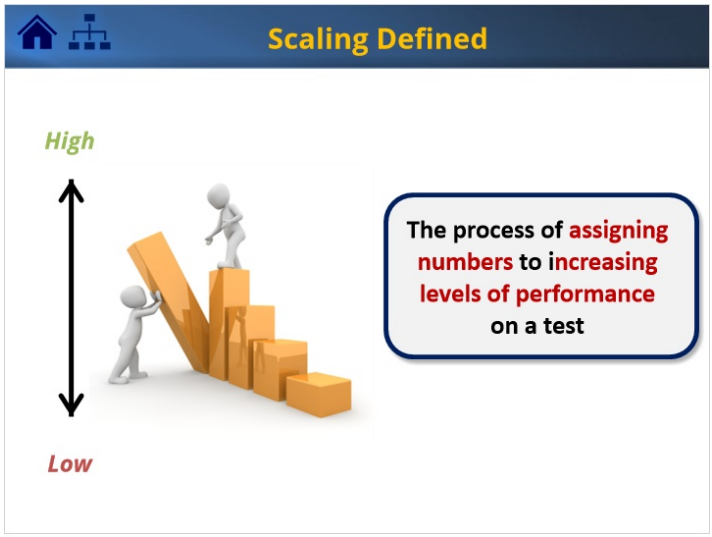


2.3 Topic Selection

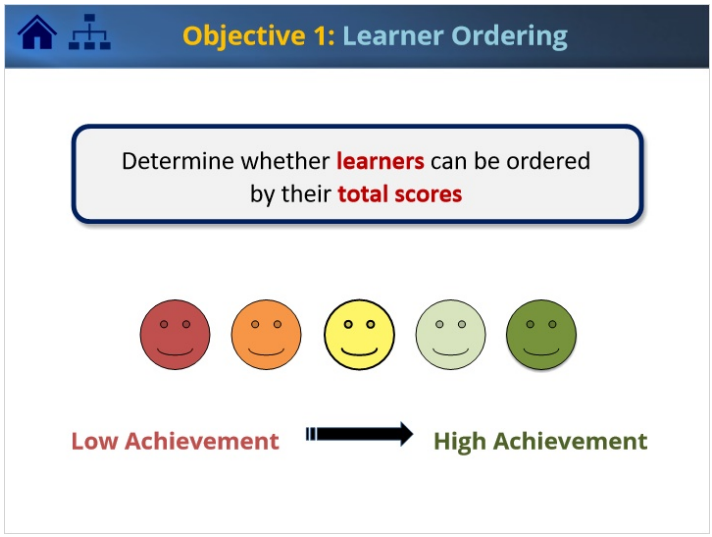


2.4 Bookmark: Introduction

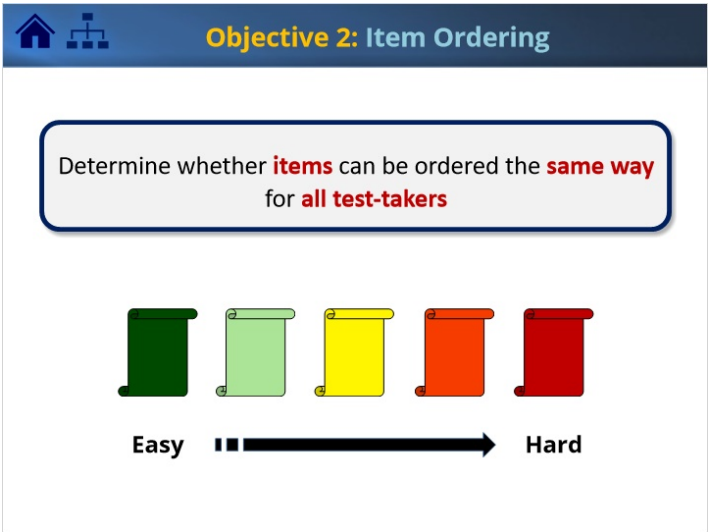
2.5 Definition: Scaling



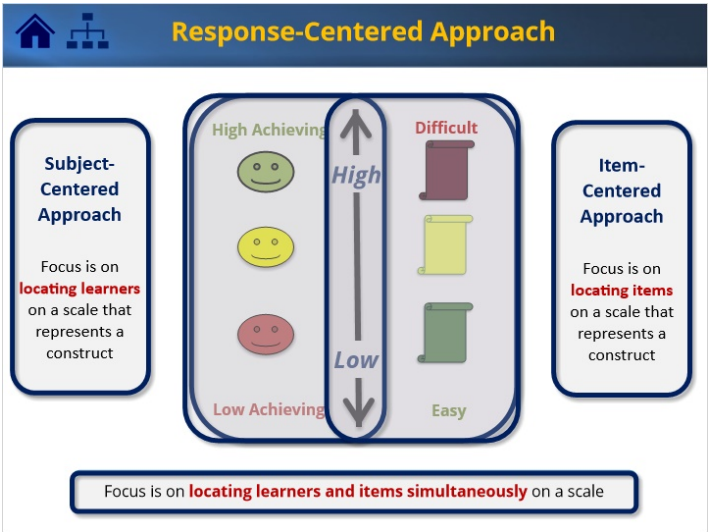
2.6 Learner Objective



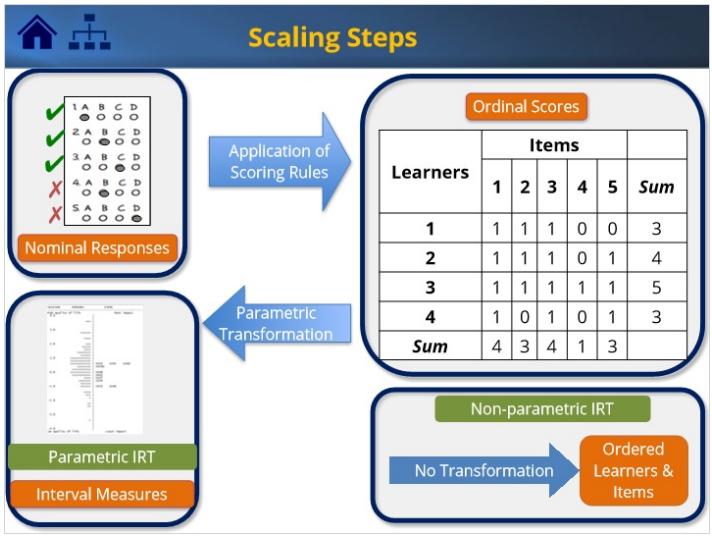
2.7 Item Objective



2.8 Scaling Approaches

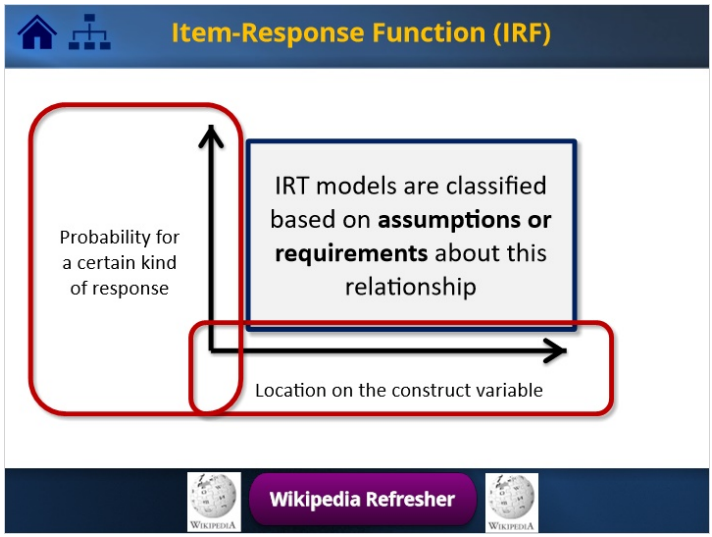


2.9 Scaling Steps

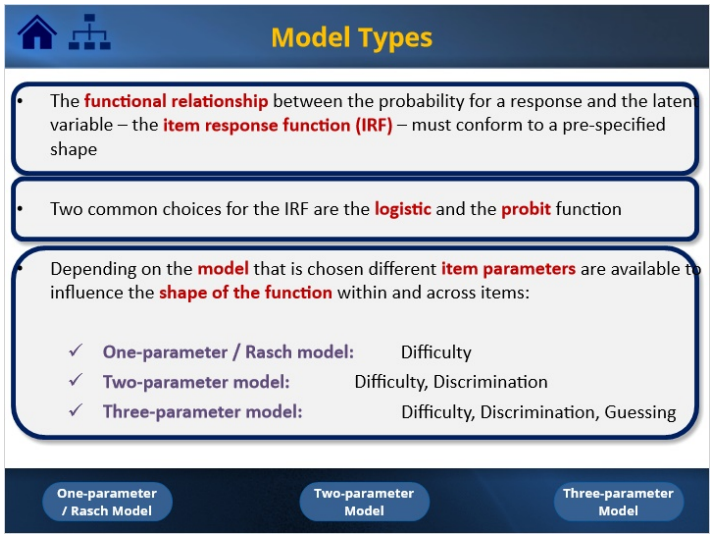


2.10 Framework Selection

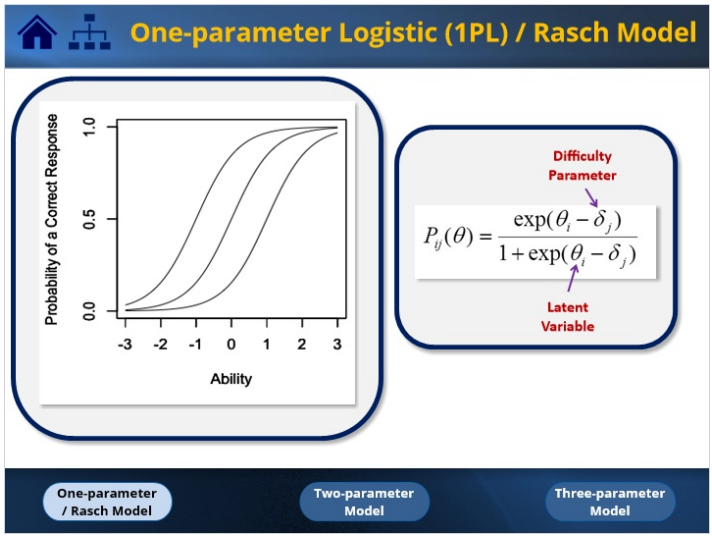
2.11 Item Response Function (IRF)



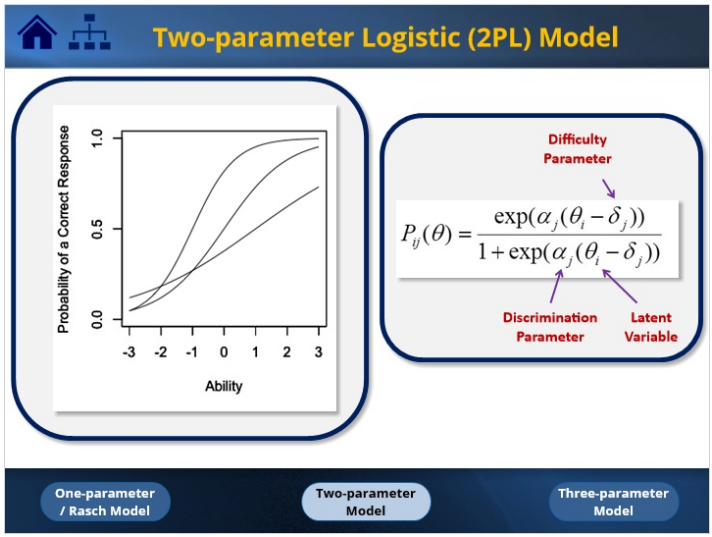
2.12 Parametric IRT



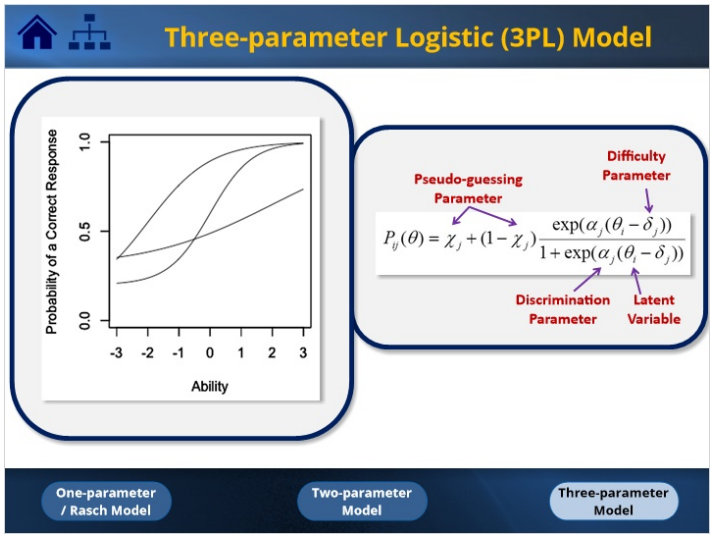
2.13 One-parameter Model



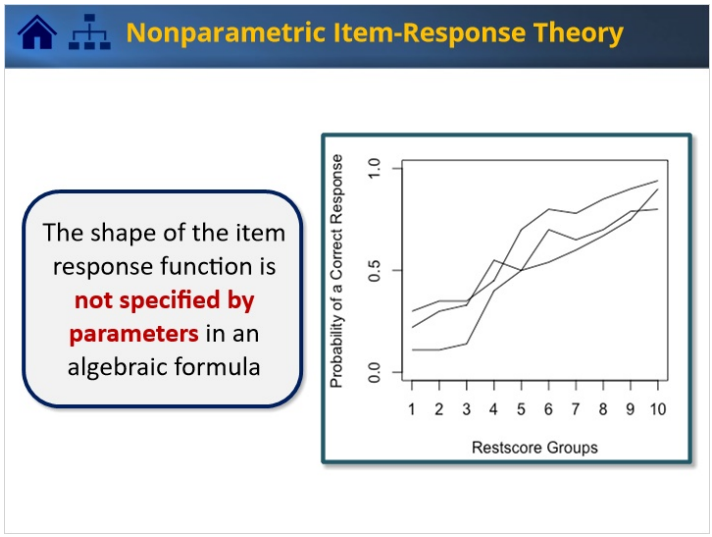
2.14 Two-parameter Model



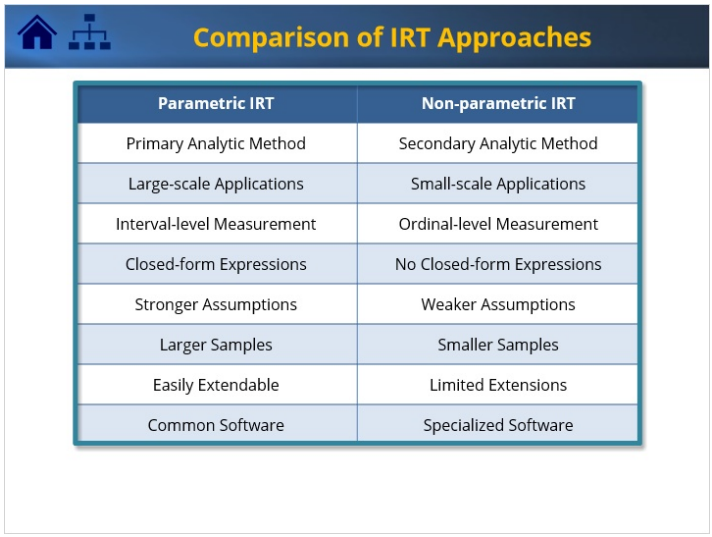
2.15 Three-parameter Model



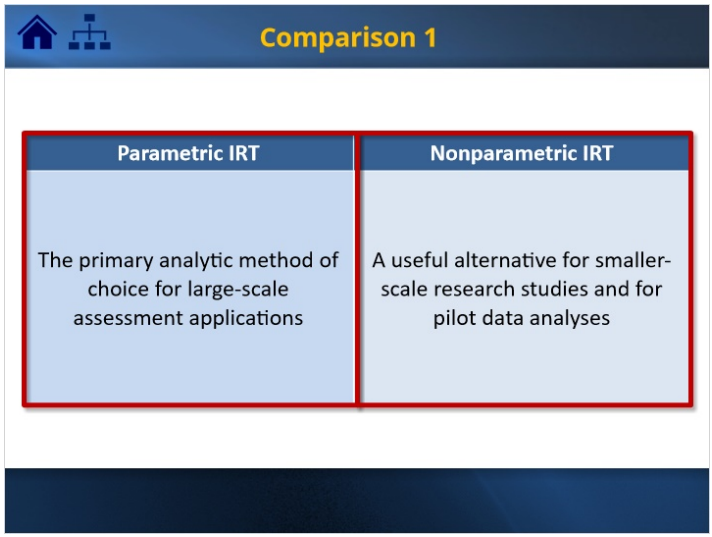
2.16 Nonparametric IRT



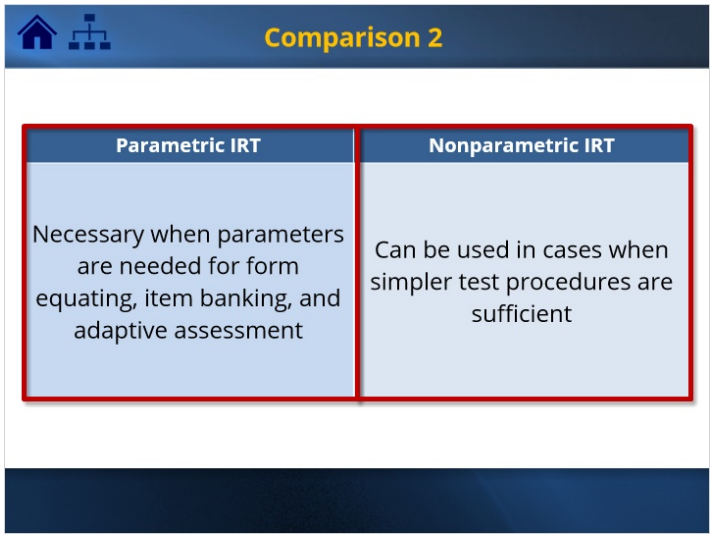
2.17 Framework Comparisons



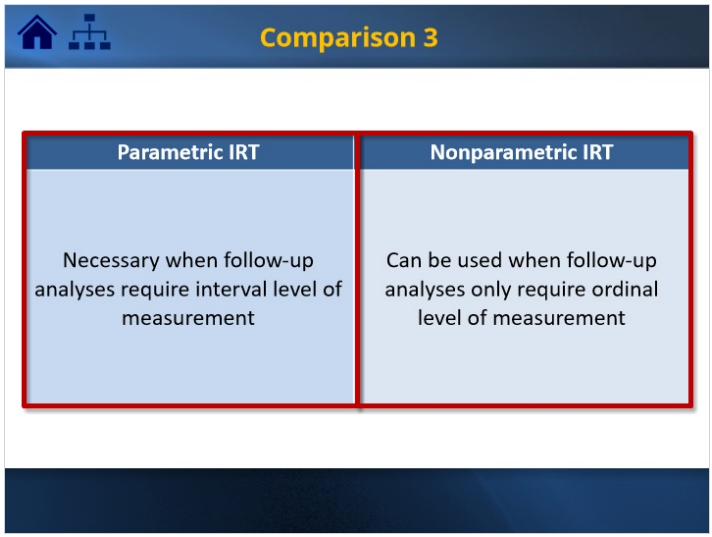
2.18 Comparison 1



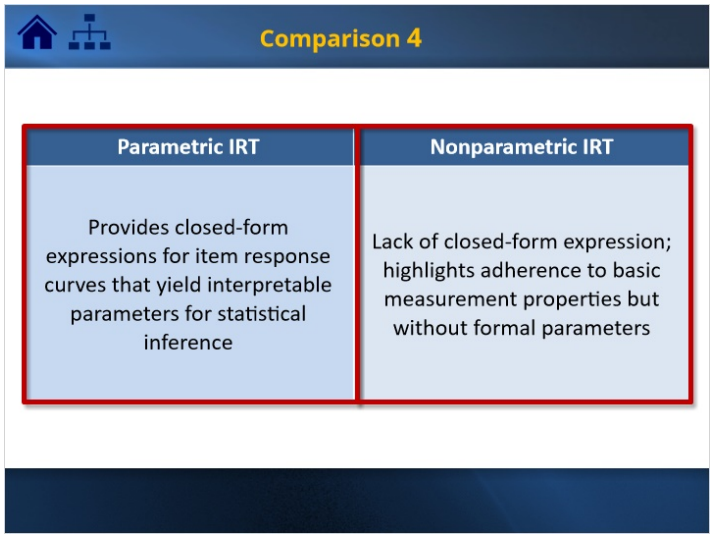
2.19 Comparison 2



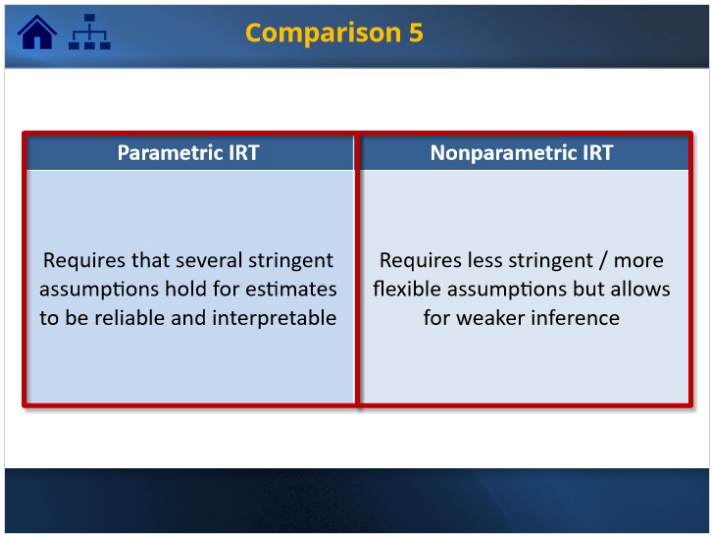
2.20 Comparison 3



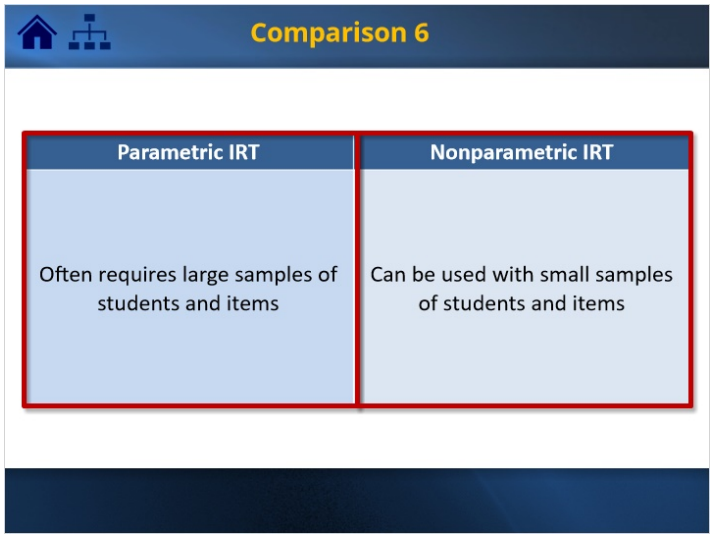
2.21 Comparison 4



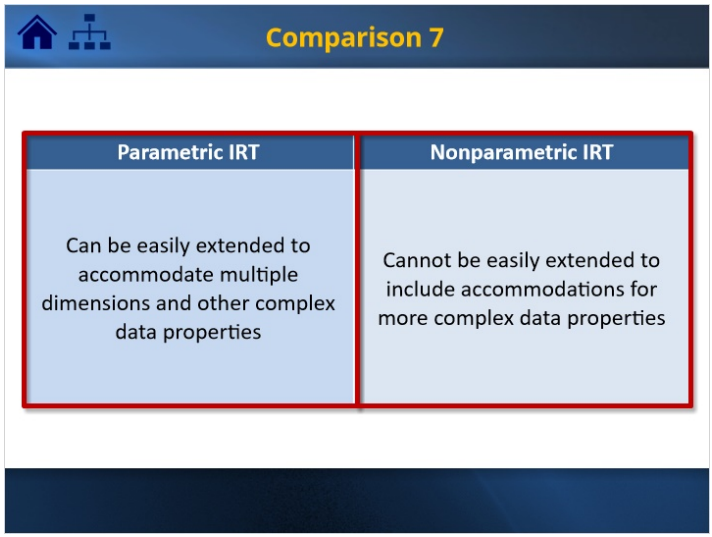
2.22 Comparison 5



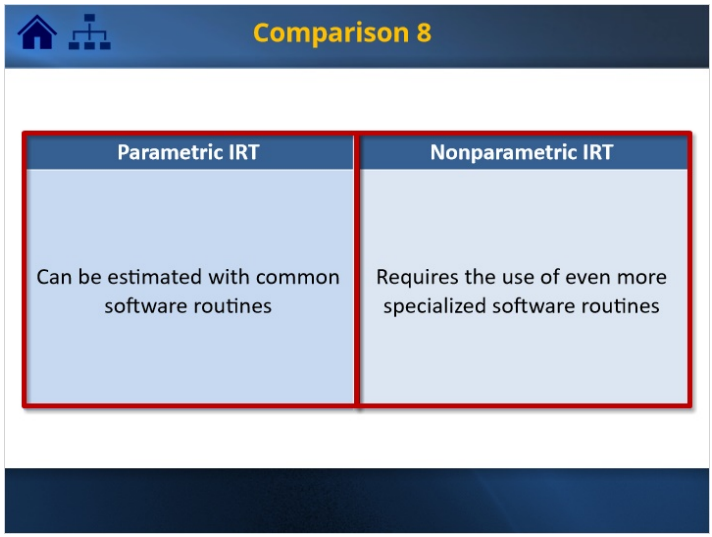
2.23 Comparison 6



2.24 Comparison 7



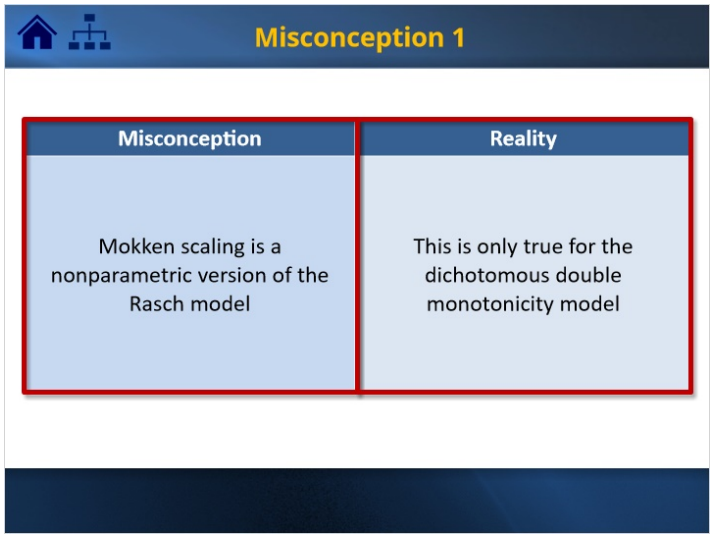
2.25 Comparison 8



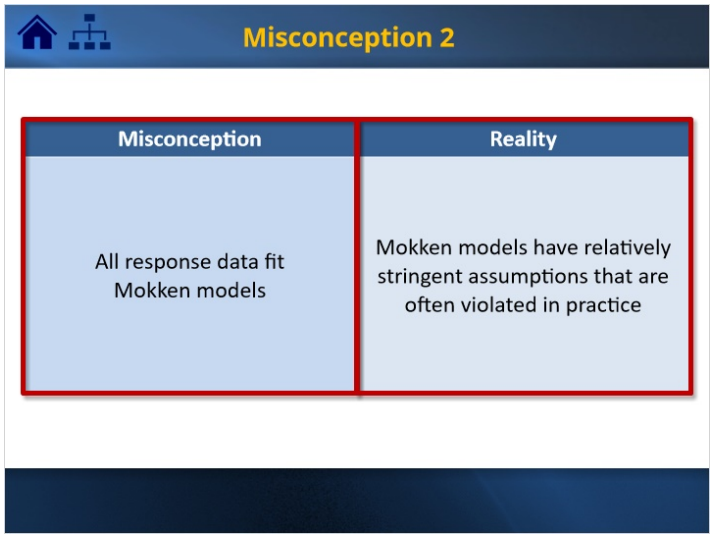
2.26 Bookmark: Misconceptions

2.27 Common Misconceptions

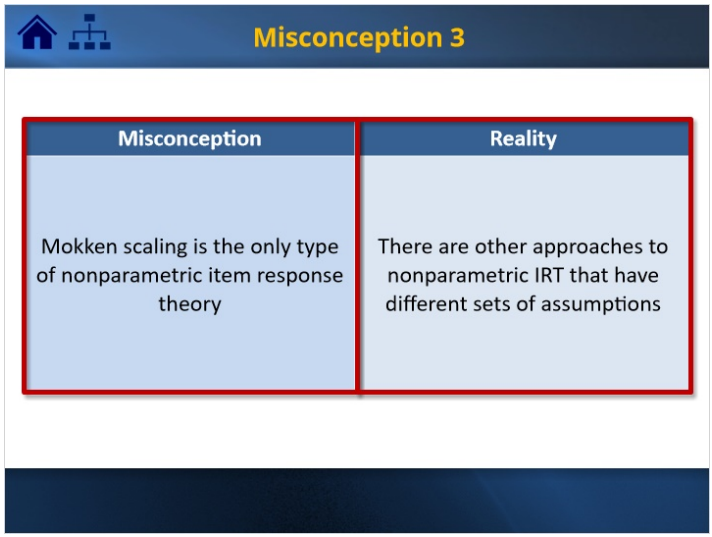
2.28 Misconception 1



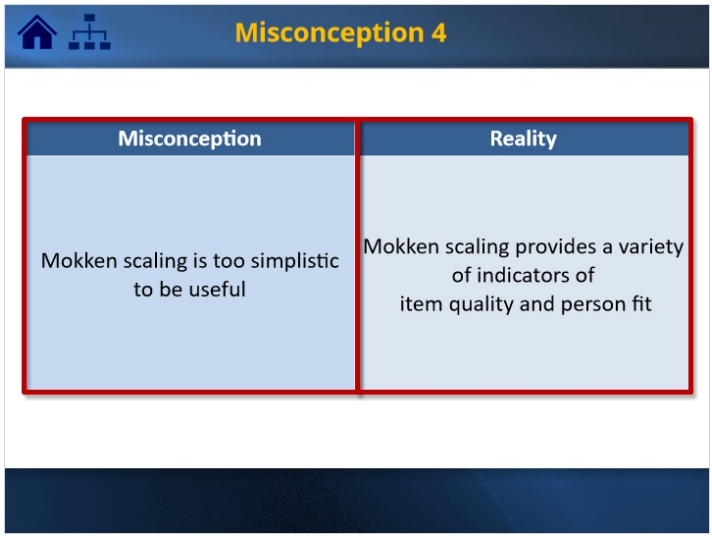
2.29 Misconception 2



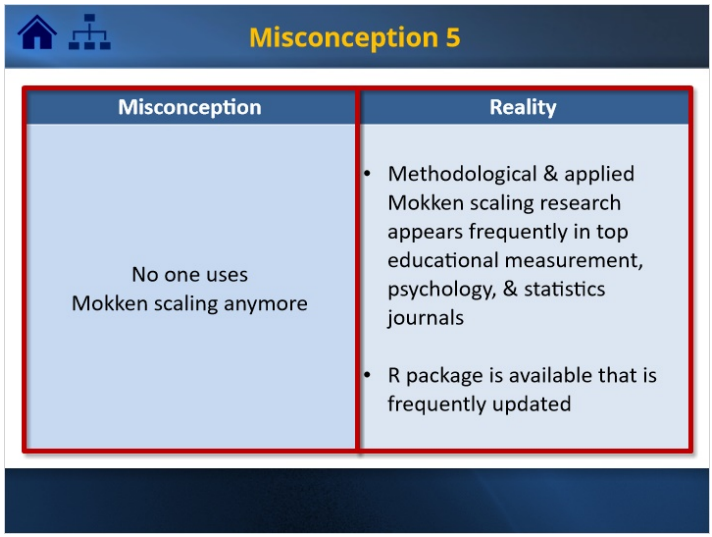
2.30 Misconception 3



2.31 Misconception 4

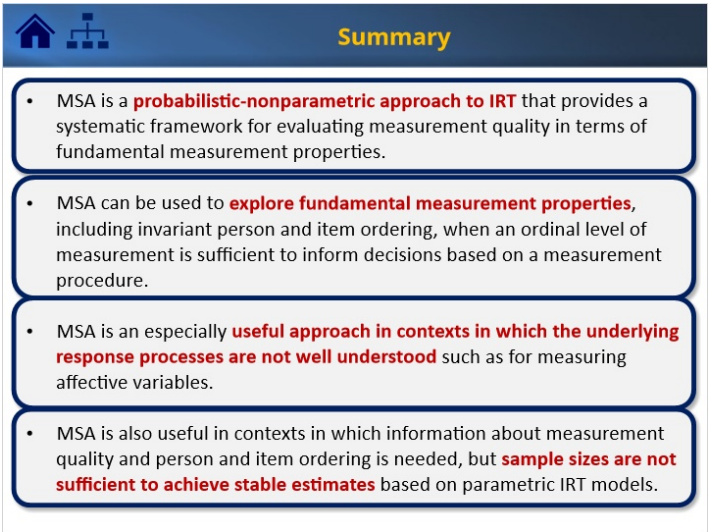


2.32 Misconception 5

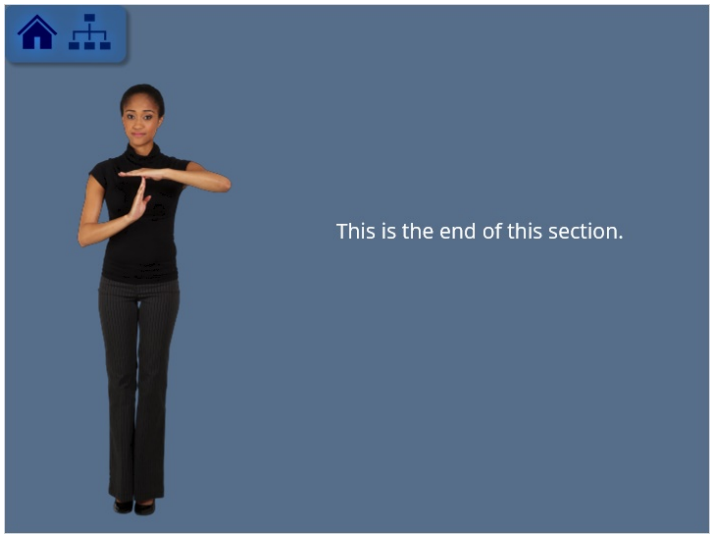


2.33 Bookmark: Summary

2.34 Summary: Section 1



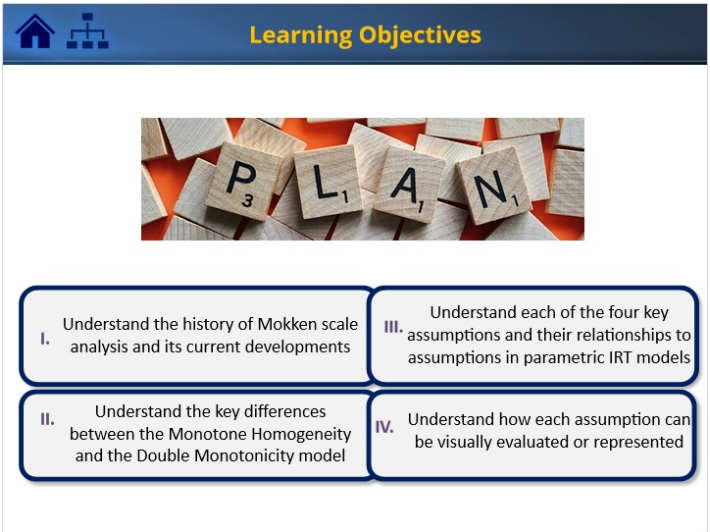
2.35 Section 1 Bookend



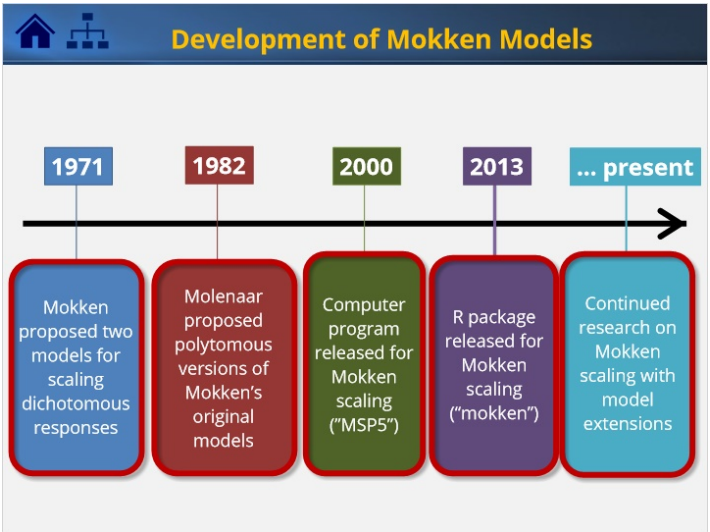
3. Section 2: Mokken Models

3.1 Cover: Section 2

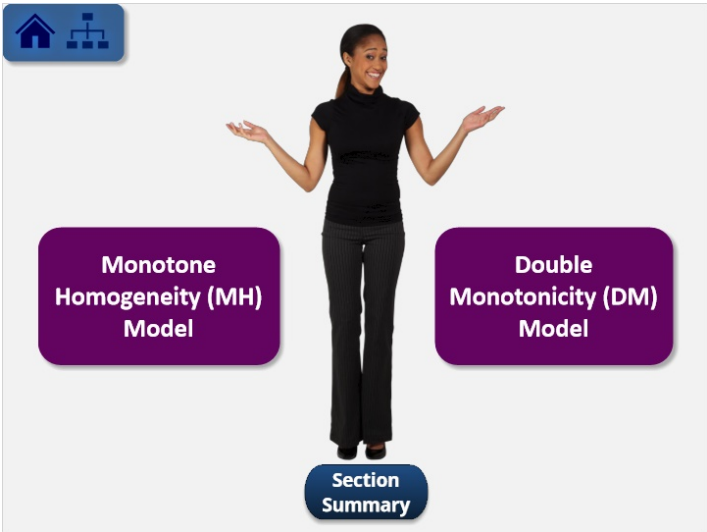
3.2 Objectives: Section 2



3.3 Development of Mokken Models

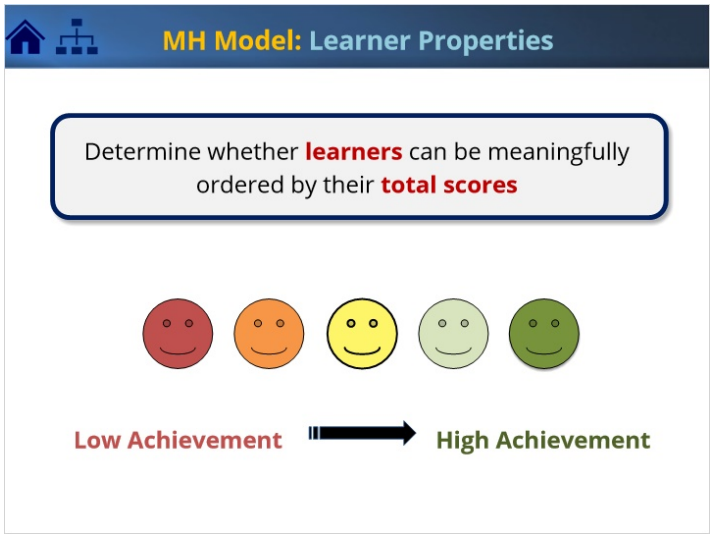


3.4 Model Selection

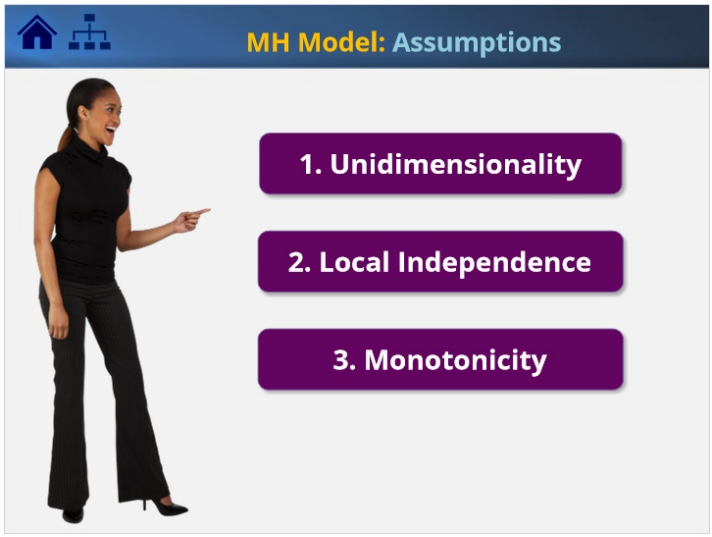


3.5 Bookmark: MH Model

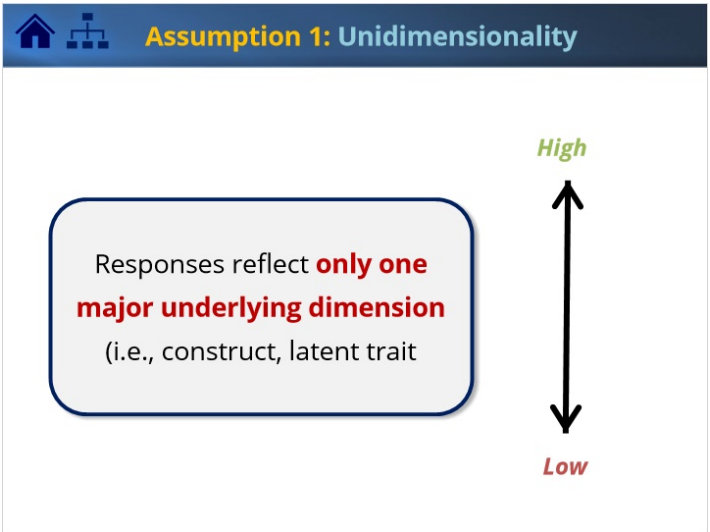
3.6 Learner Objective: MH Model



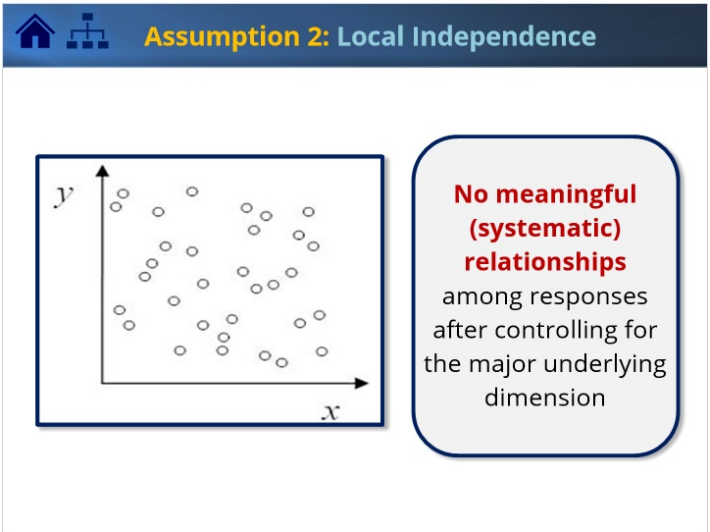
3.7 MH Model Assumptions



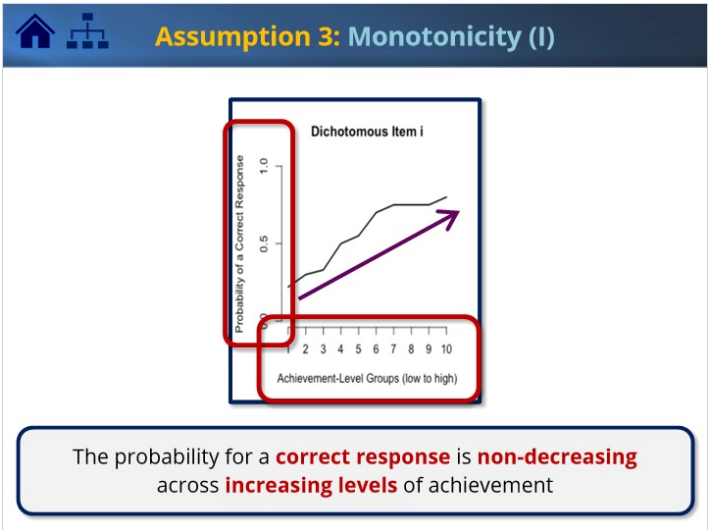
3.8 Unidemensionality



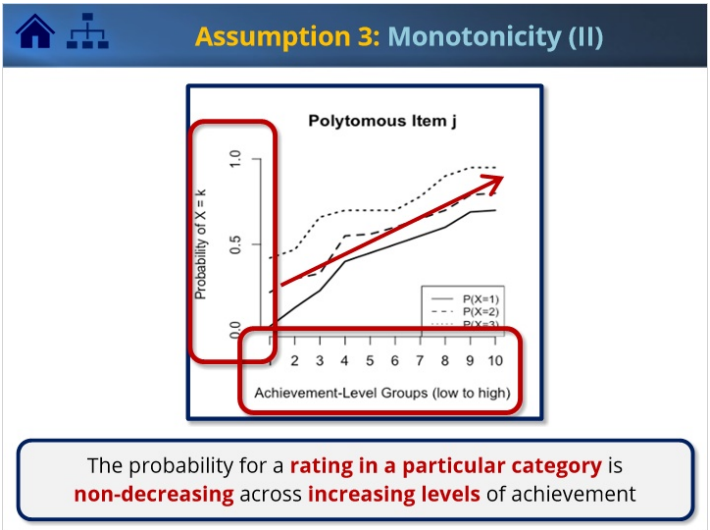
3.9 Local Independence



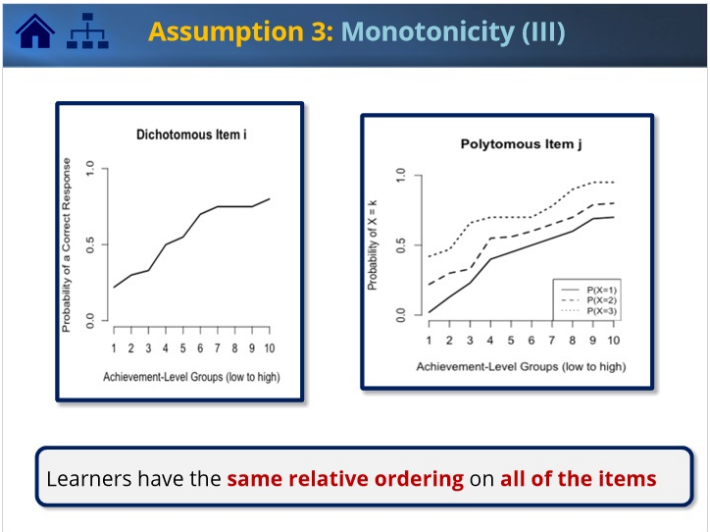
3.10 Monotonicity: Dichotomous Items



3.11 Monotonicity: Polytomous Items

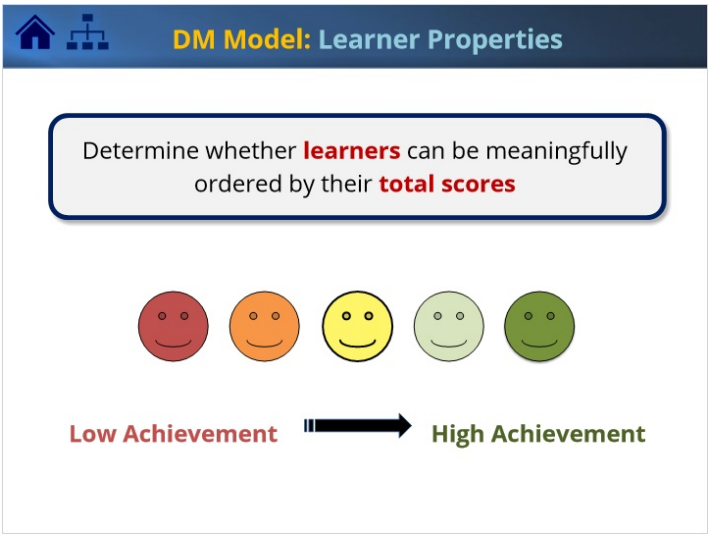


3.12 Monotonicity: Item Ordering

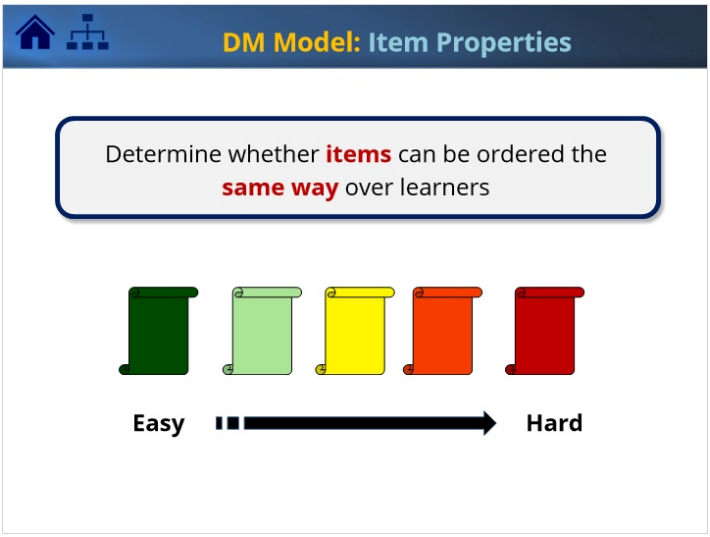


3.13 Bookmark: DM Model

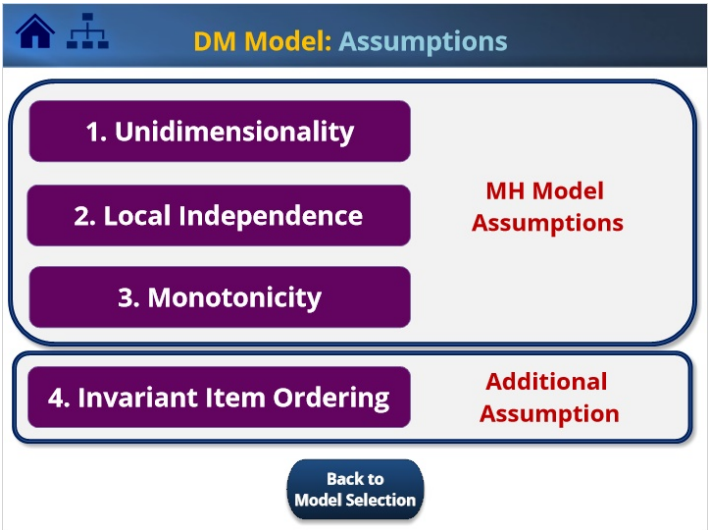
3.14 Learner Objective: DM Model



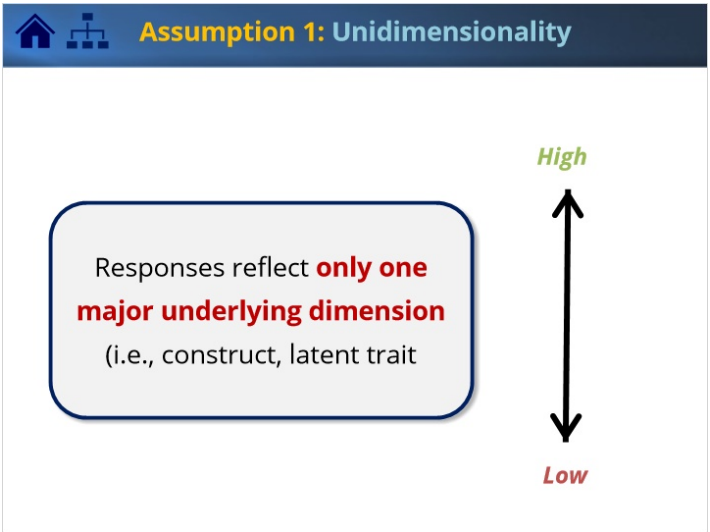
3.15 Item Objective: DM Model



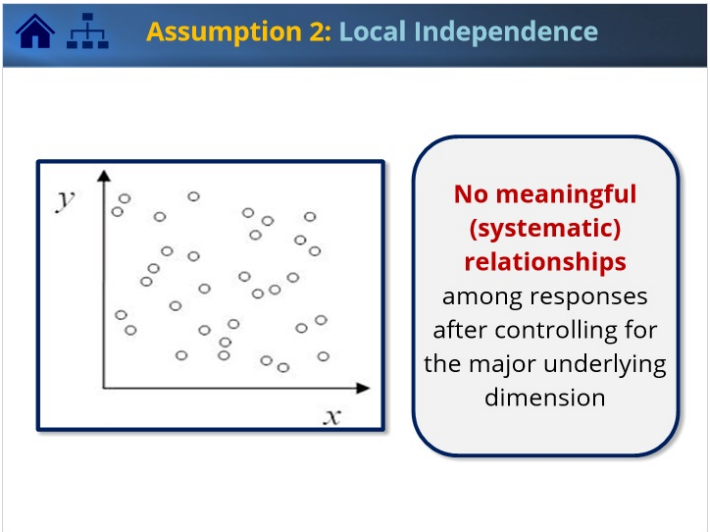
3.16 DM Model Assumptions



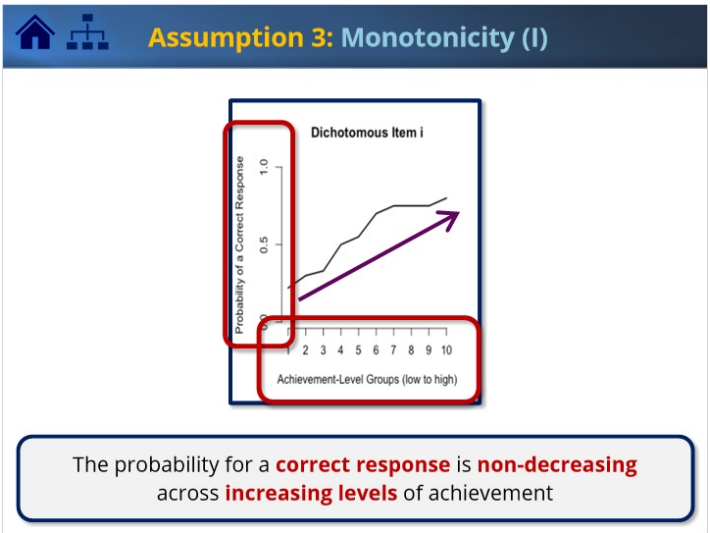
3.17 Unidemensionality



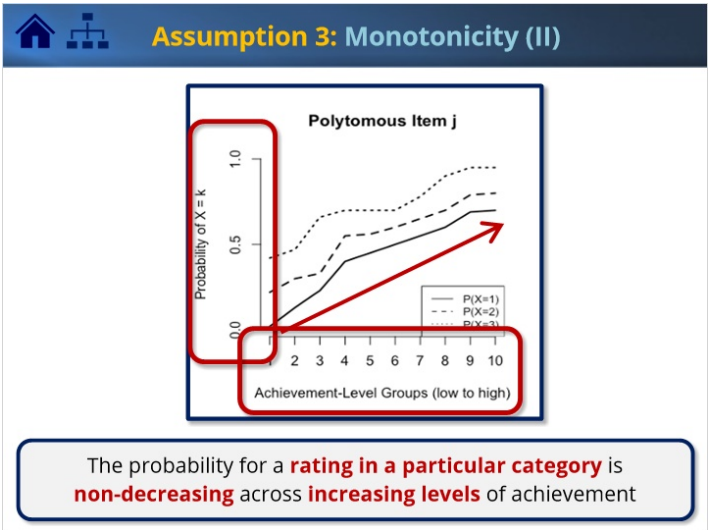
3.18 Local Independence



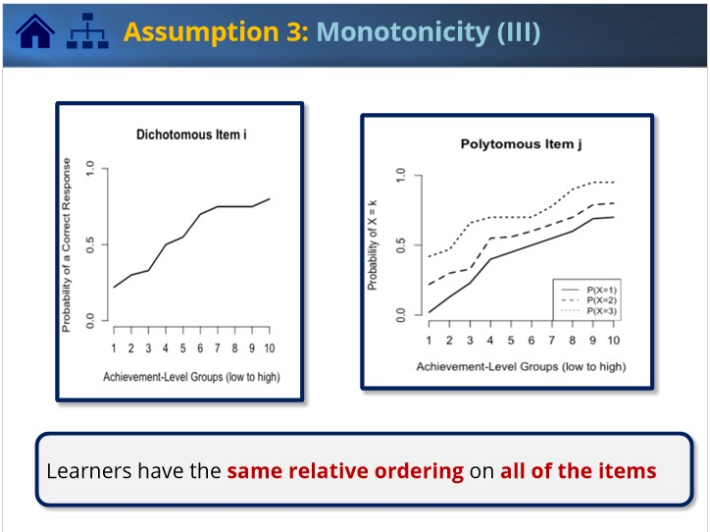
3.19 Monotonicity: Dichotomous Items



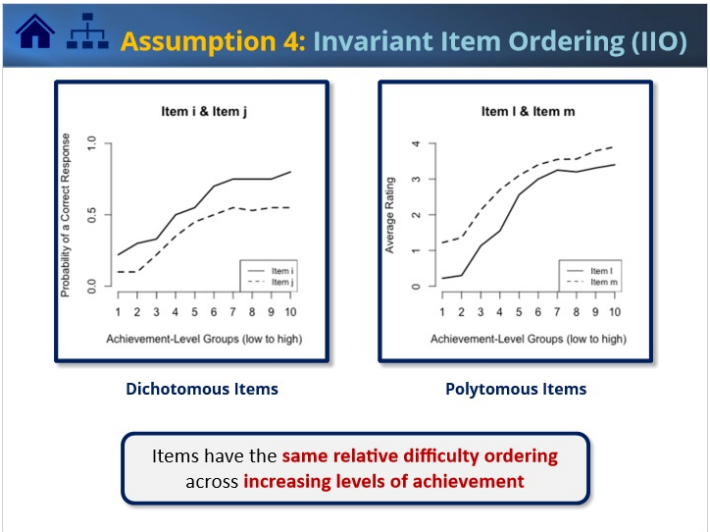
3.20 Monotonicity: Polytomous Items



3.21 Monotonicity: Item Ordering

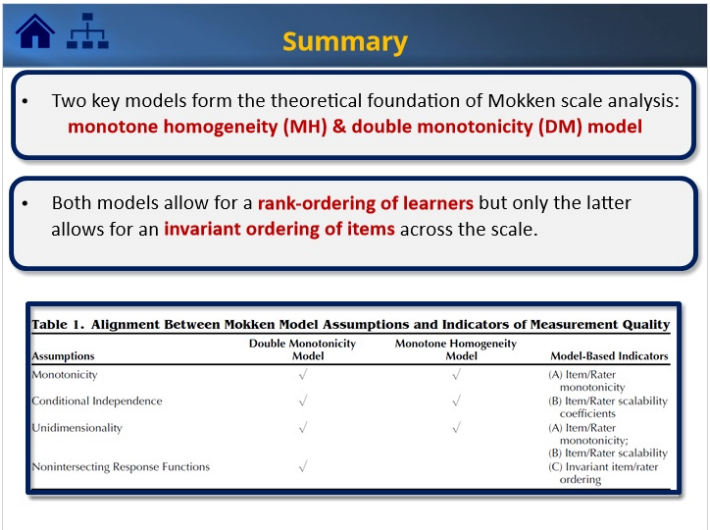


3.22 Invariant Item Ordering

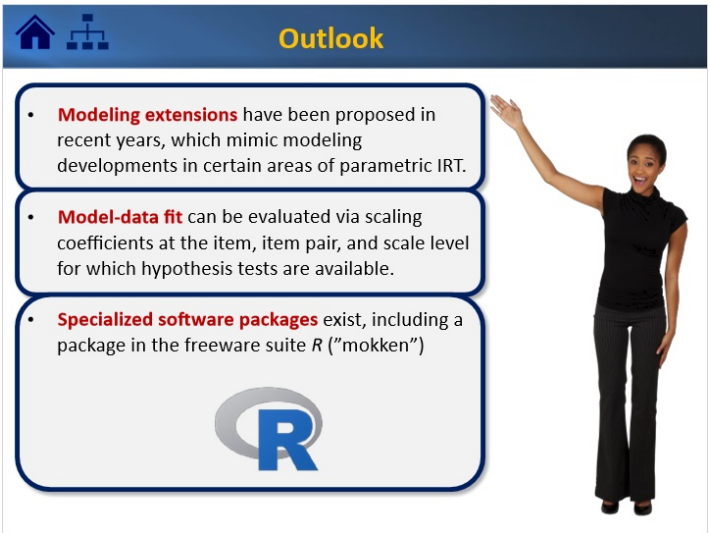


3.23 Bookmark: Summary

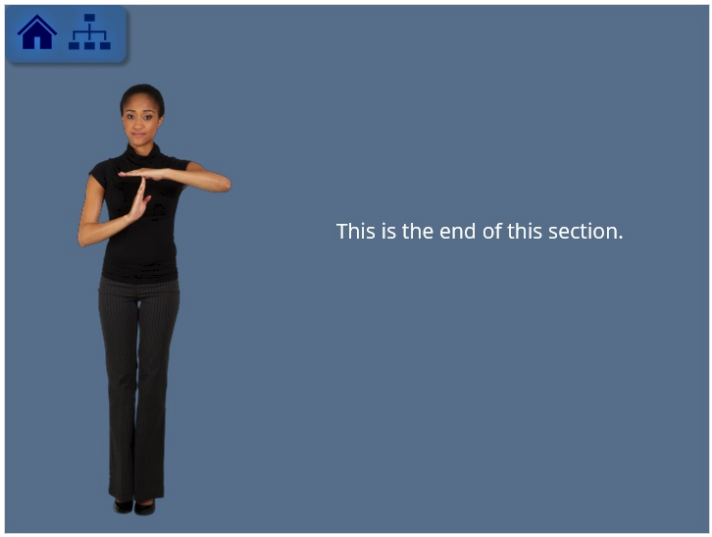
3.24 Summary: Section 2



3.25 Outlook

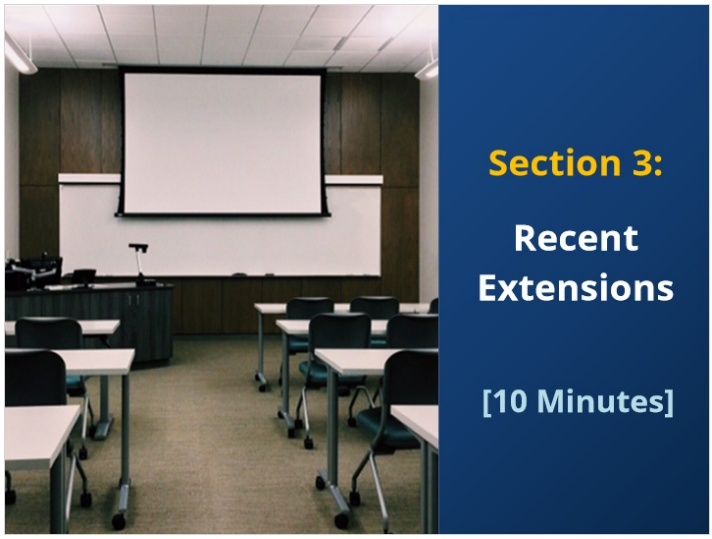


3.26 Bookend:Summary

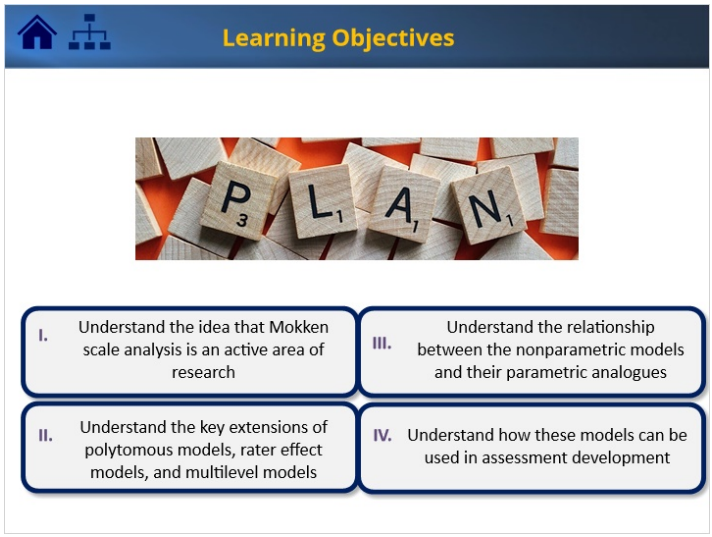


4. Section 3: Recent Extensions

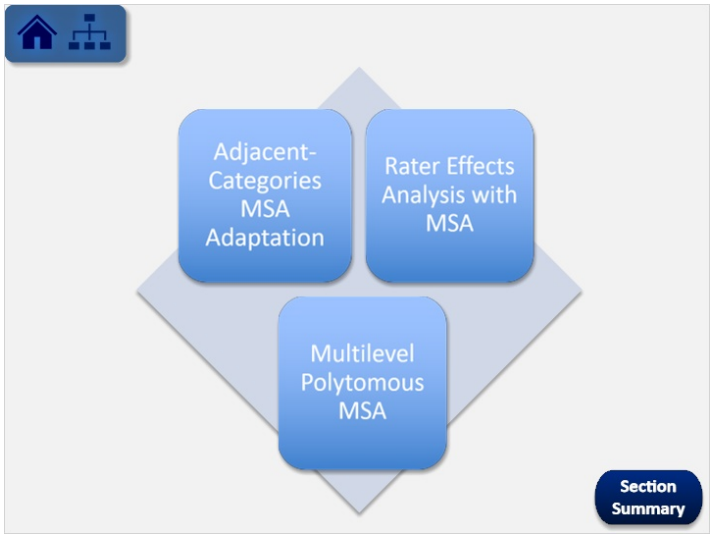
4.1 Cover: Section 3



4.2 Objectives: Section 3

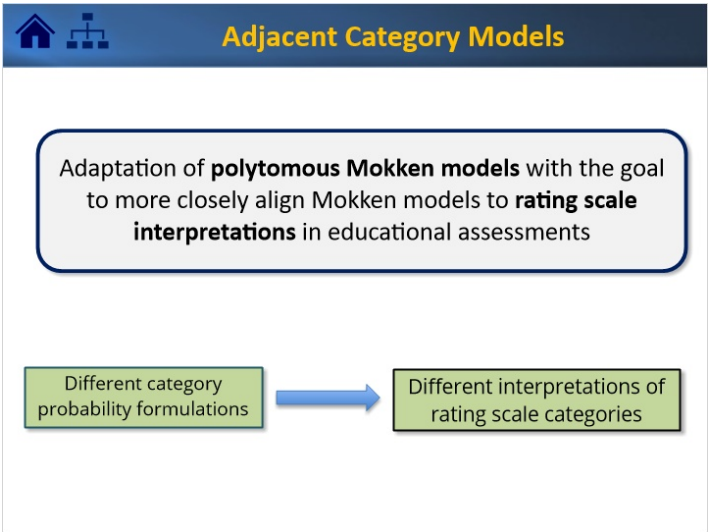


4.3 Extension Selection

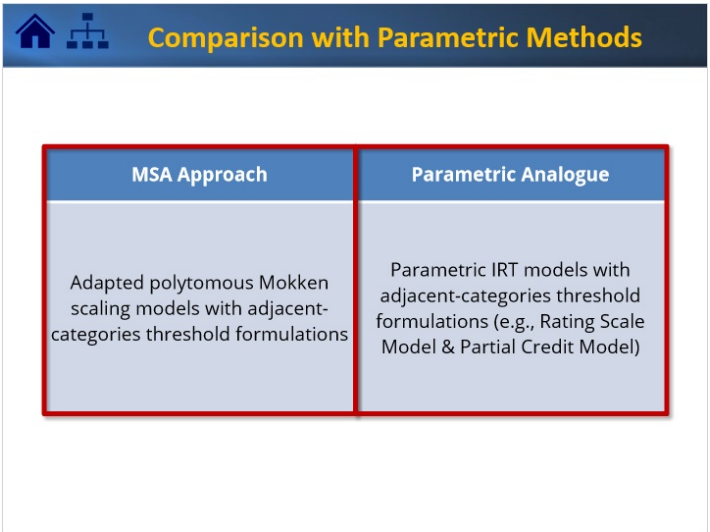


4.4 Bookmark: Adj Cat Models

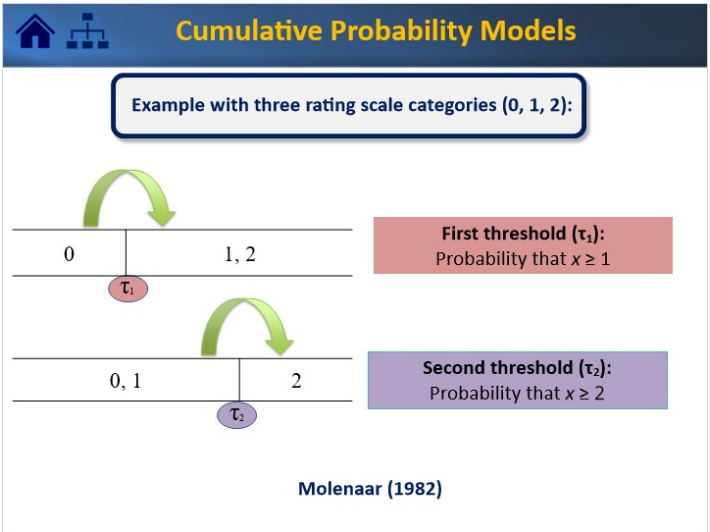
4.5 ACMs: Introduction (I)



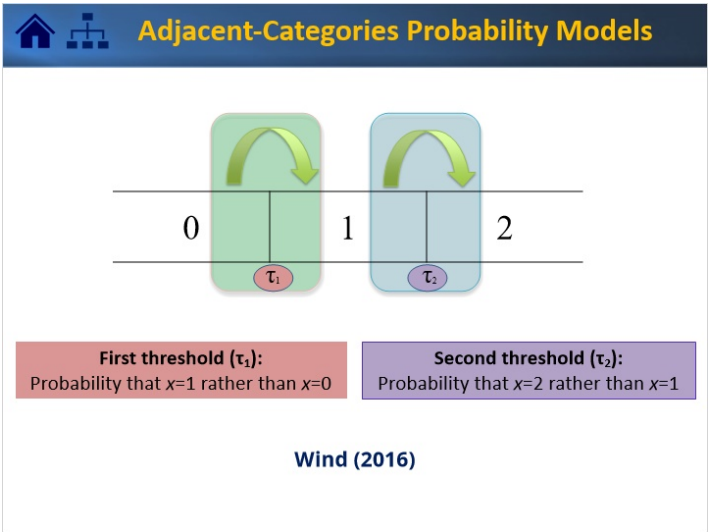
4.6 ACMs: Introduction (II)



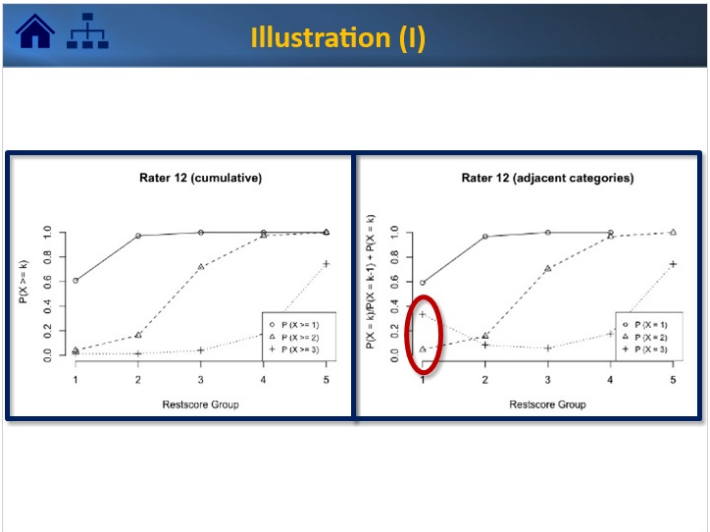
4.7 ACMs: Introduction (III)



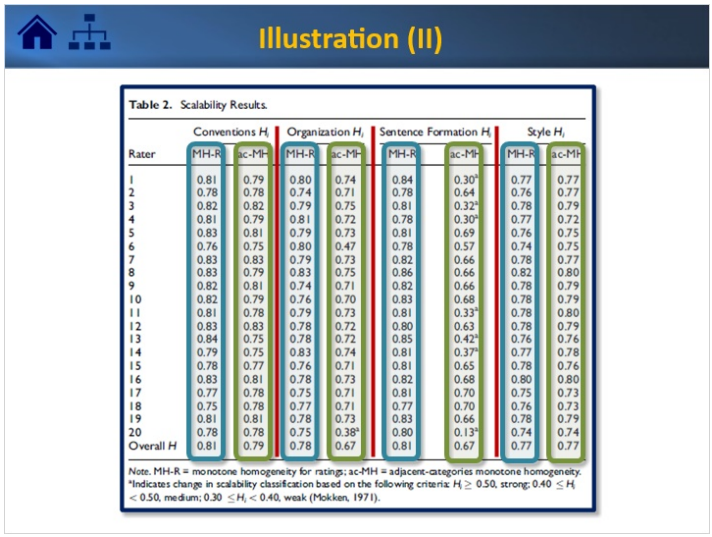
4.8 ACMs: Introduction (V)



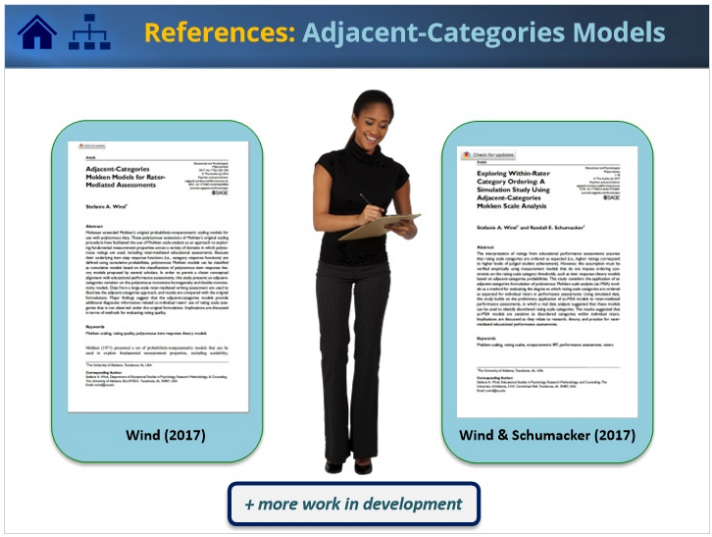
4.9 ACMs: Illustration (I)



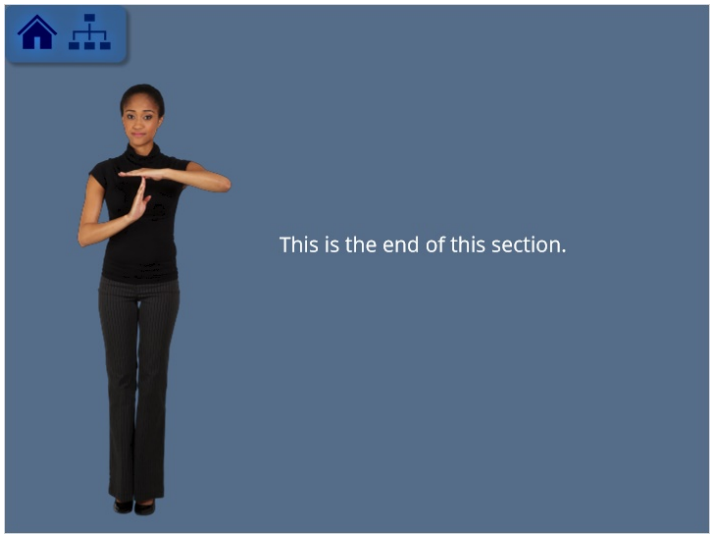
4.10 ACMs: Illustration (II)



4.11 ACMs: References

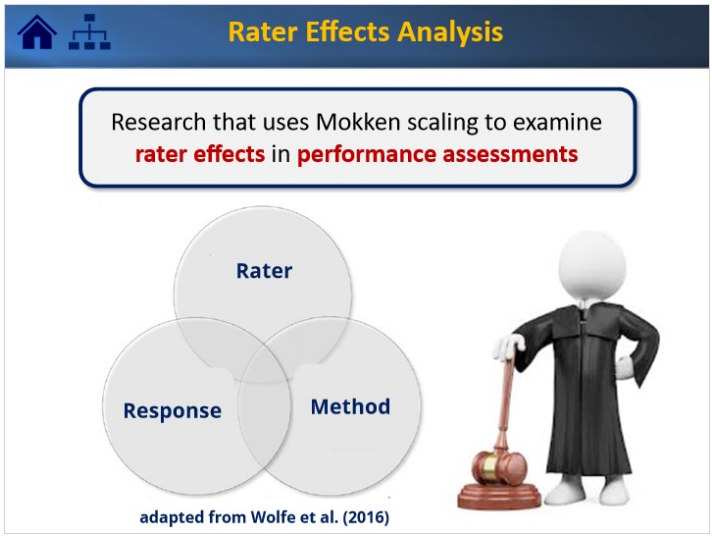


4.12 Bookend: Adj Cat Models

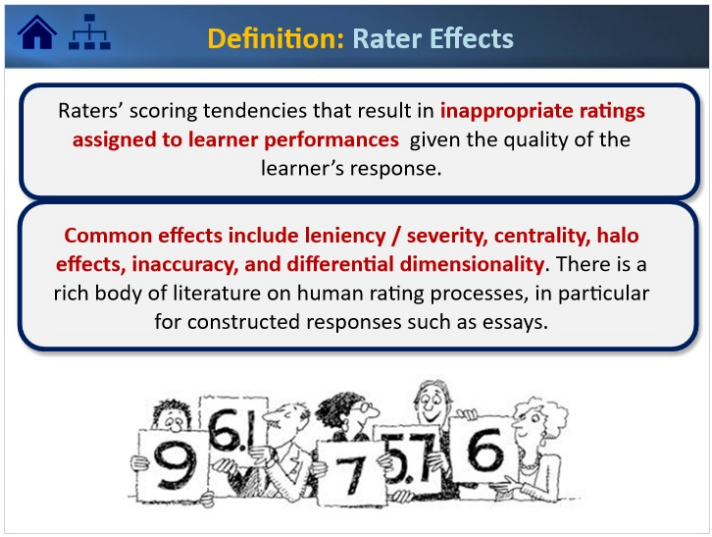


4.13 Bookmark: Rater Models

4.14 RMs: Introduction (I)



4.15 RMs: Introduction (II)



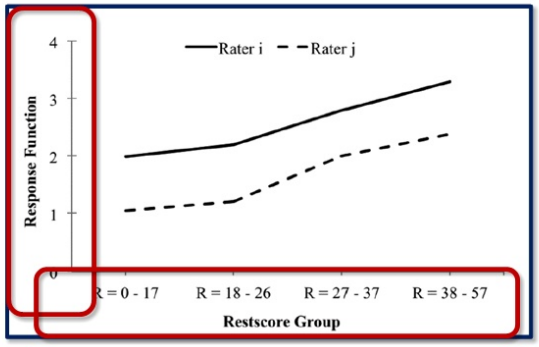
4.16 RMs: Introduction (III)

Comparison with Parametric Methods

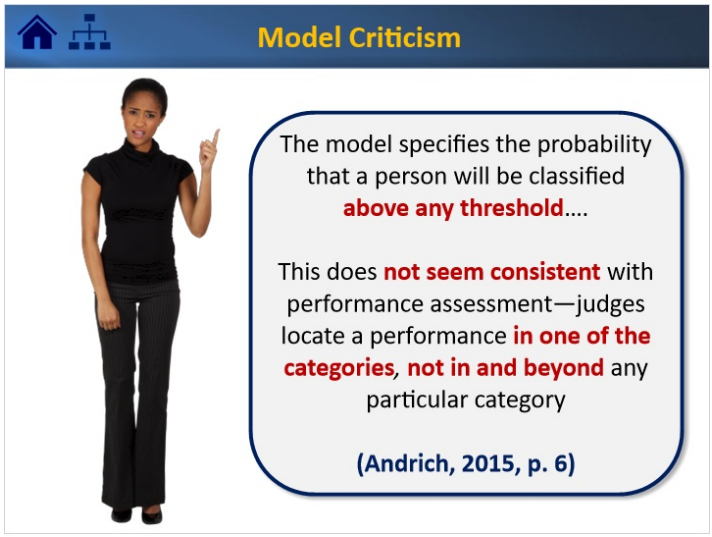
MSA Approach	Parametric Analogue
Nonparametric approach allows for the examination of rater effects via graphical displays of idiosyncratic rater behavior Scalability coefficients for individual raters can be used to quantify their relative fit with the model assumptions	Parametric IRT models include parameters for rater characteristics Inclusion of rater parameters improves score precision for learners and allows for diagnostic information about raters

4.17 RMs: Illustration (I)

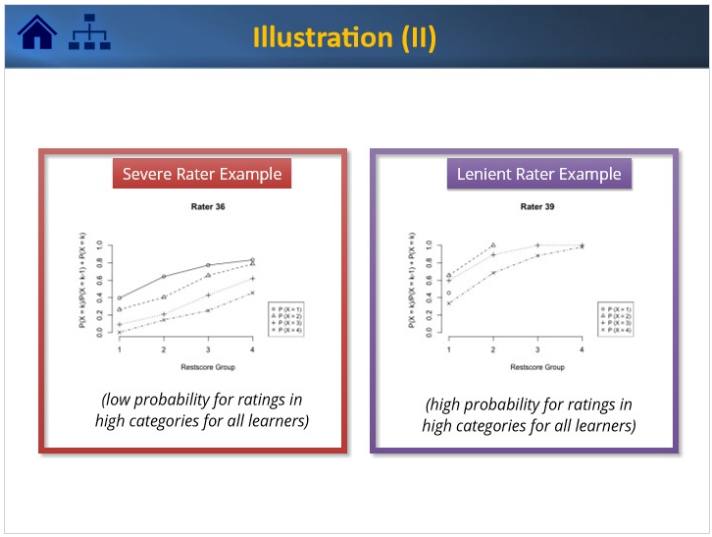
Illustration (I)



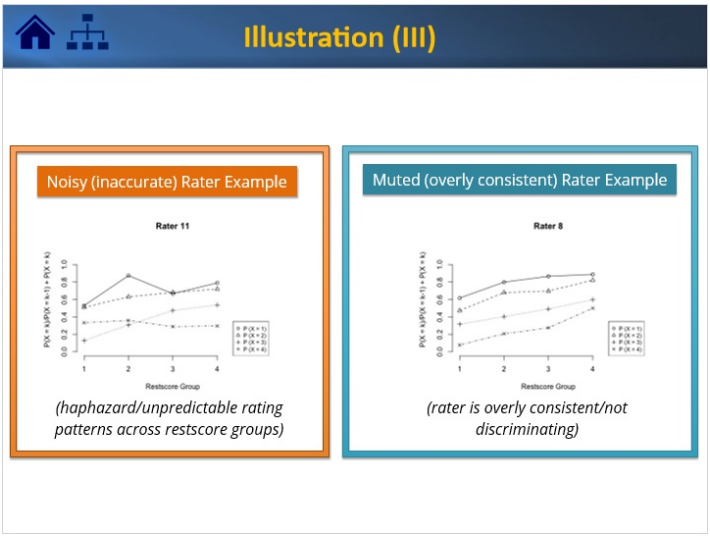
4.18 ACMs: Introduction (IV)



4.19 RMs: Illustration (II)



4.20 RMs: Illustration (III)



4.21 RMs: Illustration (IV)

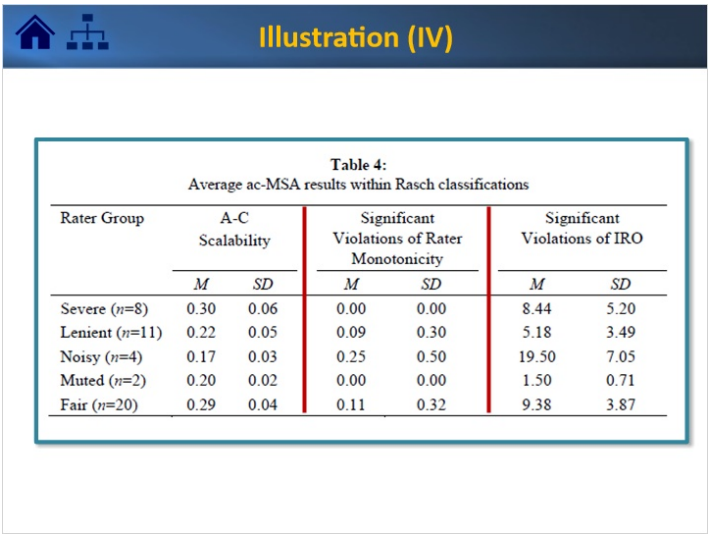
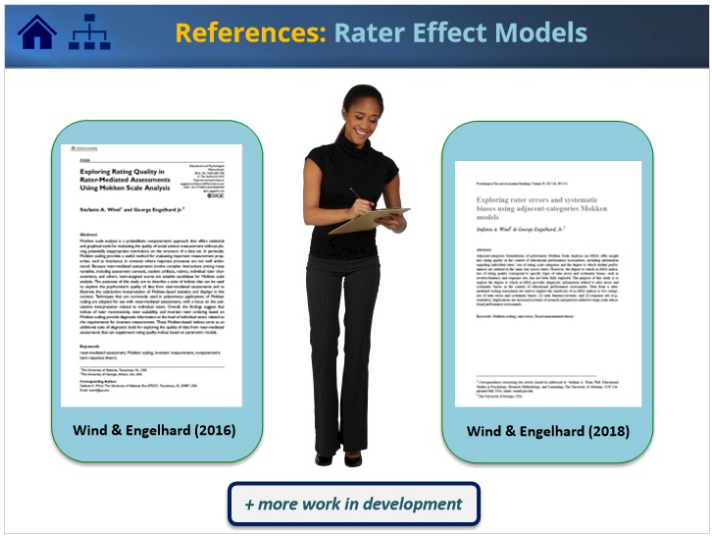


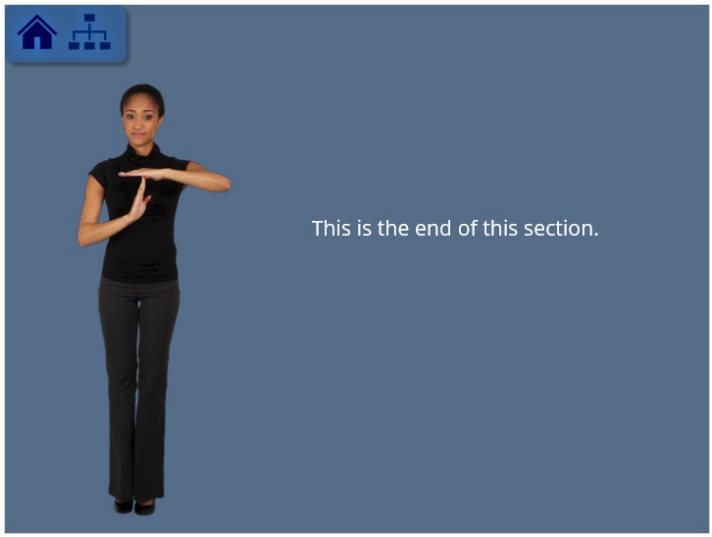
Table 4:
Average ac-MSA results within Rasch classifications

Rater Group	A-C Scalability		Significant Violations of Rater Monotonicity		Significant Violations of IRO	
	M	*SD*	*M*	*SD*	*M*	*SD*
Severe (n=8)	0.30	0.06	0.00	0.00	8.44	5.20
Lenient (n=11)	0.22	0.05	0.09	0.30	5.18	3.49
Noisy (n=4)	0.17	0.03	0.25	0.50	19.50	7.05
Muted (n=2)	0.20	0.02	0.00	0.00	1.50	0.71
Fair (n=20)	0.29	0.04	0.11	0.32	9.38	3.87

4.22 RMs: References

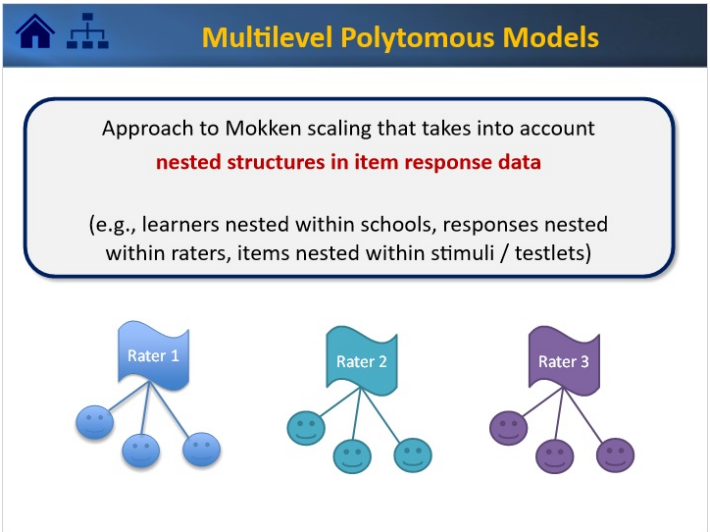


4.23 Bookend: Rater Models

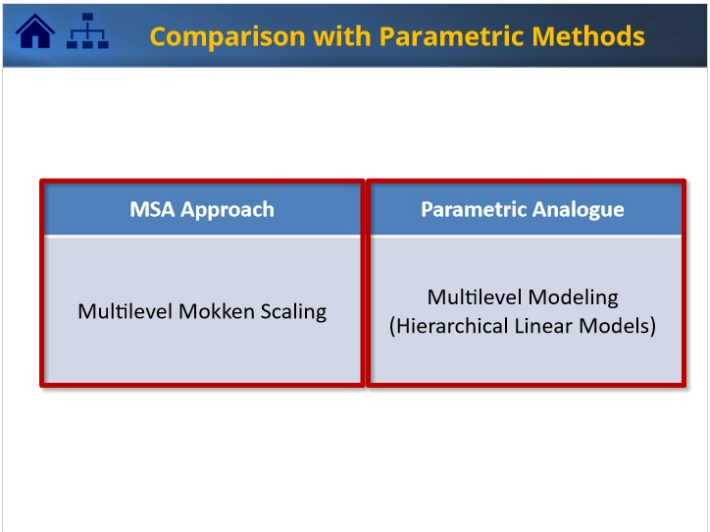


4.24 Bookmark: Multilevel Models

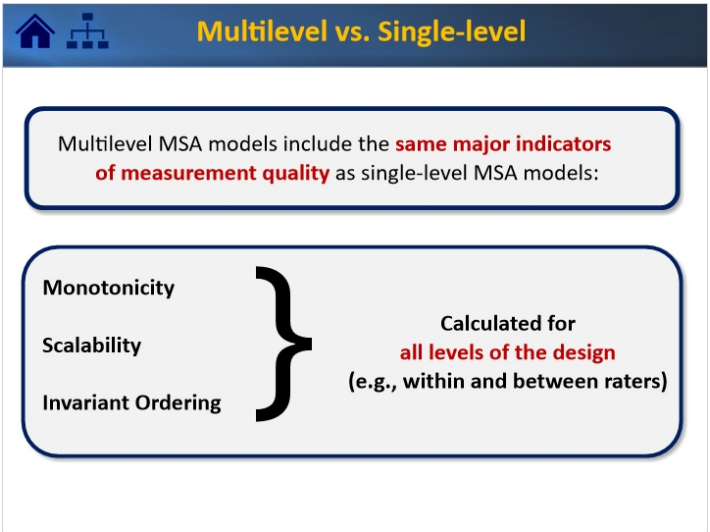
4.25 MLMs: Introduction (I)



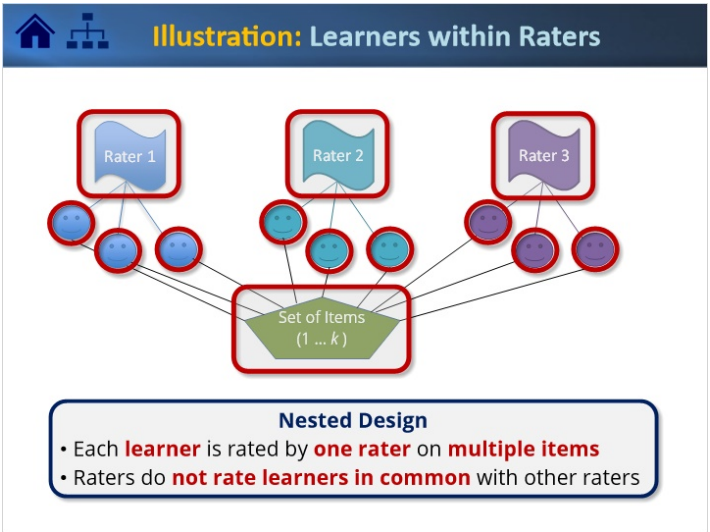
4.26 MLMs: Introduction (II)



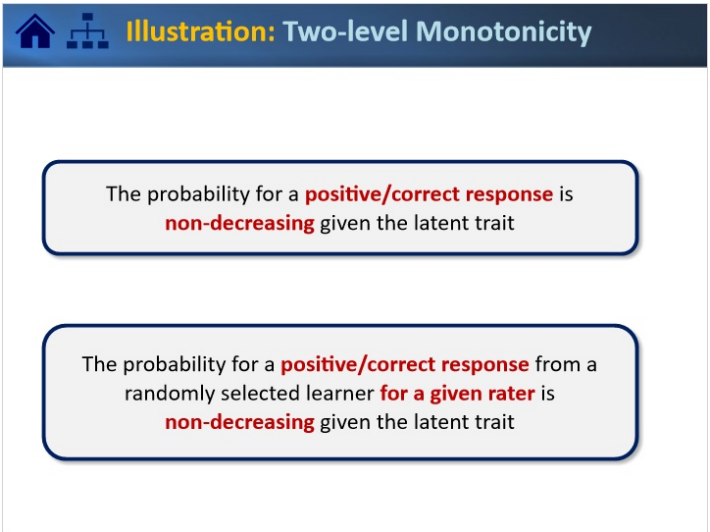
4.27 MLMs: Introduction (III)



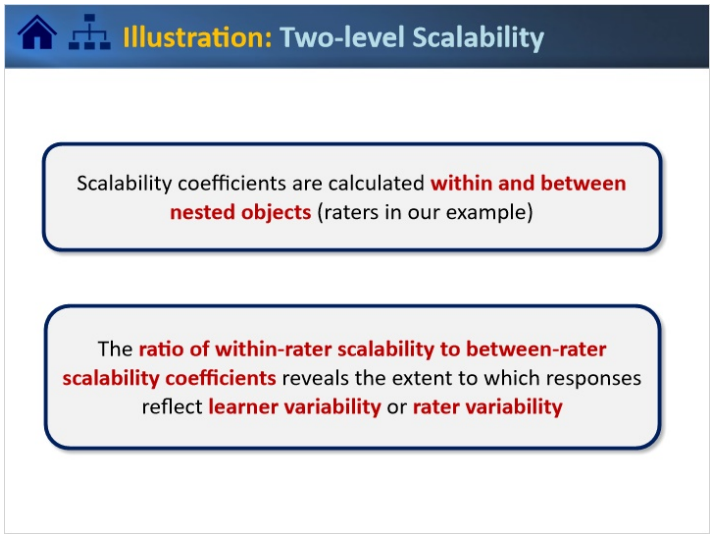
4.28 MLMs: Illustration: Learners within Raters



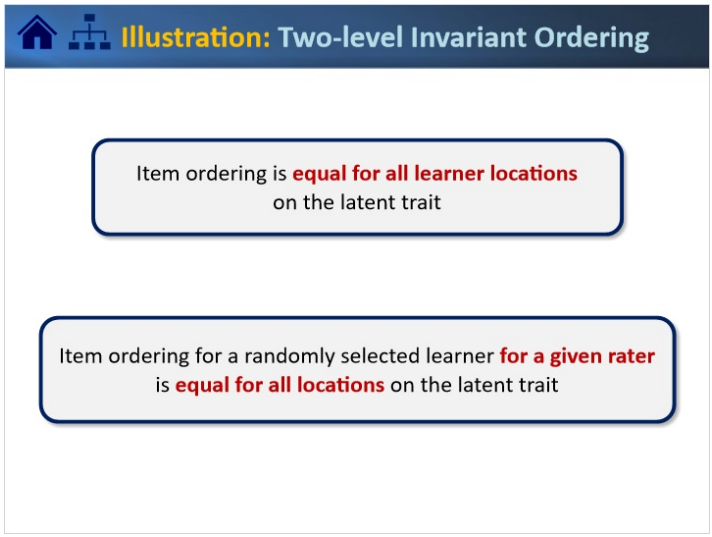
4.29 MLMs: Illustration: Two-level Monotonicity



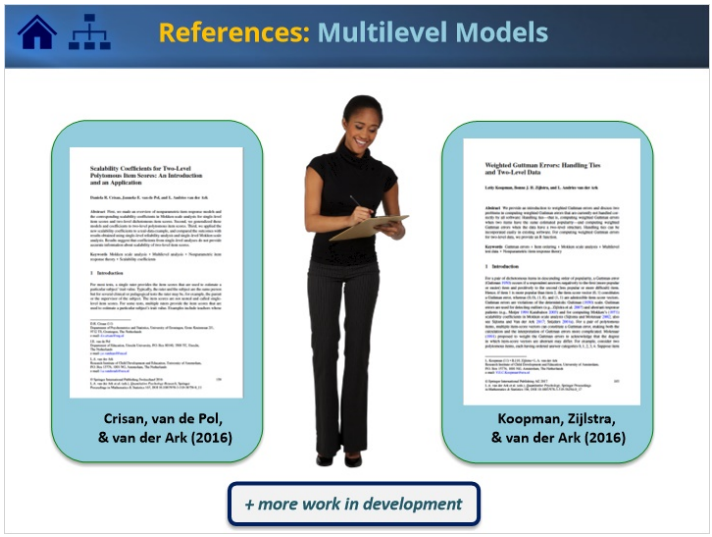
4.30 MLMs: Illustration: Two-level Scalability



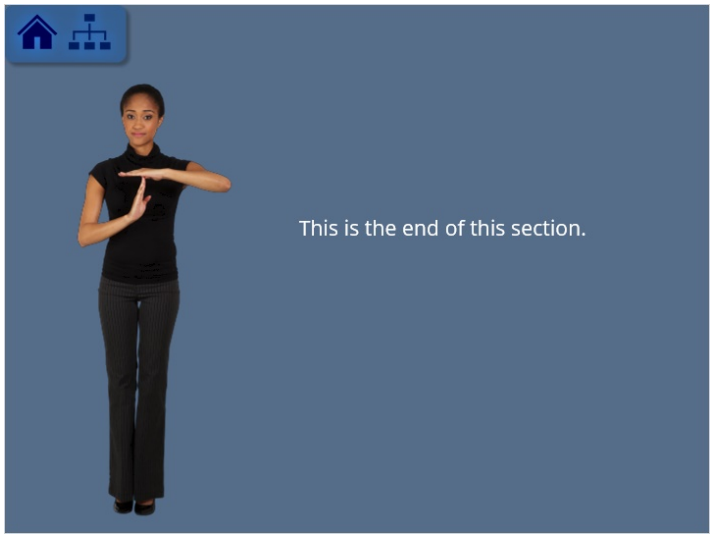
4.31 MLMs: Illustration: Two-level Invariant Ordering



4.32 MLMs: References

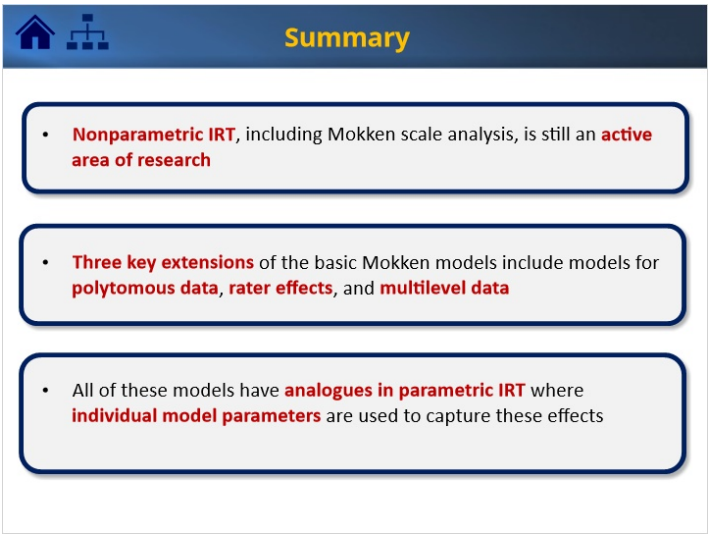


4.33 Bookend: Multilevel Models

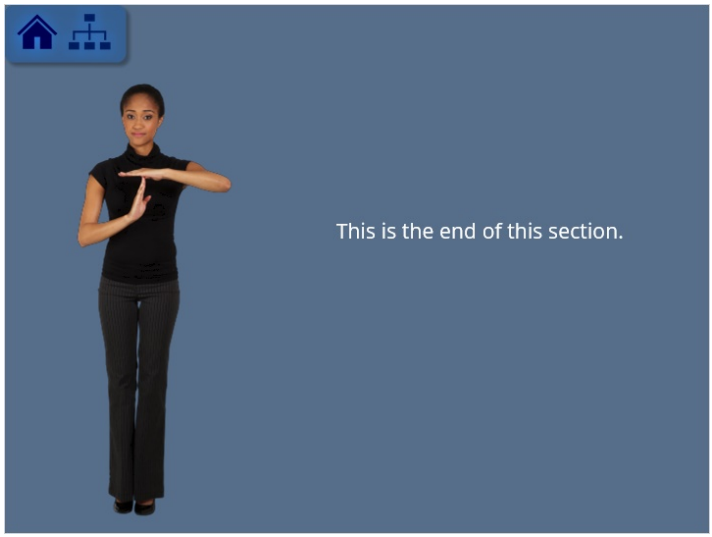


4.34 Bookmark: Summary

4.35 Summary: Section 3

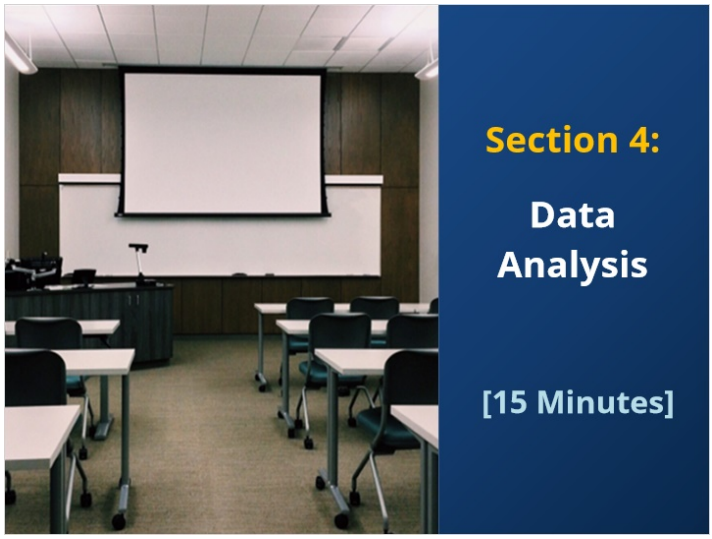


4.36 Bookend: Summary

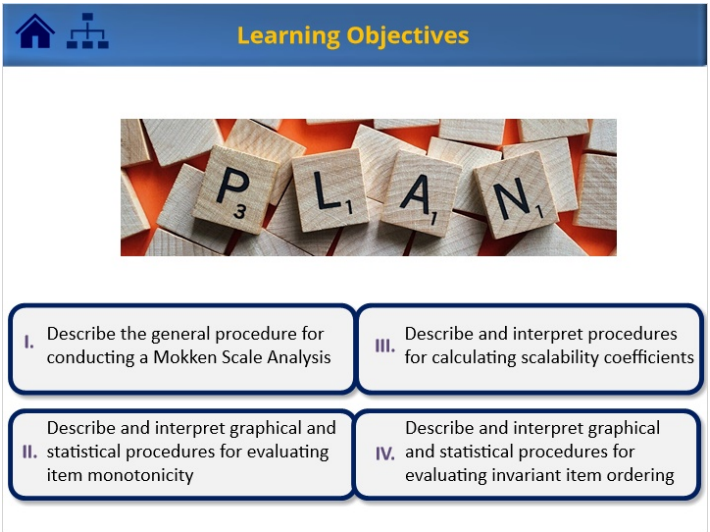


5. Section 4: Data Analysis

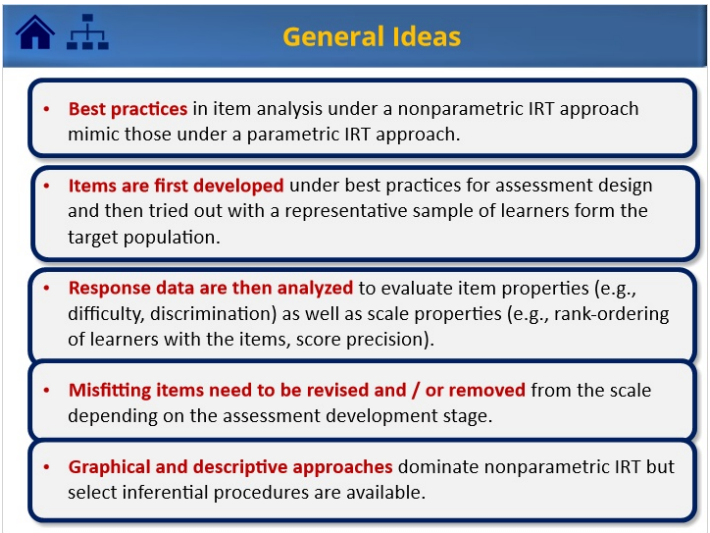
5.1 Cover: Section 4



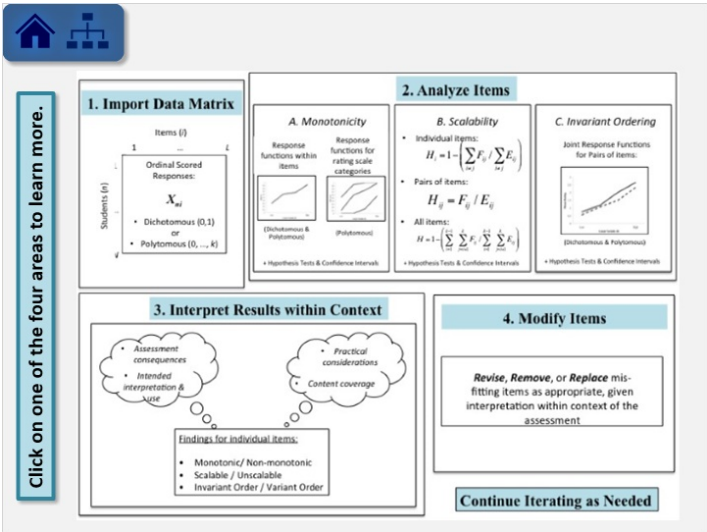
5.2 Objectives: Section 4



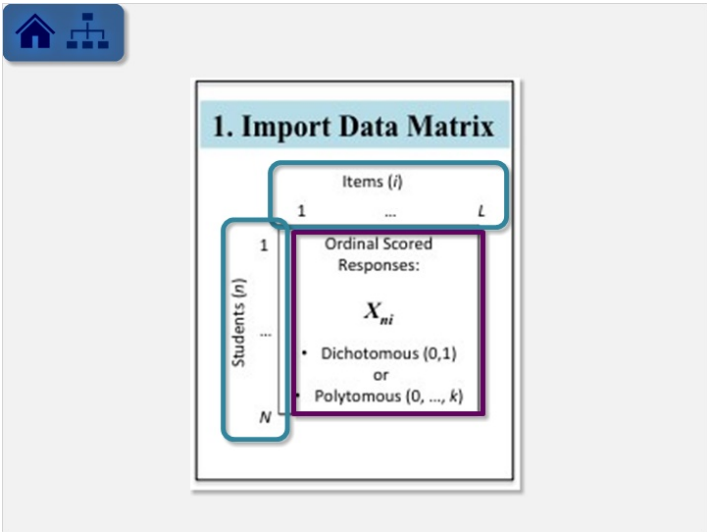
5.3 General Ideas



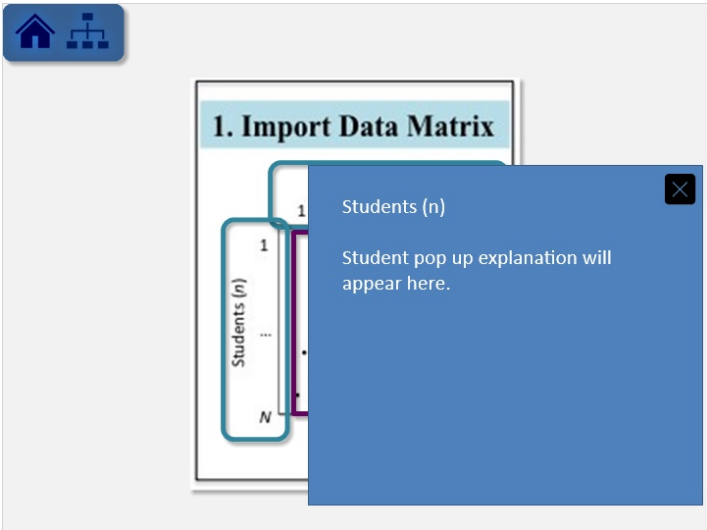
5.4 Activity Selection



5.5 Step 1



Student Pop (Slide Layer)



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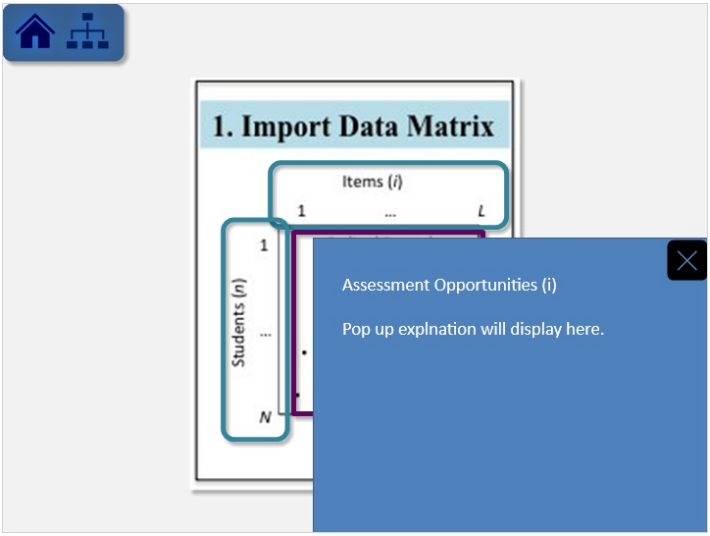
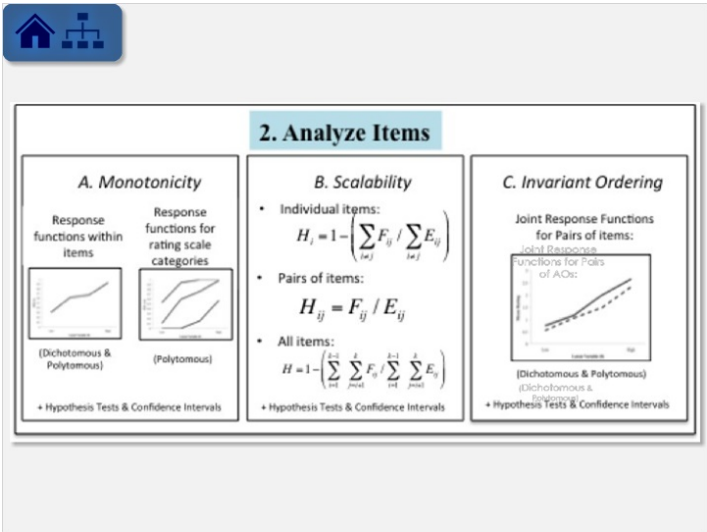
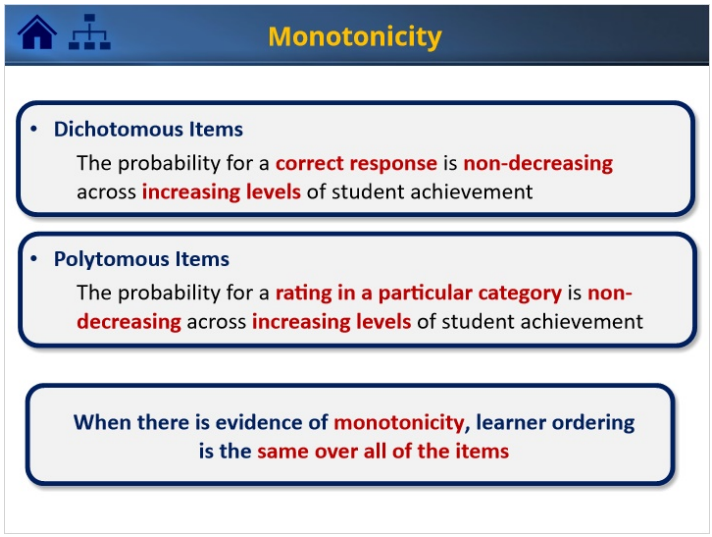


5.6 Step 2: Topic Selection

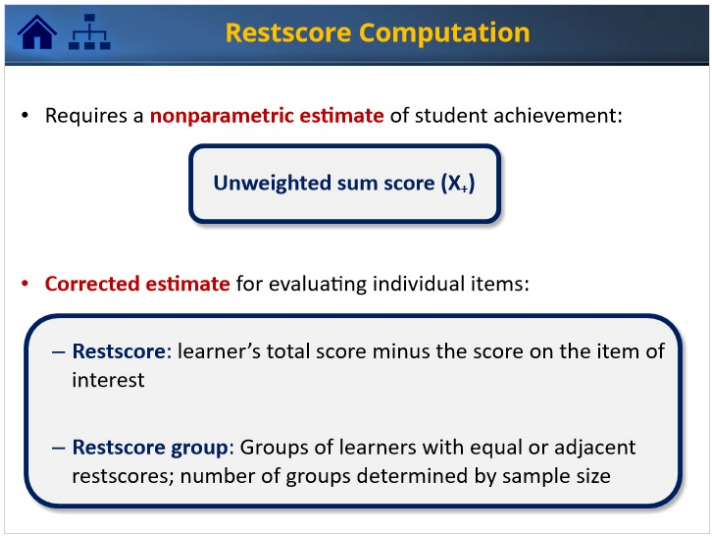


5.7 Bookmark: Monotonicity

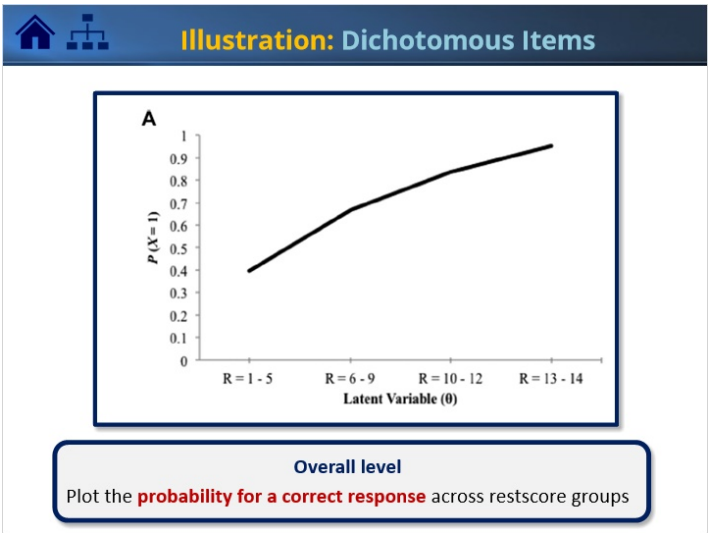
5.8 Monotonicity (I)



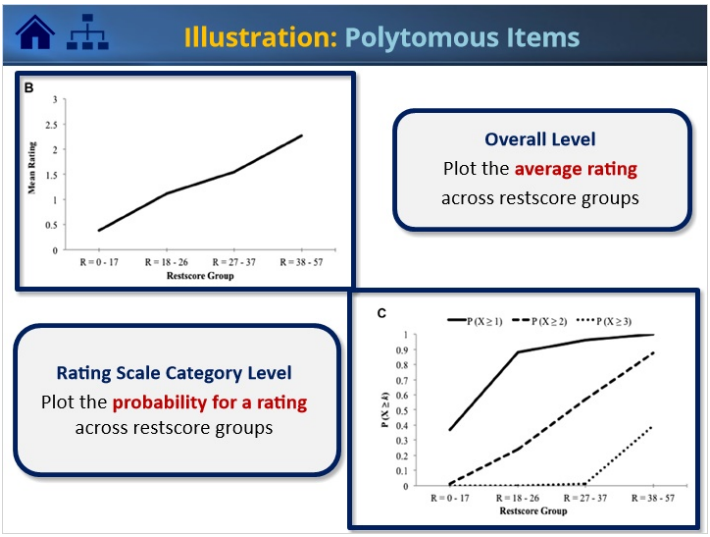
5.9 Monotonicity (II)



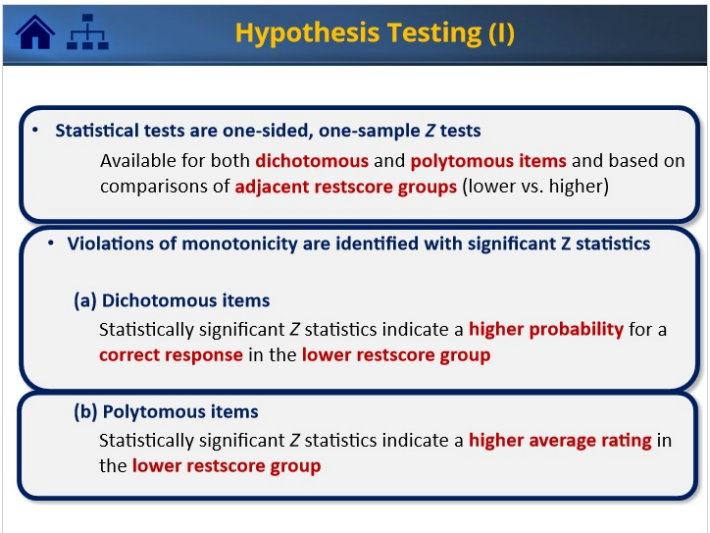
5.10 Monotonicity (III)



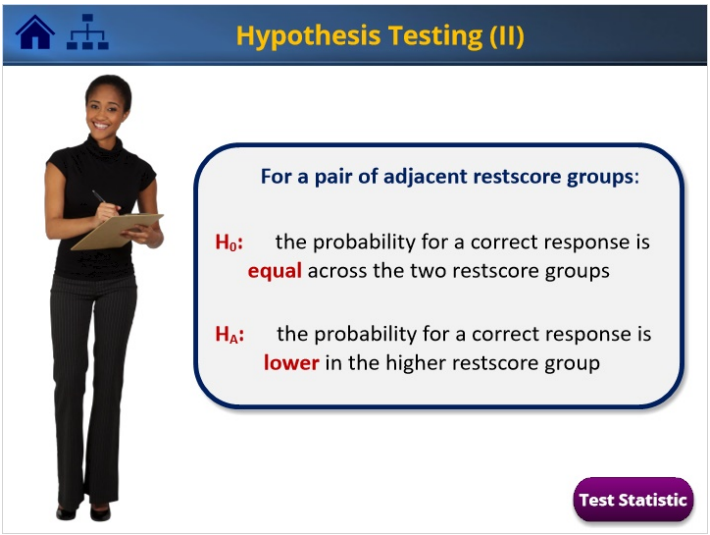
5.11 Monotonicity (IV)



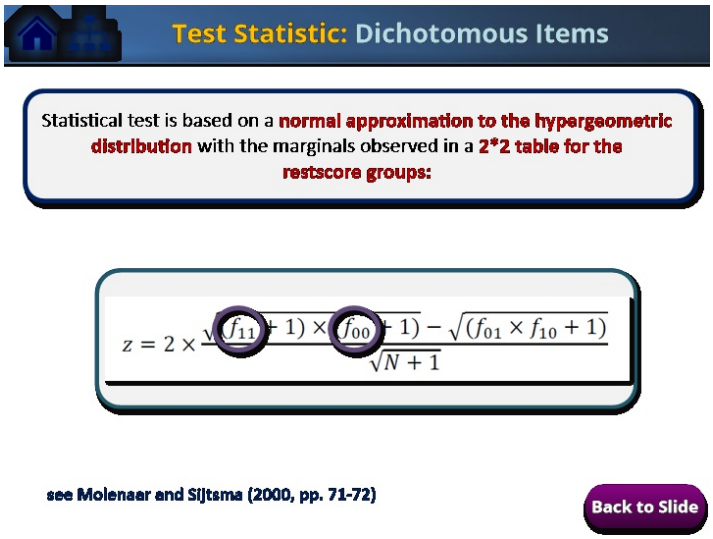
5.12 Monotonicity (V)



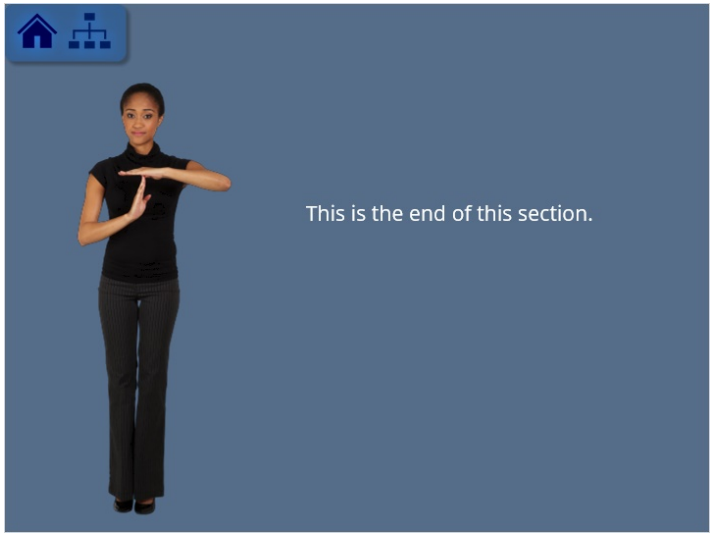
5.13 Monotonicity (VI)



Test Statistic: Dichotomous Items (Slide Layer)

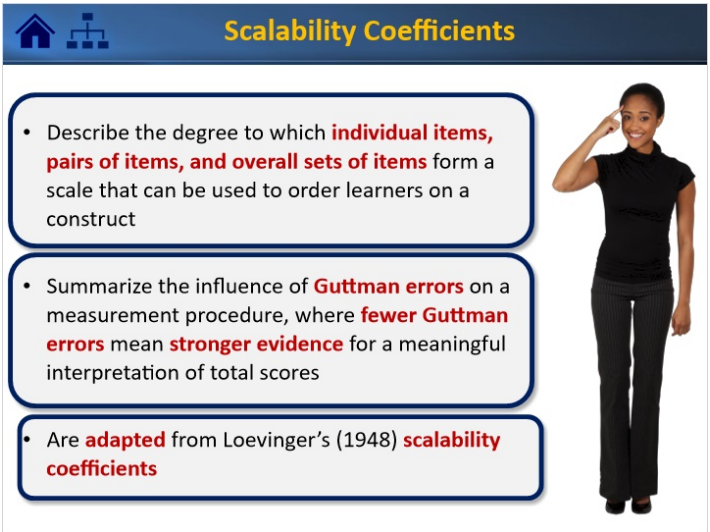


5.14 Bookend: Monotonicity

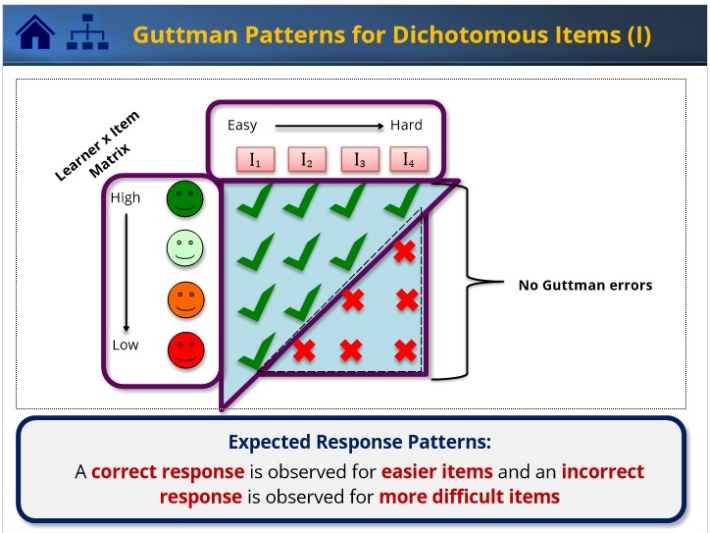


5.15 Bookmark: Scalability

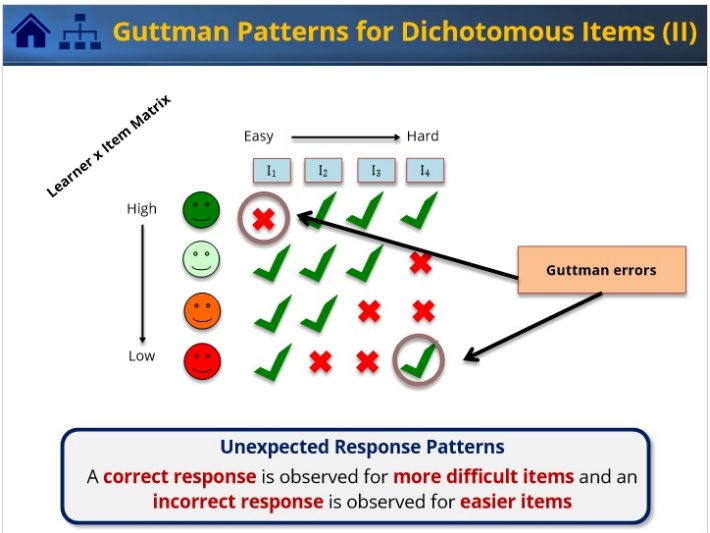
5.16 Scalability (I)



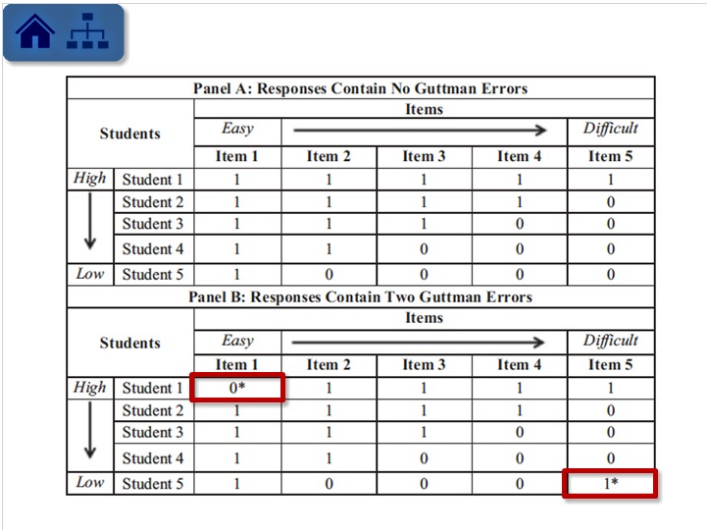
5.17 Scalability (II)



5.18 Scalability (III)



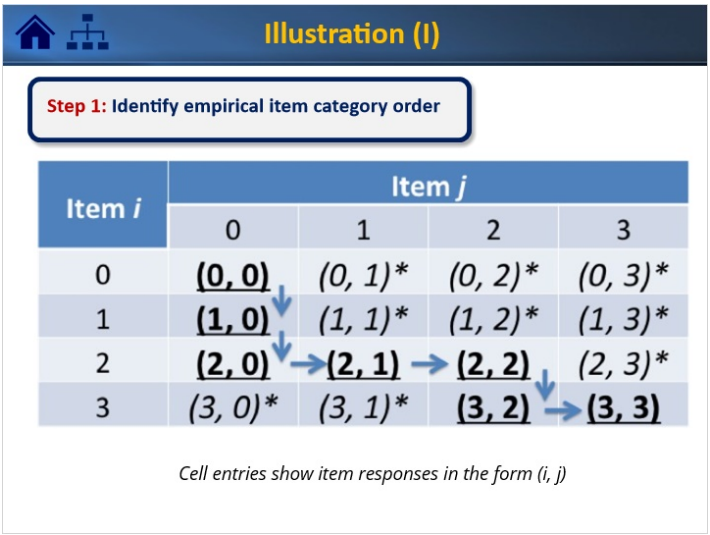
5.19 Scalability (IV)



Panel A: Responses Contain No Guttman Errors						
Students		Items				
		Easy →				*Difficult*
		Item 1	Item 2	Item 3	Item 4	Item 5
High	Student 1	1	1	1	1	1
↓	Student 2	1	1	1	1	0
	Student 3	1	1	1	0	0
	Student 4	1	1	0	0	0
Low	Student 5	1	0	0	0	0

Panel B: Responses Contain Two Guttman Errors						
Students		Items				
		Easy →				*Difficult*
		Item 1	Item 2	Item 3	Item 4	Item 5
High	Student 1	0*	1	1	1	1
↓	Student 2	1	1	1	1	0
	Student 3	1	1	1	0	0
	Student 4	1	1	0	0	0
Low	Student 5	1	0	0	0	1*

5.20 Scalability (V)



5.21 Scalability (VI)

Illustration (II)

Step 2: Use item category order to identify Guttman-expected ratings

Joint Rating (Item i, Item j)	Ordered Rating Scale Categories (Easy→ Difficult)							
	Item i = 0	Item j = 0	Item i = 1	Item i = 2	Item j = 1	Item j = 2	Item i = 3	Item j = 3
0, 0	1	1	0	0	0	0	0	0
1, 0	1	1	1	0	0	0	0	0
2, 0	1	1	1	1	0	0	0	0
2, 1	1	1	1	1	1	0	0	0
2, 2	1	1	1	1	1	1	0	0
3, 2	1	1	1	1	1	1	1	0
3, 3	1	1	1	1	1	1	1	1

Cell entries show recoded item responses where 0 = fail, 1 = pass

5.22 Scalability (VII)

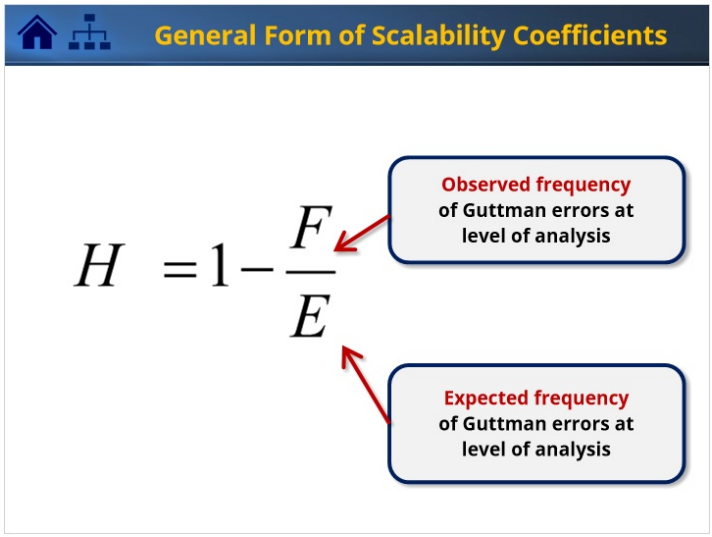
Illustration (III)

Step 3: Use item category order to identify Guttman errors

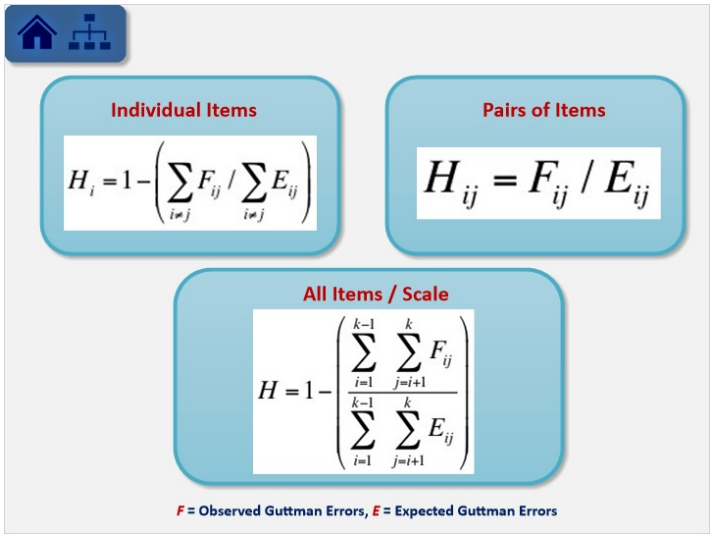
Joint Rating (Item i, Item j)	Ordered Rating Scale Categories (Easy→ Difficult)							
	Item i = 0	Item j = 0	Item i = 1	Item i = 2	Item j = 1	Item j = 2	Item i = 3	Item j = 3
0, 1	1	1	0	0	1*	0	0	0
0, 2	1	1	0	0	1*	1*	0	0
0, 3	1	1	0	0	1*	1*	0	1*
1, 1	1	1	1	0	1*	0	0	0
1, 2	1	1	1	0	1*	1	0	0
1, 3	1	1	1	1	1	1	0	1*
2, 3	1	1	1	1	1	0	0	1*
3, 0	1	0	1*	1	0	1*	1	0
3, 1	1	1	0	0	1*	0	0	0

Cell entries show recoded item responses where 0 = fail, 1 = pass

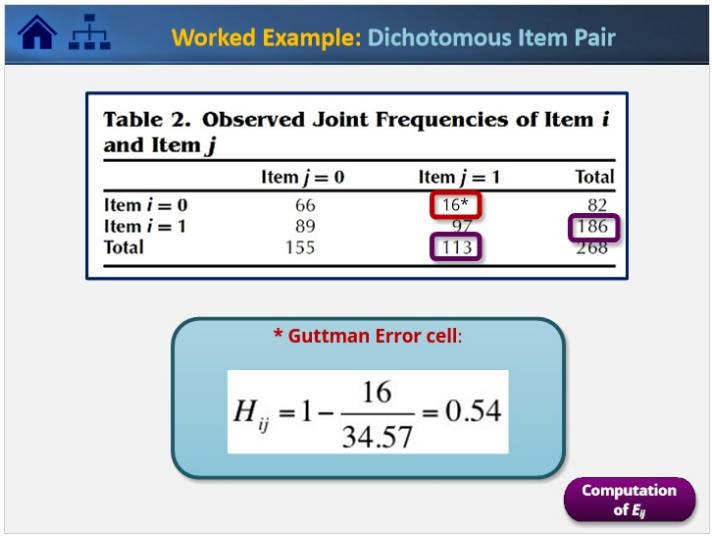
5.23 Scalability (VIII)



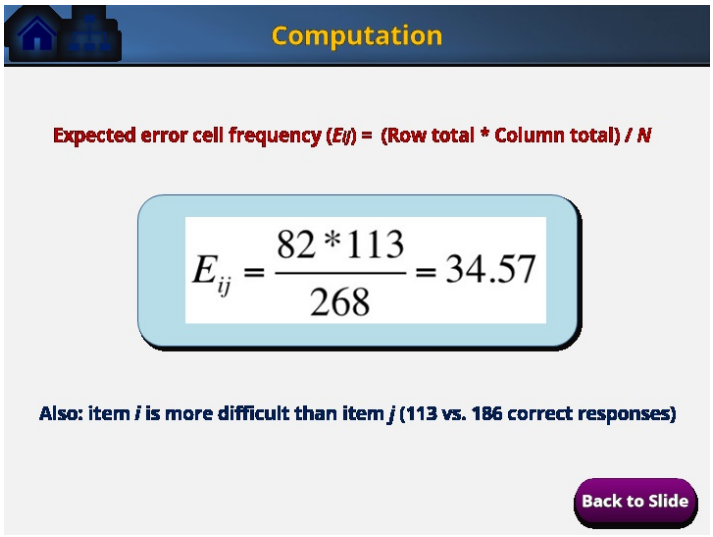
5.24 Scalability (IX)



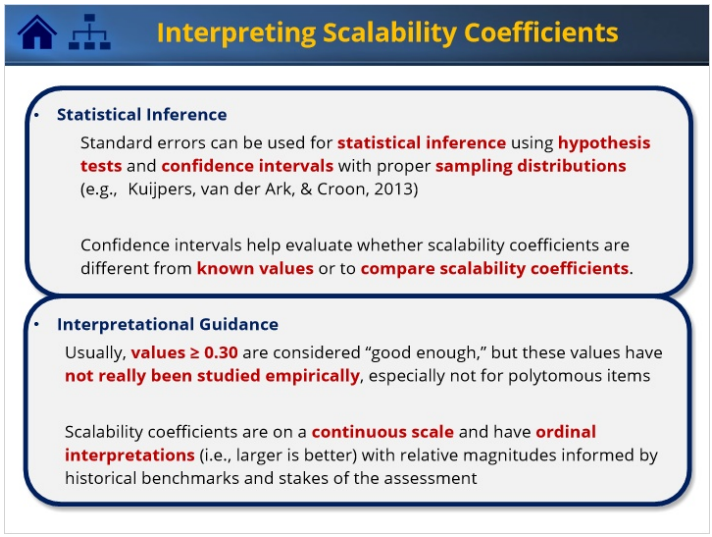
5.25 Scalability (X)



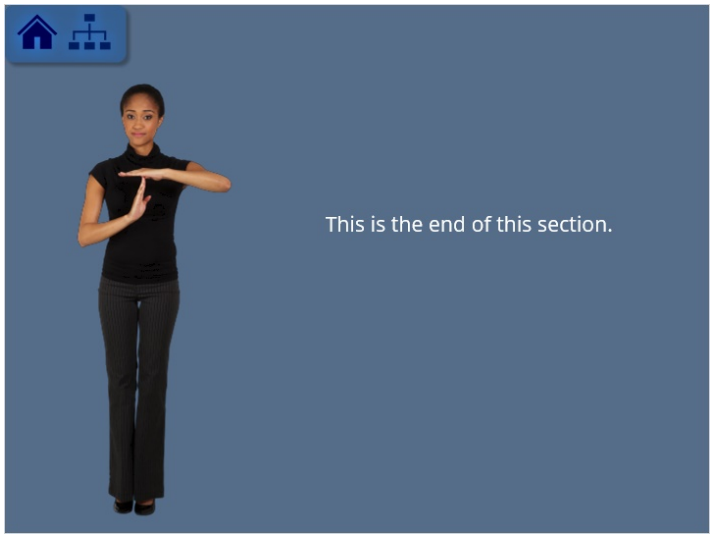
Computation (Slide Layer)



5.26 Scalability (XI)

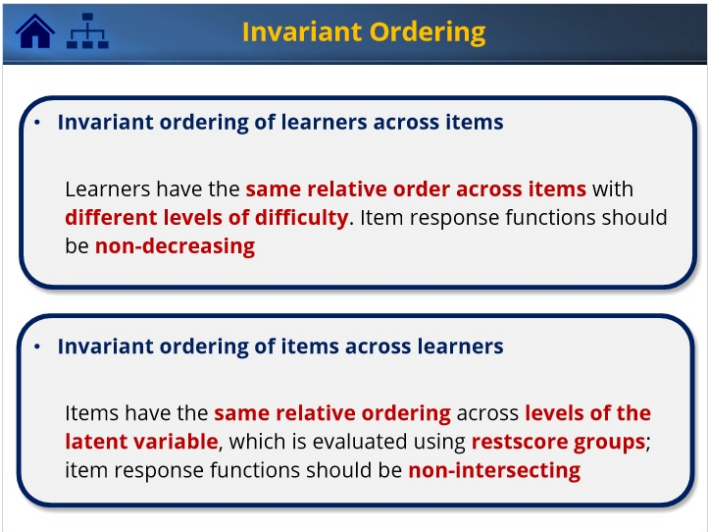


5.27 Bookend: Scalability

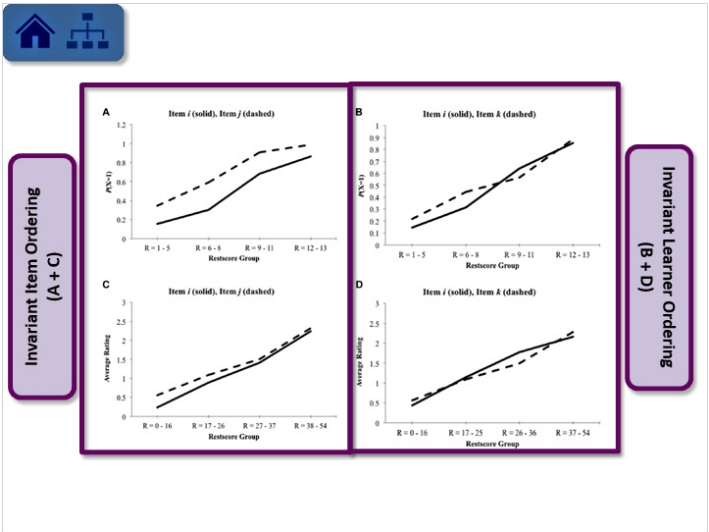


5.28 Bookmark: Invariant Item Ordering

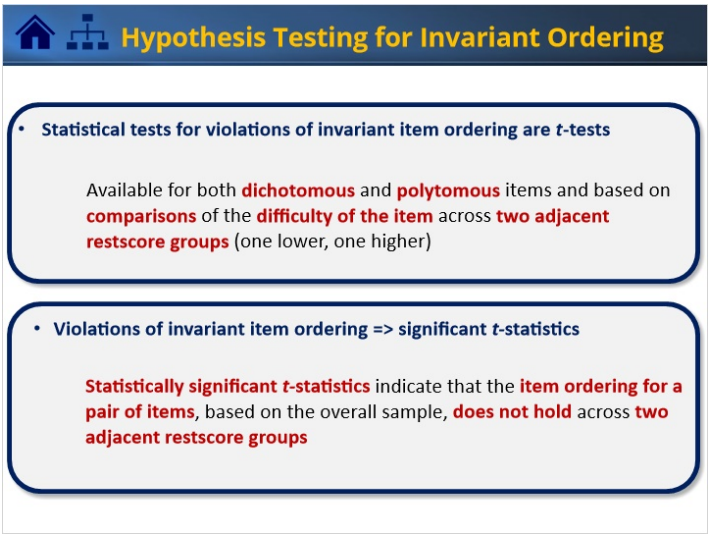
5.29 Invariant Ordering (I)



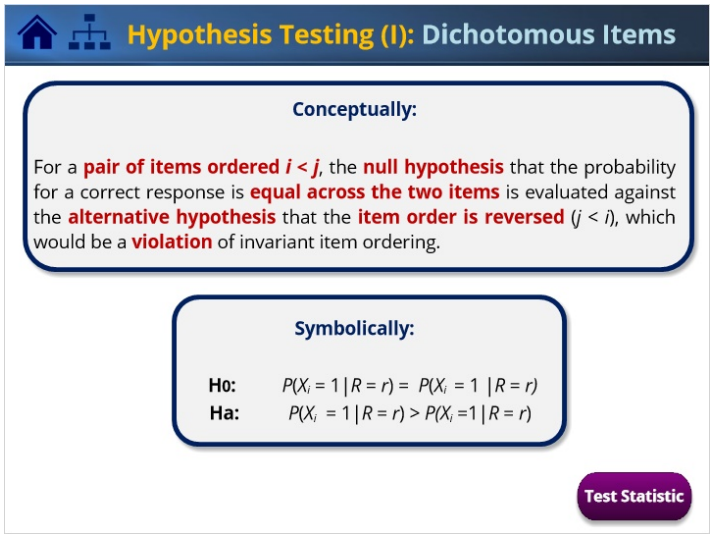
5.30 Invariant Ordering (II)



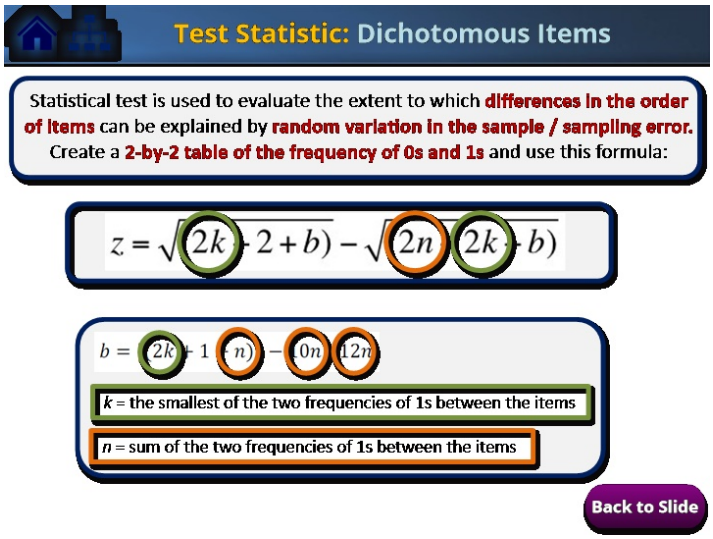
5.31 Invariant Ordering (III)



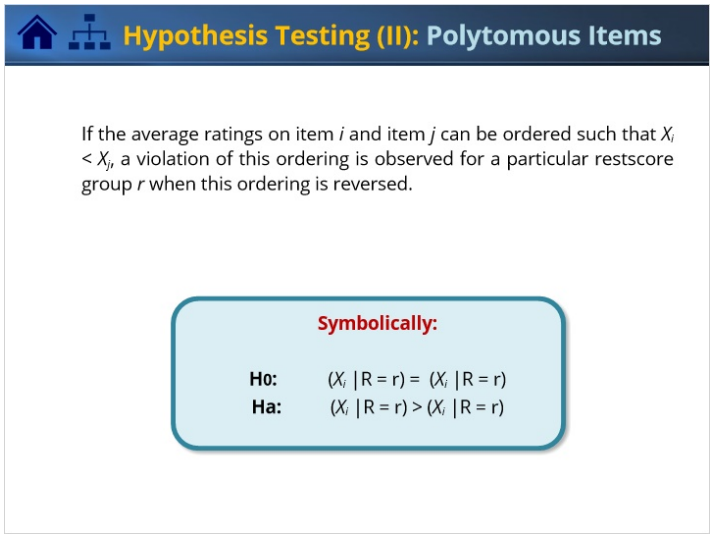
5.32 Invariant Ordering (IV)



Test Statistic (Slide Layer)

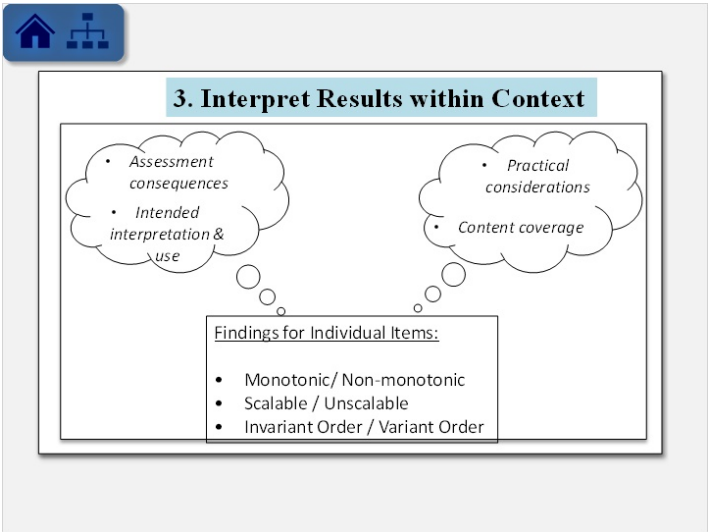


5.33 Invariant Ordering (V)

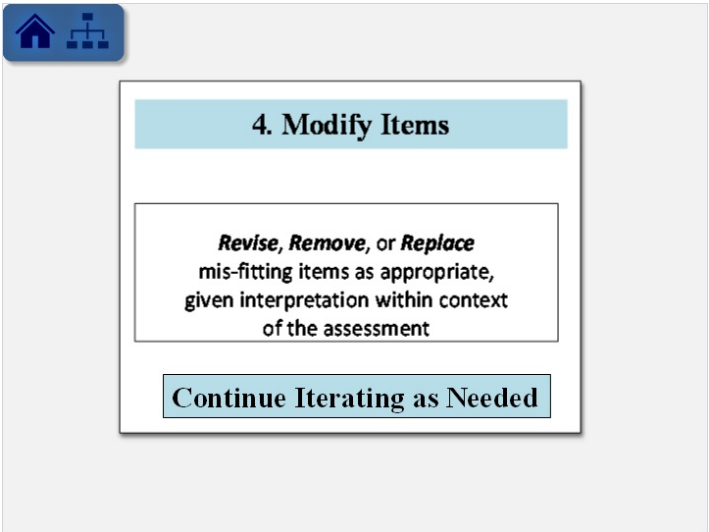


5.34 Bookend: Invariant Item Ordering

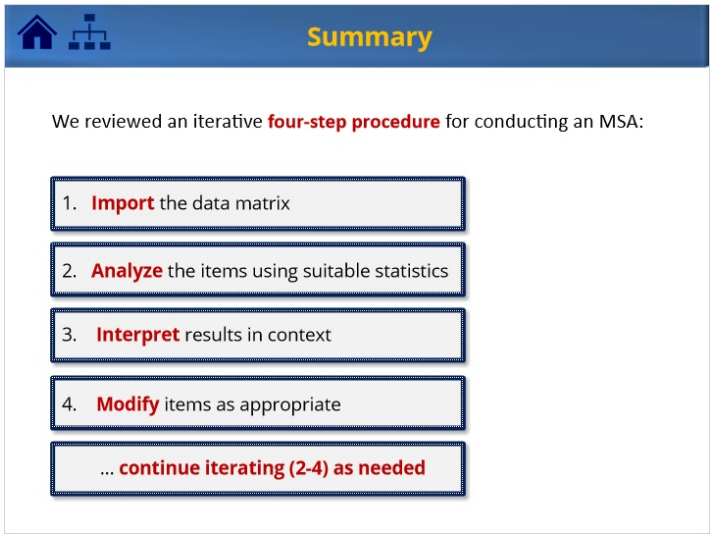
5.35 Step 3



5.36 Step 4



5.37 Summary: Section 4



5.38 Bookend: Section 4

5.39 Module Cover (END)