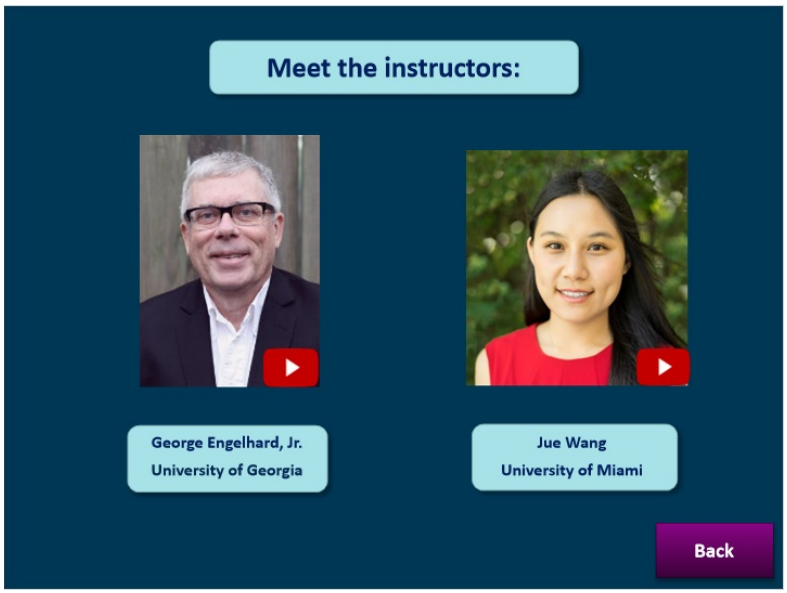
DM10 SLIDES (Rasch Measurement Theory, Version 2.1)

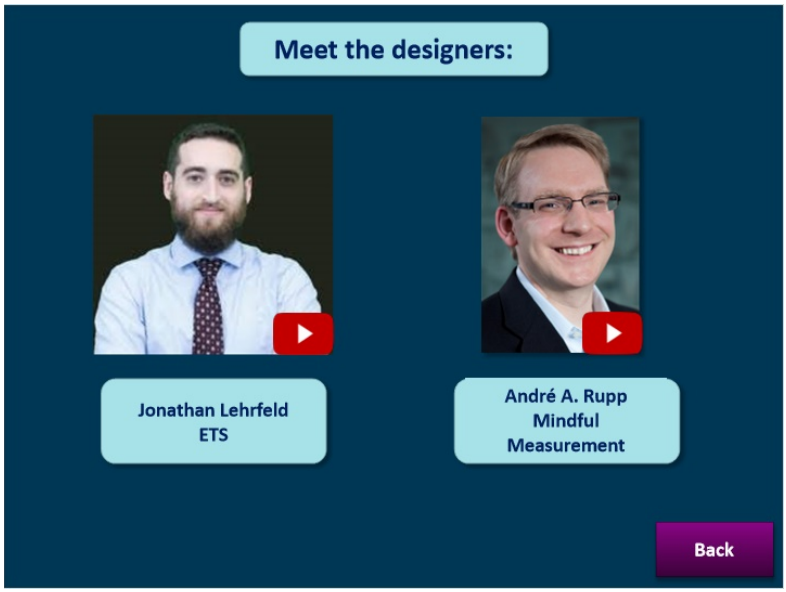
1. Module Overview

1.1 Module Cover (START)

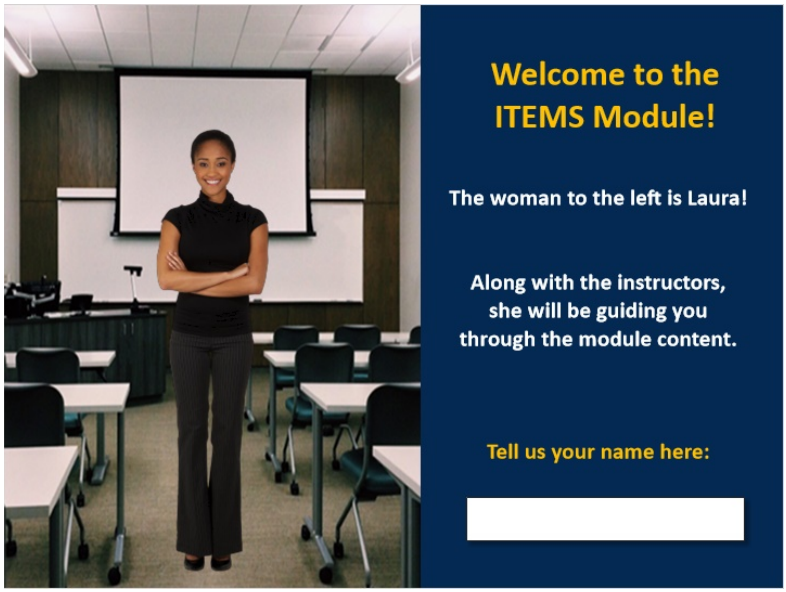
1.2 Instructors



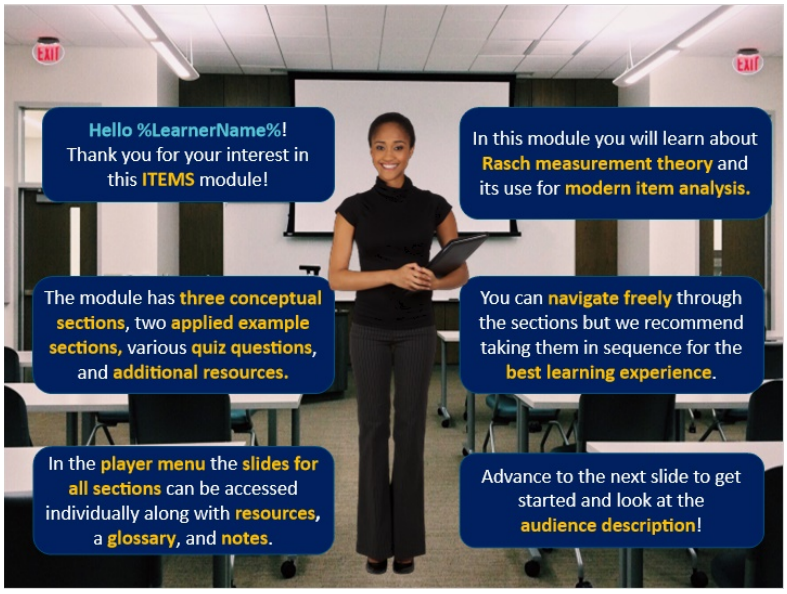
1.3 Designers



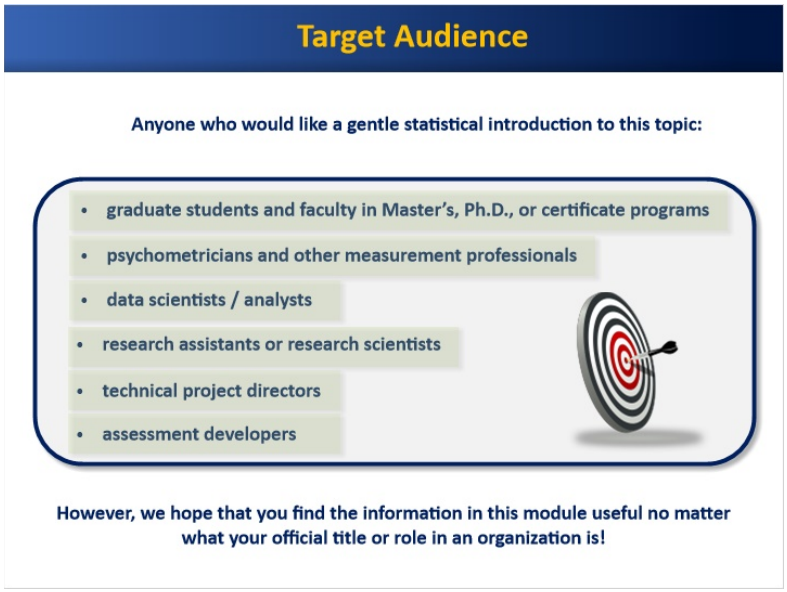
1.4 Welcome



1.5 Overview



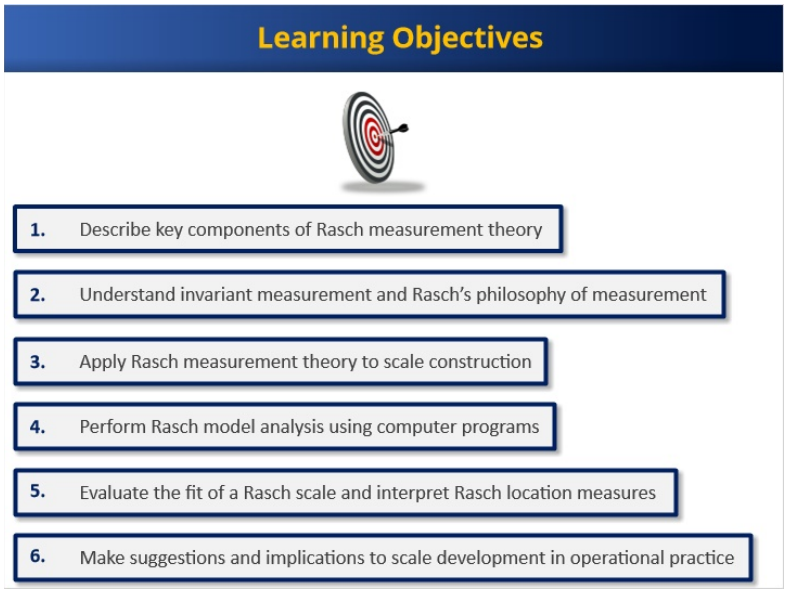
1.6 Target Audience



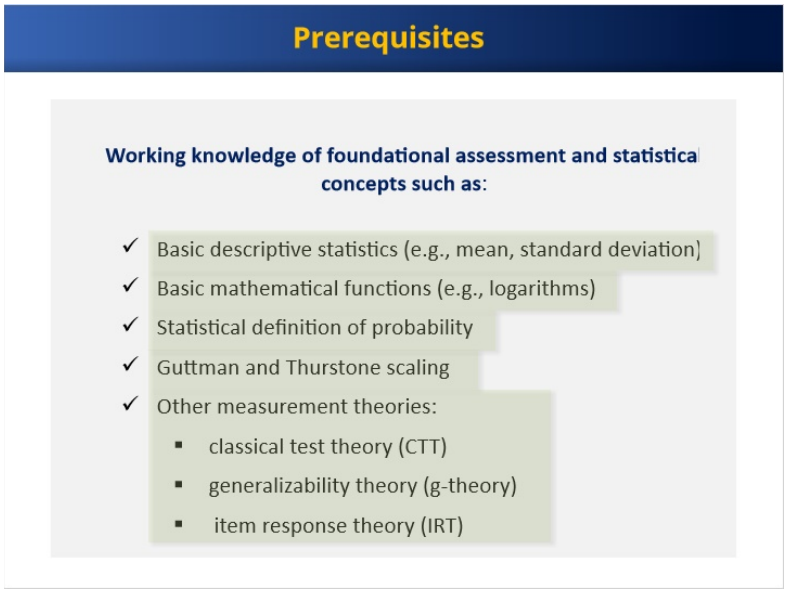
1.7 Expectations (I)

1.8 Expectations (II)

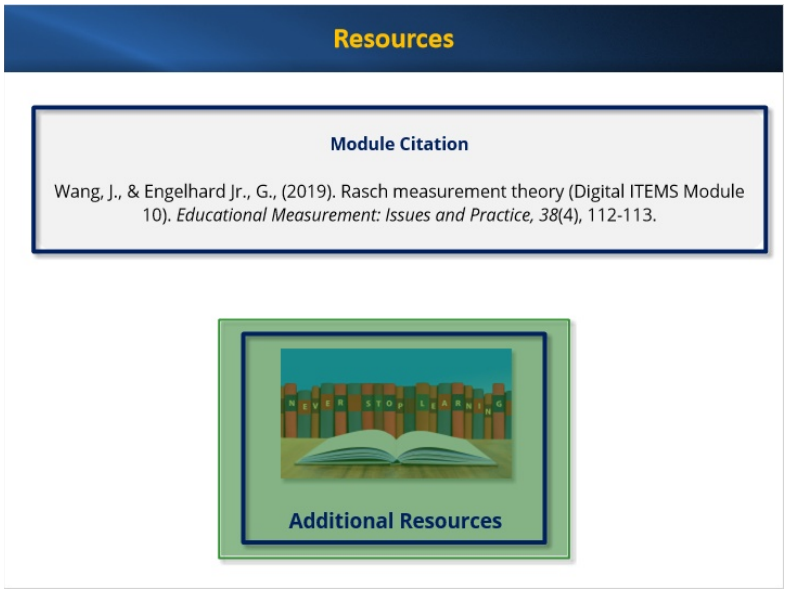
1.9 Learning Objectives



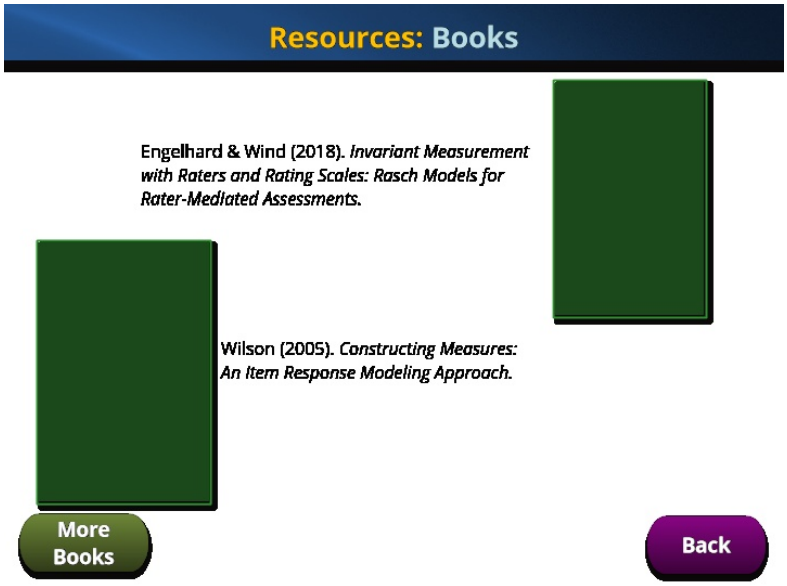
1.10 Prerequisites



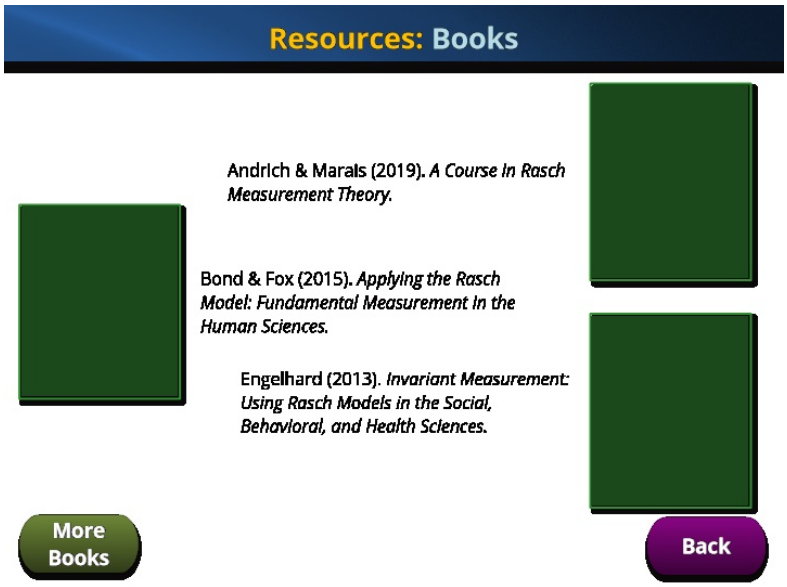
1.11 Resources



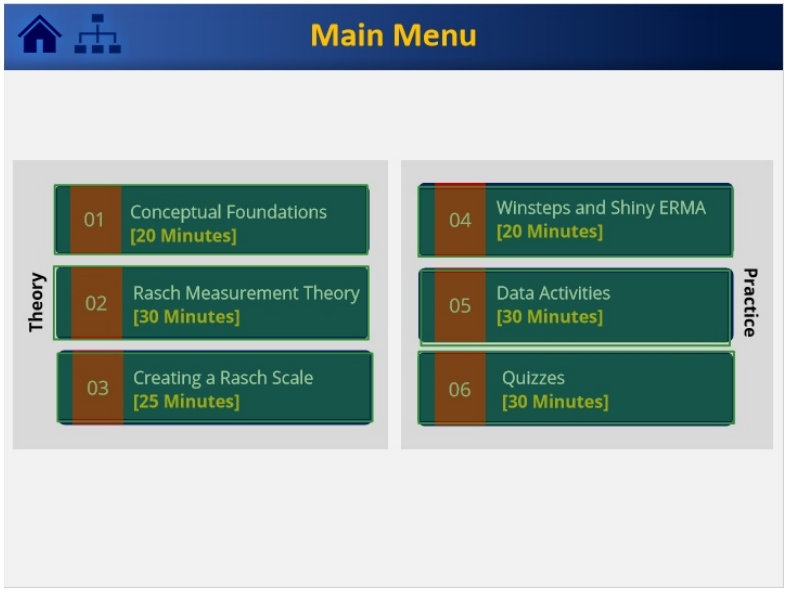
Resources 2 (Slide Layer)



Resources 1 (Slide Layer)



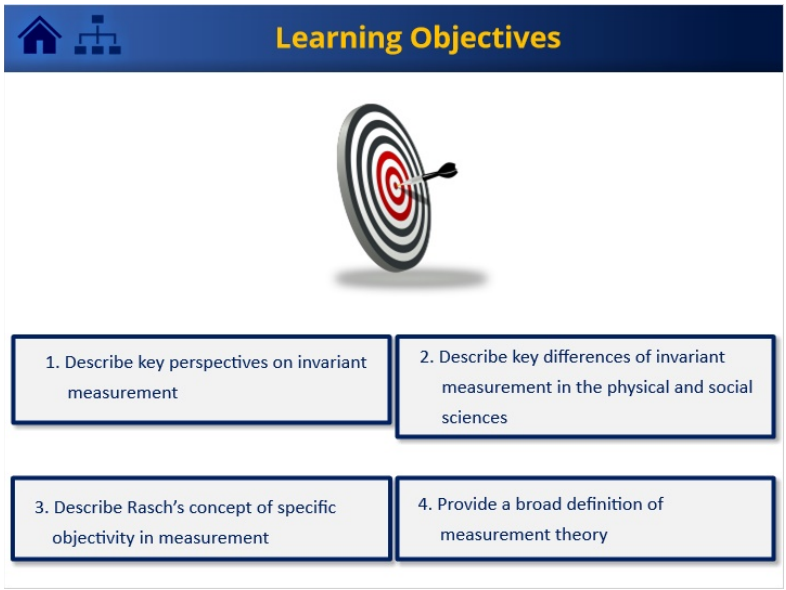
1.12 Main Menu



2. Section 1: Conceptual Foundations

2.1 Cover: Section 1

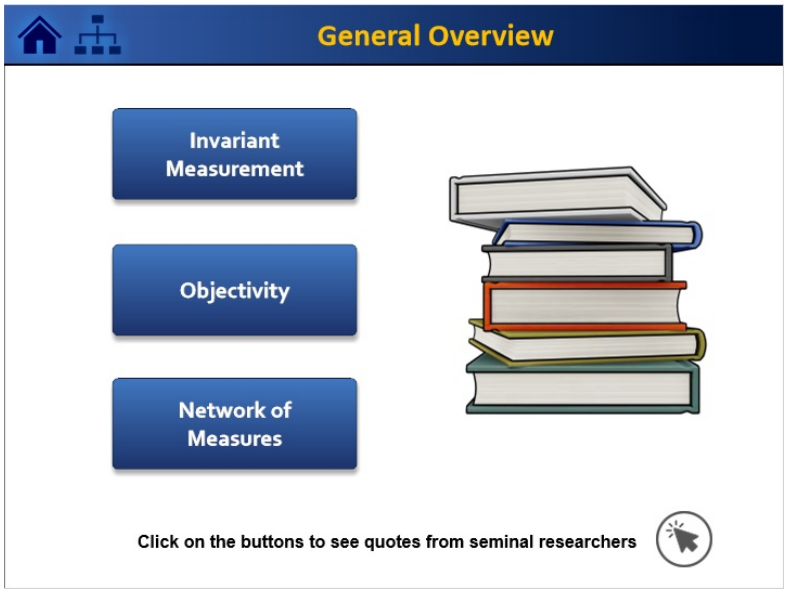
2.2 Objectives: Section 1



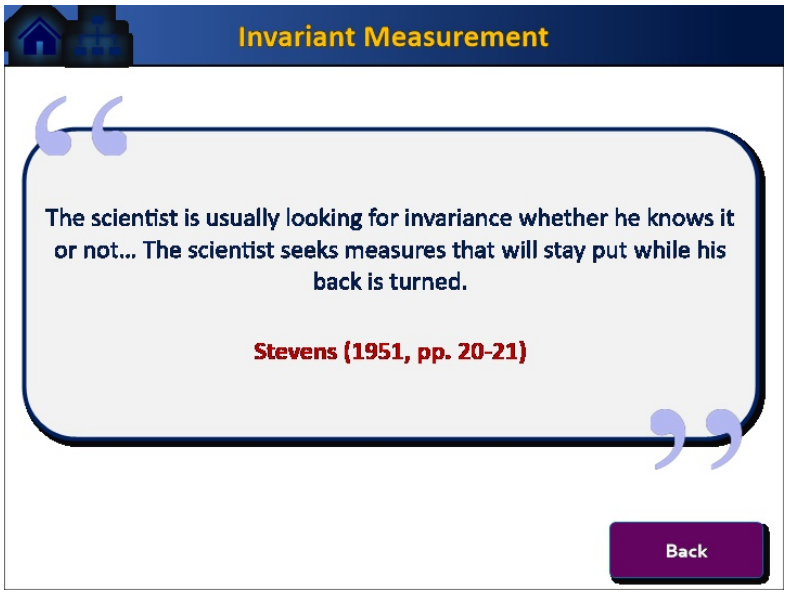
2.3 Topic Selection

2.4 Bookmark: Overview

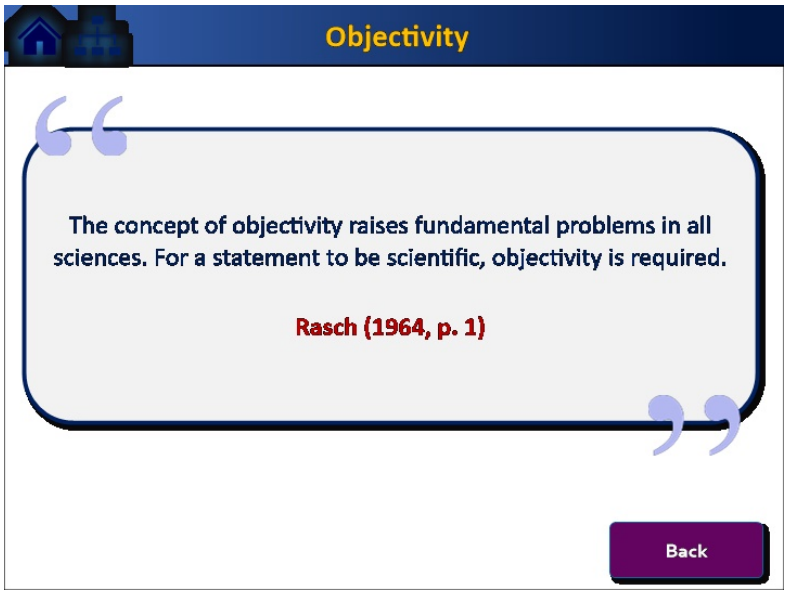
2.5 Perspectives on Invariant Measurement



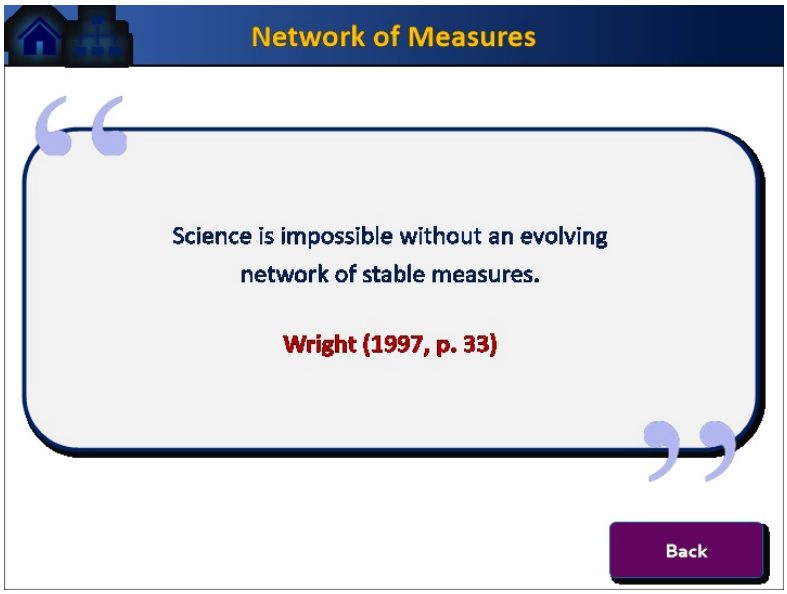
Invariant Measurement (Slide Layer)



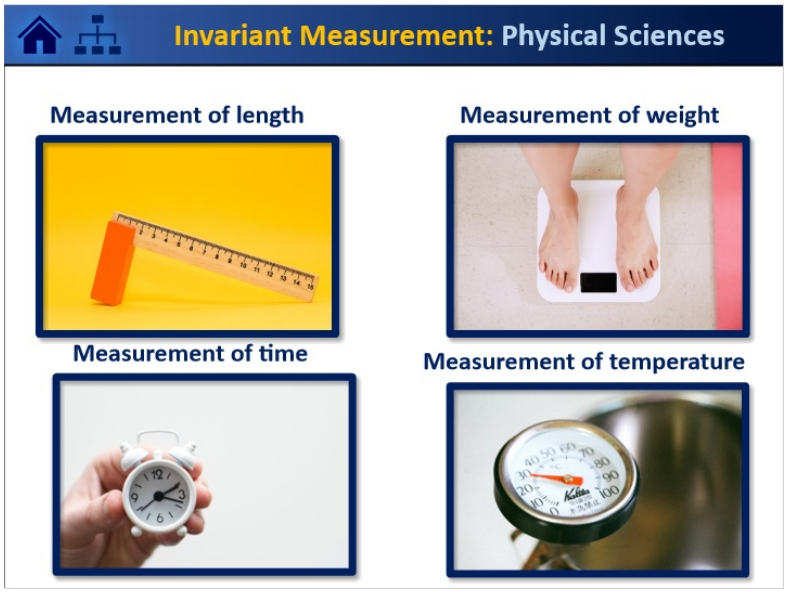
Objectivity (Slide Layer)



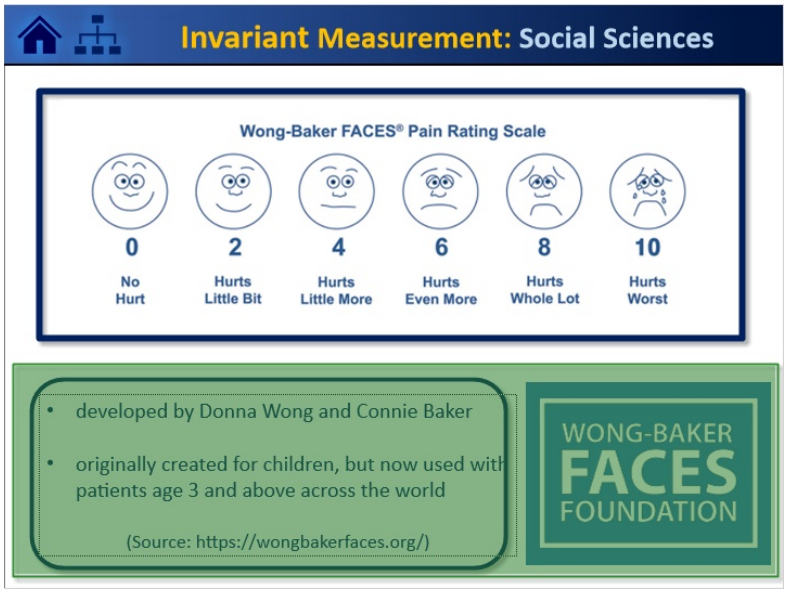
Network of Measures (Slide Layer)



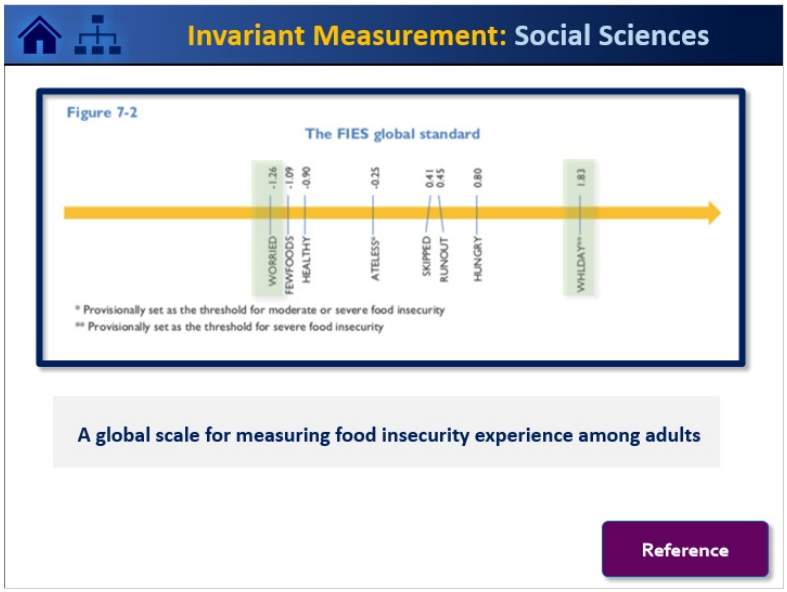
2.6 Invariant Measurement in Physical Sciences



2.7 Invariant Measurement in Social Sciences 1

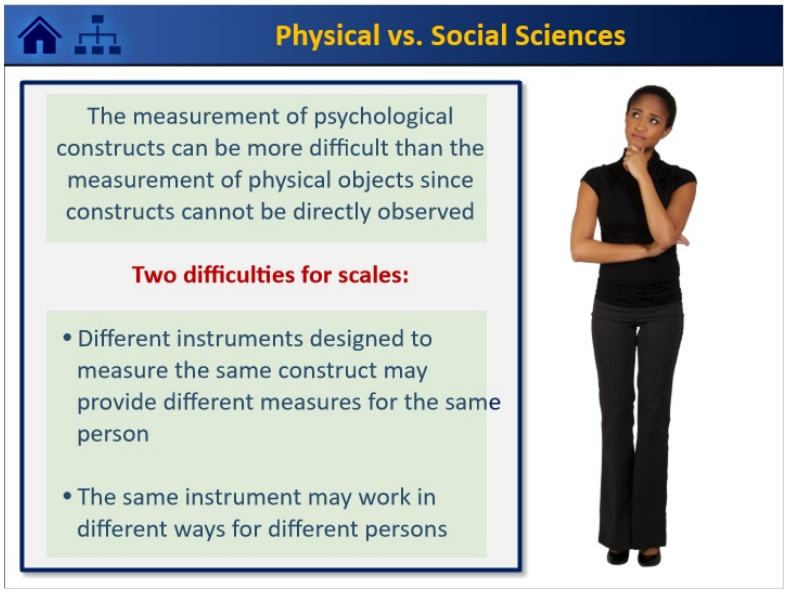


2.8 Invariant Measurement in Social Sciences 2

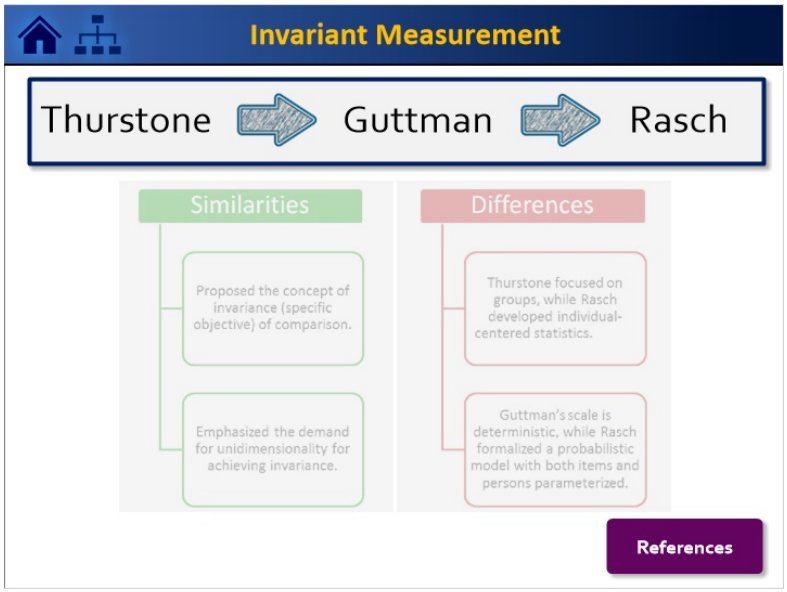


References (Slide Layer)

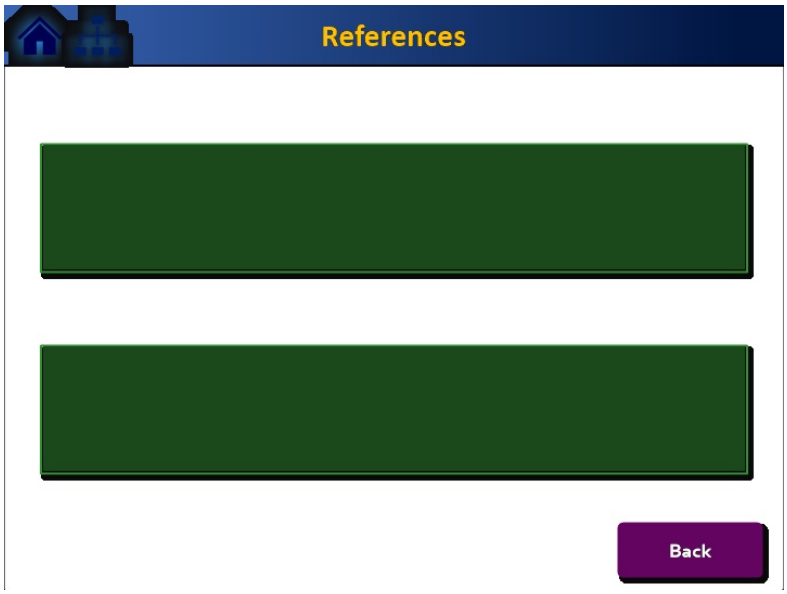
2.9 Measurement in Physical vs. Social Sciences



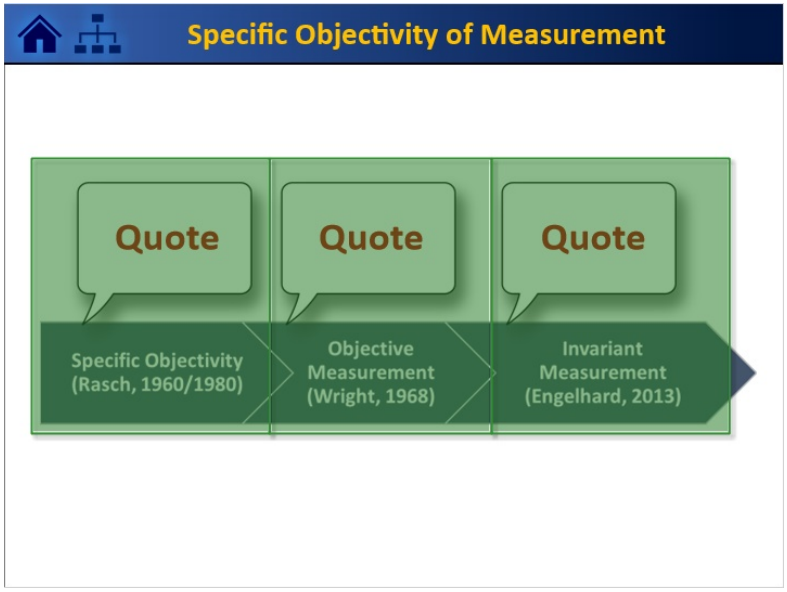
2.10 Specific Objectivity of Measurement 1



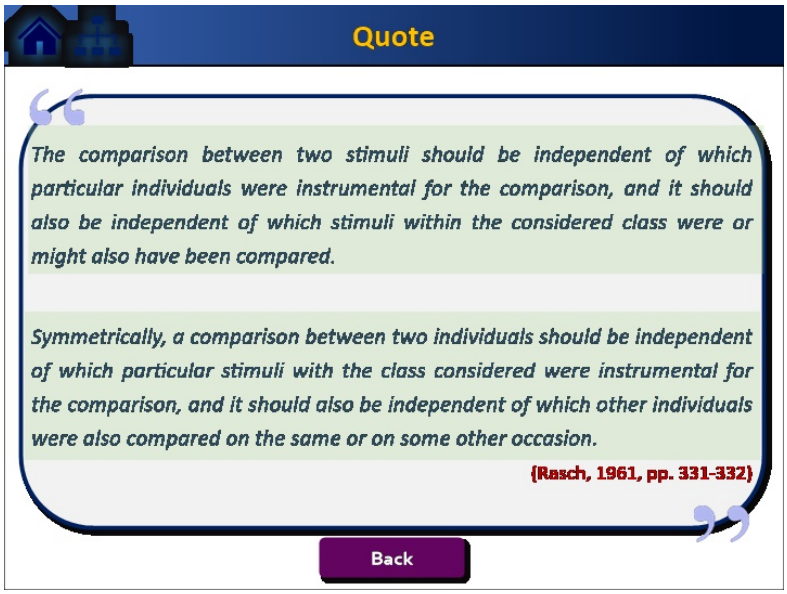
References (Slide Layer)



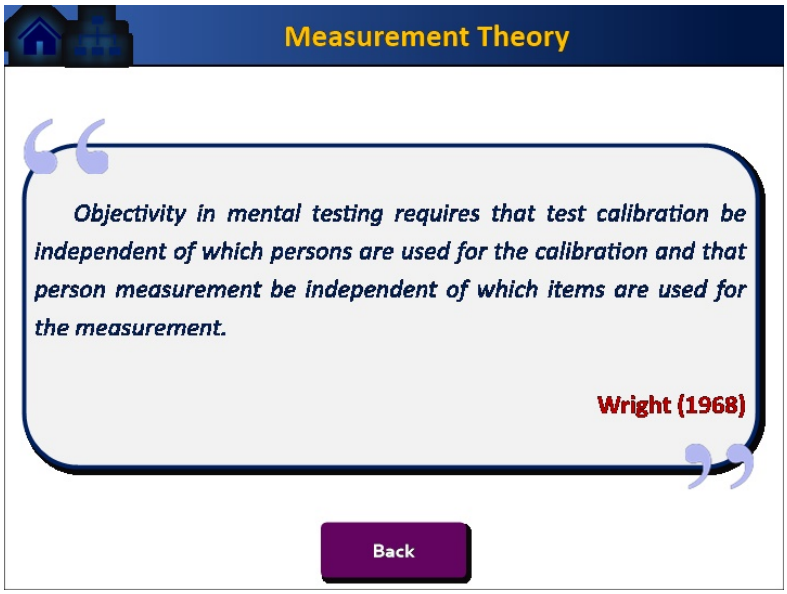
2.11 Specific Objectivity of Measurement 2



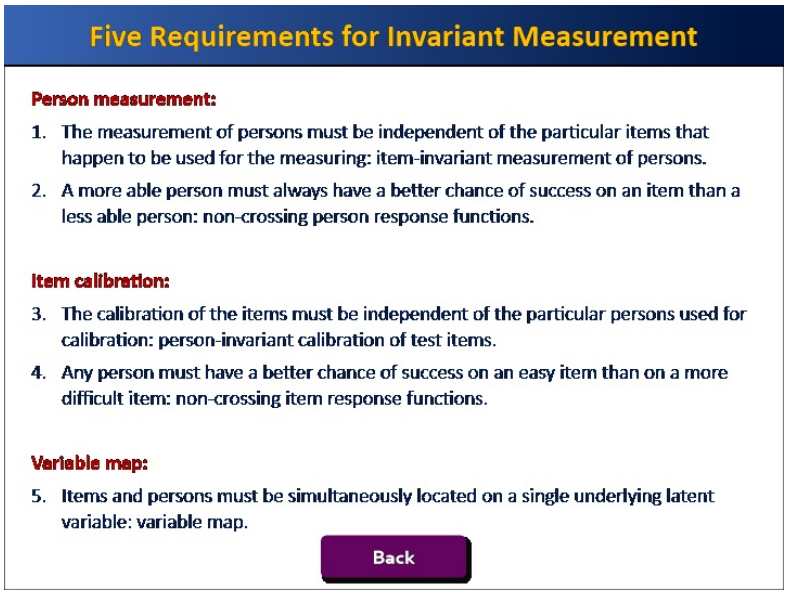
Rasch Quote (Slide Layer)



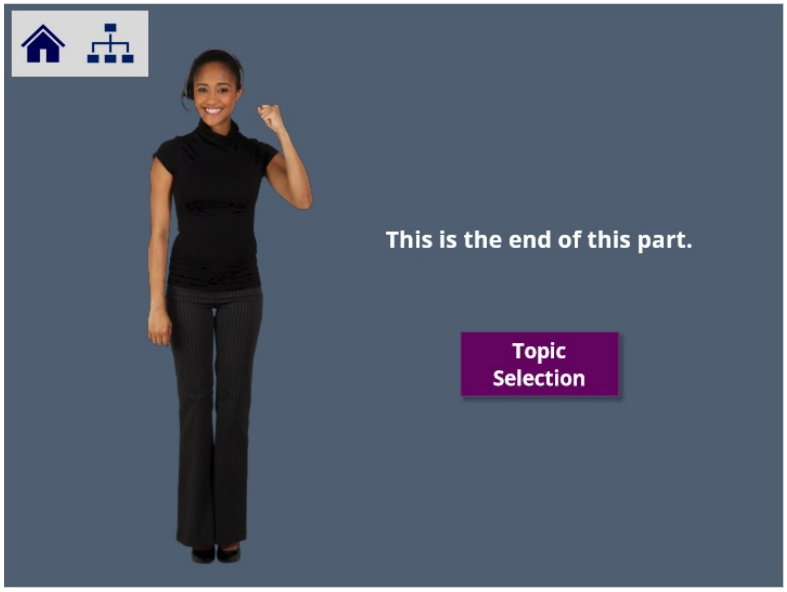
Wright Quote (Slide Layer)



Engelhard Quote (Slide Layer)

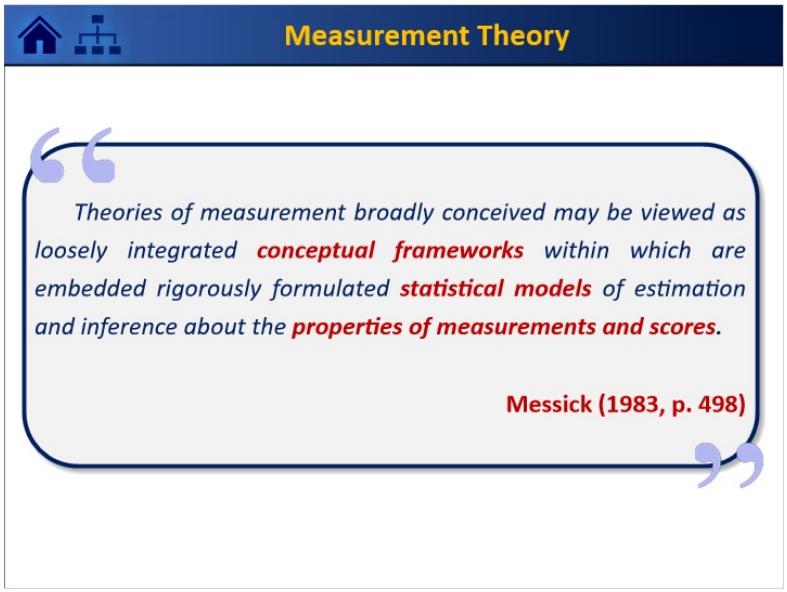


2.12 Bookend: Overview

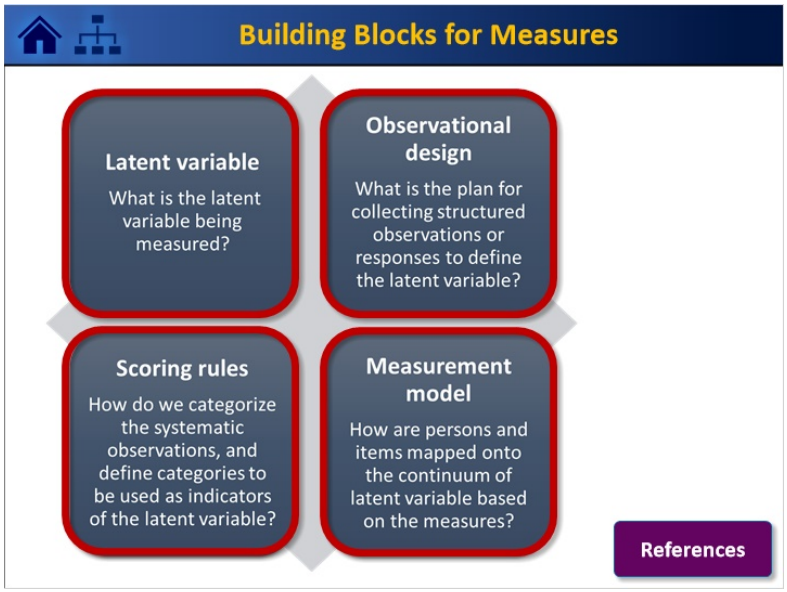


2.13 Bookmark: Measurement Theory

2.14 Measurement Theory

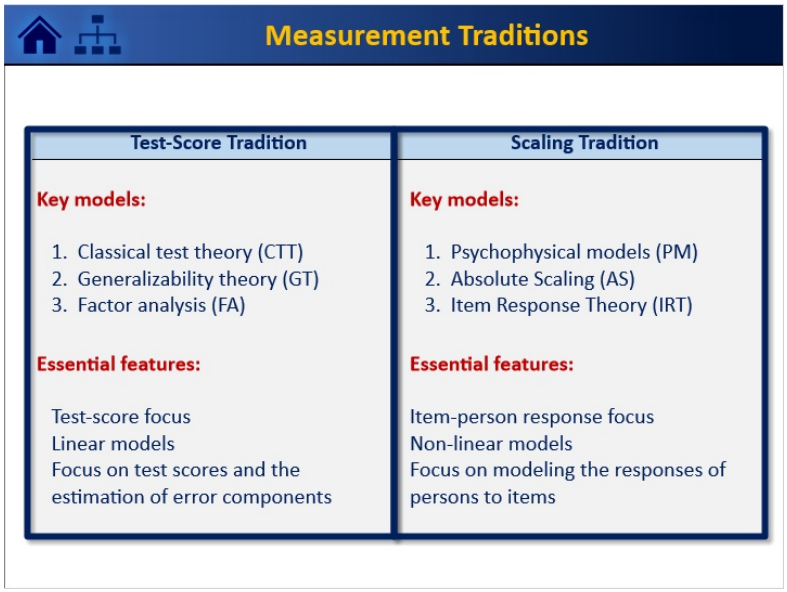


2.15 Building Blocks for Researcher-Constructed Measures

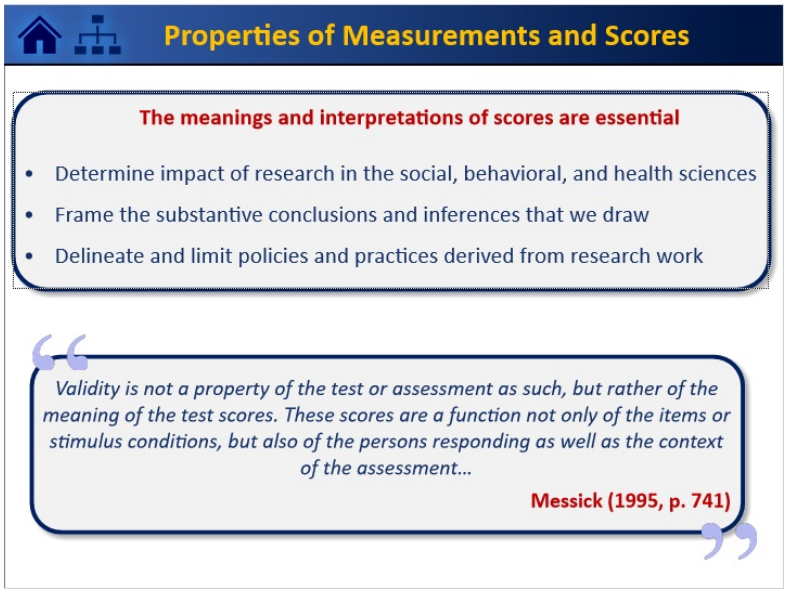


References (Slide Layer)

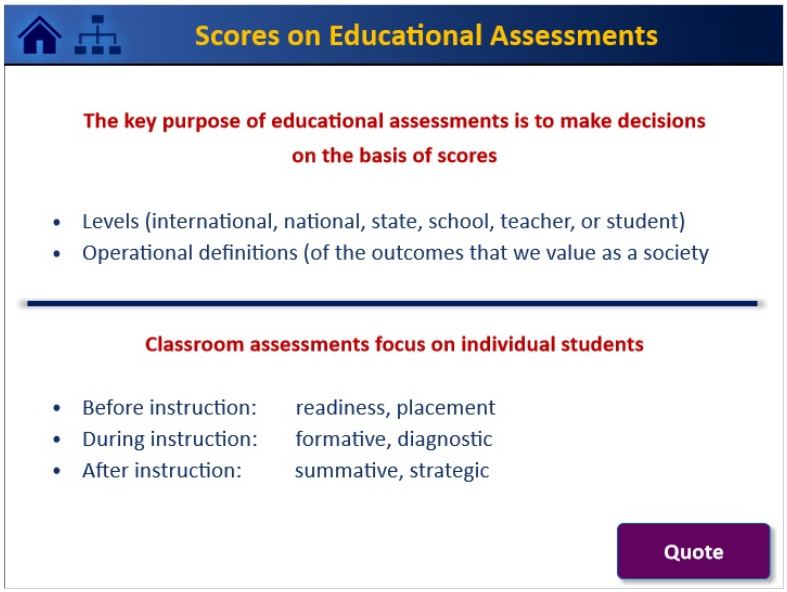
2.16 Measurement/Statistical Models



2.17 Properties of Measurements and Scores



2.18 Scores on Educational Assessments



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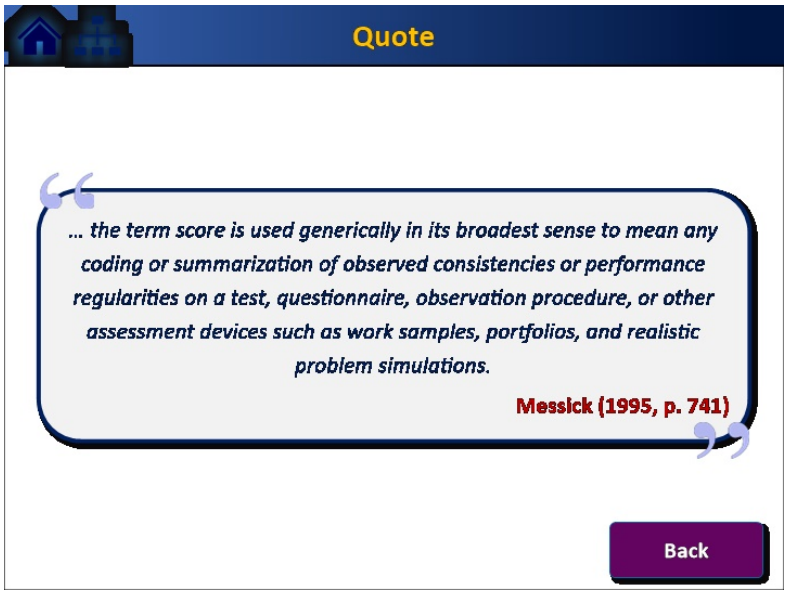
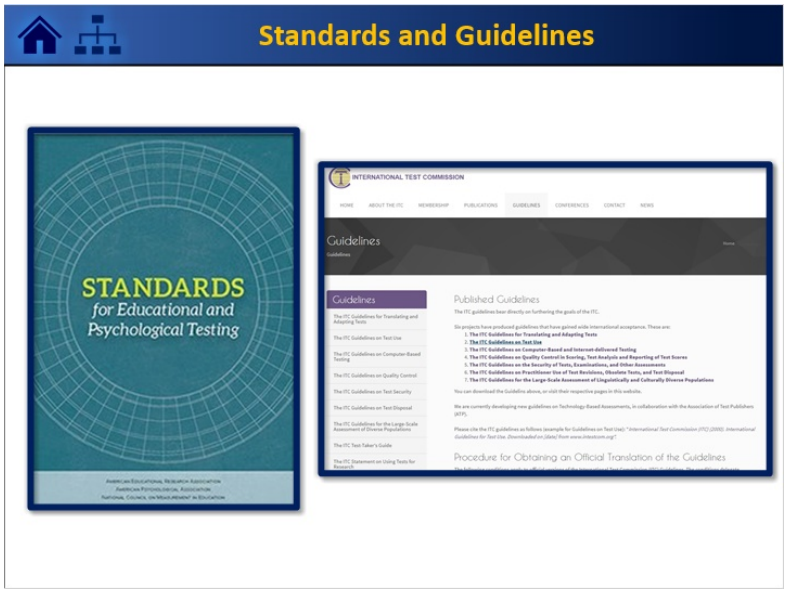
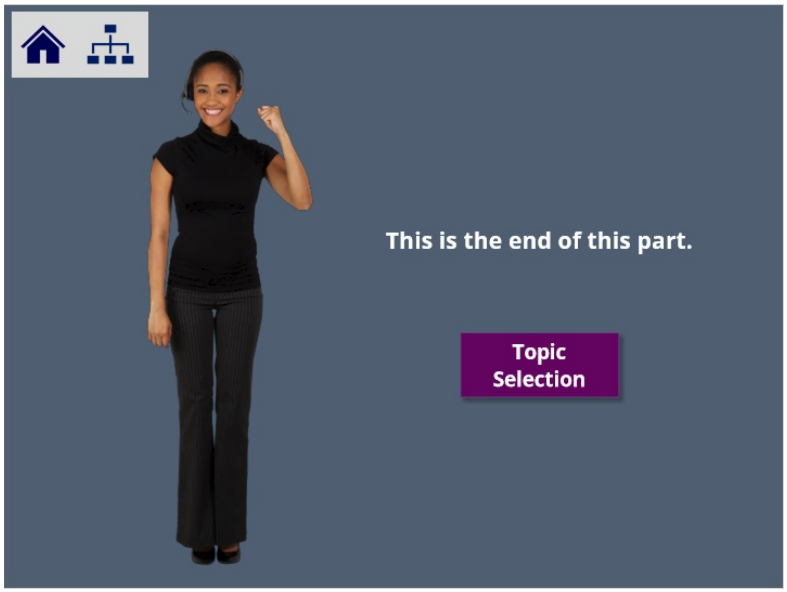


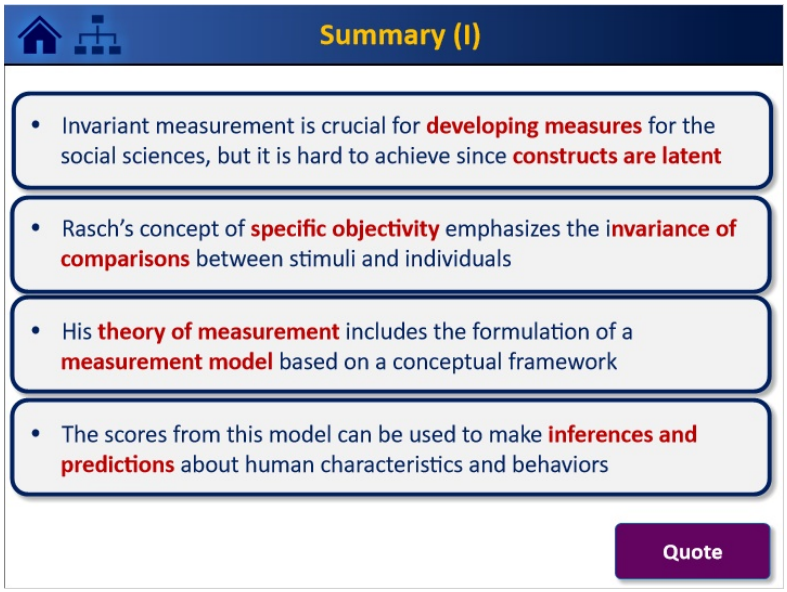
2.19 Standards & Guidelines



2.20 Bookend: Measurement Theory



2.21 Summary I



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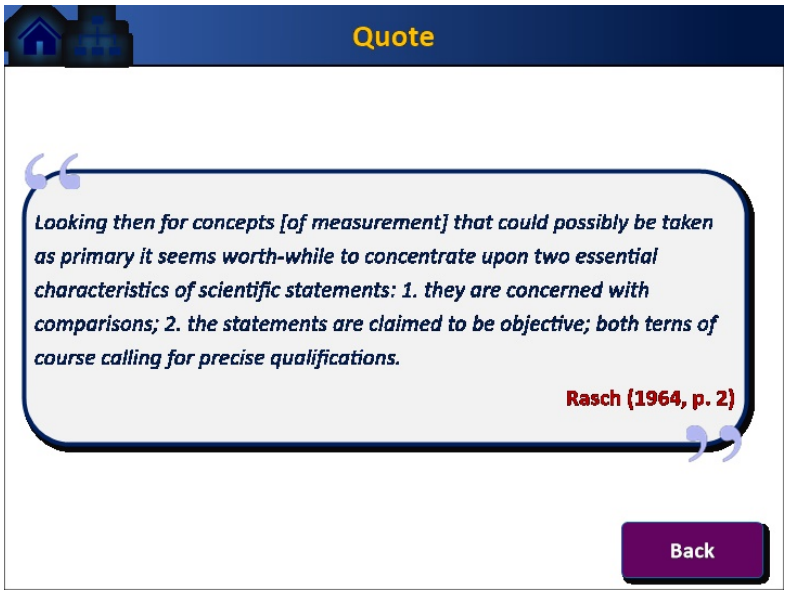
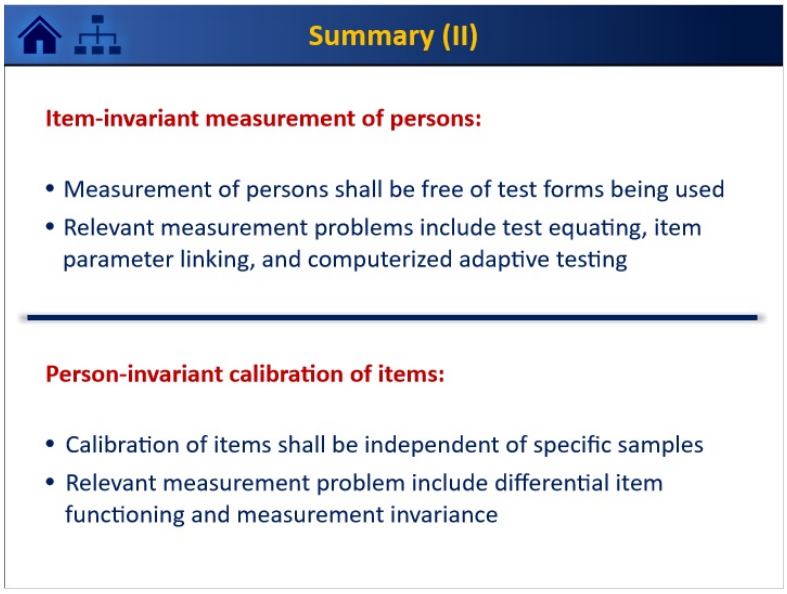
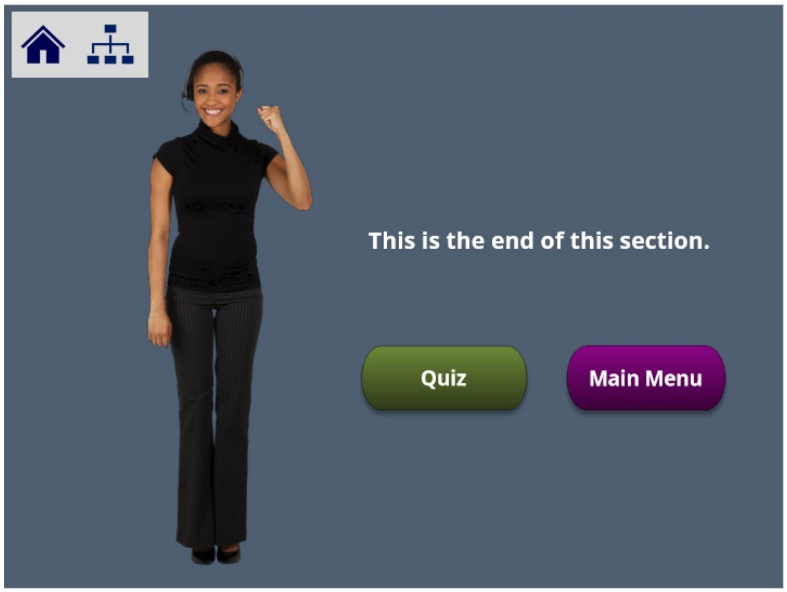


2.22 Summary II

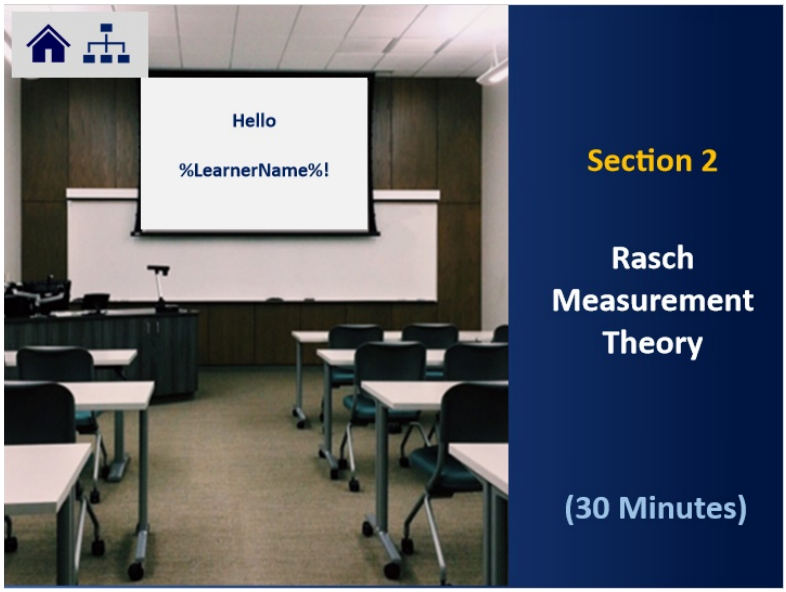


2.23 Bookend: Section 1



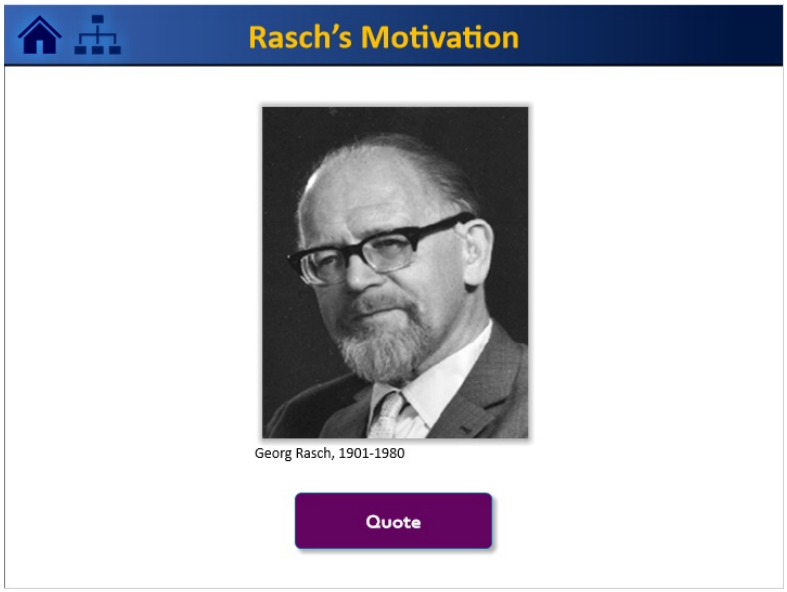
3. Section 2: Rasch Measurement Theory

3.1 Cover: Section 2



3.2 Objectives: Section 2

3.3 Rasch's Motivation



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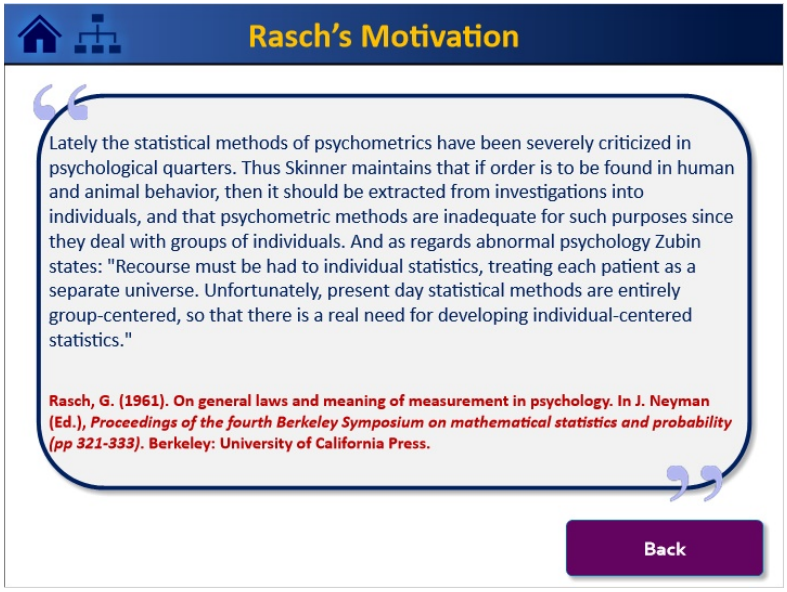
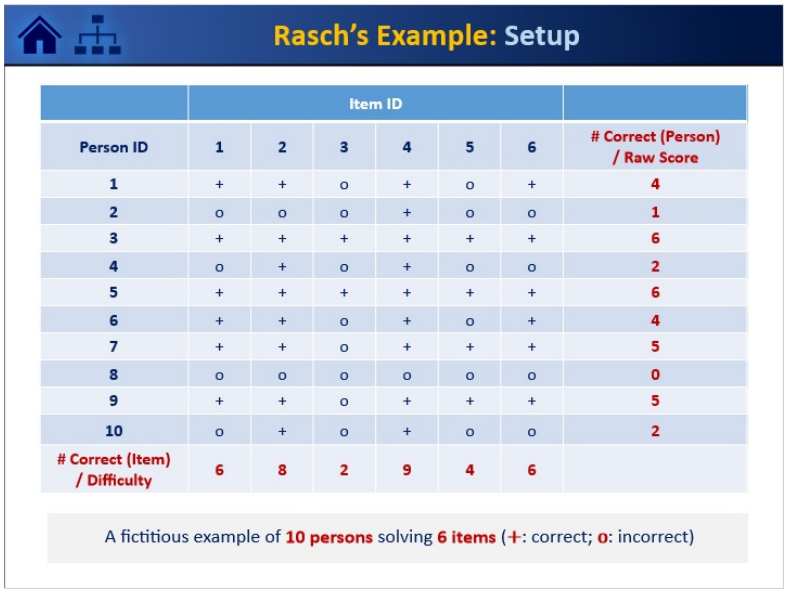


3.4 Rasch's Example I

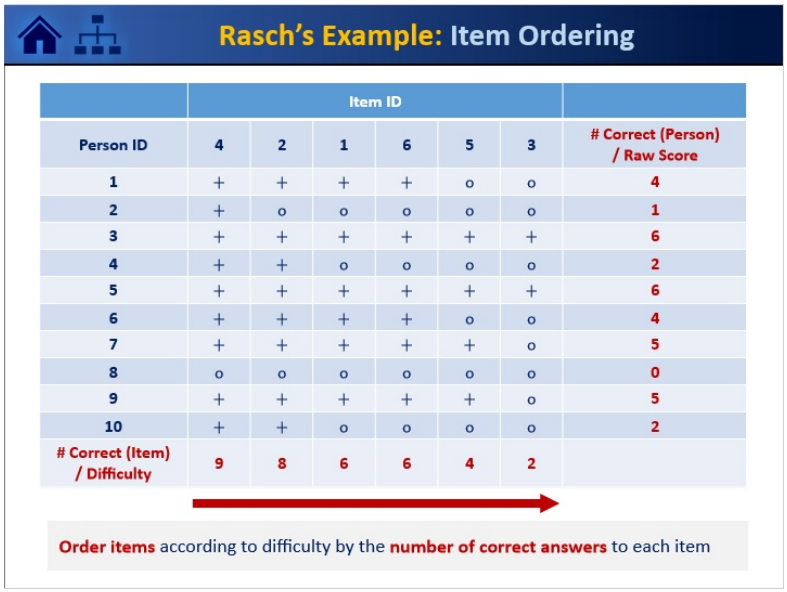


Rasch's Example: Setup

	Item ID						
Person ID	1	2	3	4	5	6	# Correct (Person) / Raw Score
1	+	+	o	+	o	+	4
2	o	o	o	+	o	o	1
3	+	+	+	+	+	+	6
4	o	+	o	+	o	o	2
5	+	+	+	+	+	+	6
6	+	+	o	+	o	+	4
7	+	+	o	+	+	+	5
8	o	o	o	o	o	o	0
9	+	+	o	+	+	+	5
10	o	+	o	+	o	o	2
# Correct (Item) / Difficulty	6	8	2	9	4	6	

A fictitious example of **10 persons** solving **6 items** (+: correct; o: incorrect)

3.5 Rasch's Example II

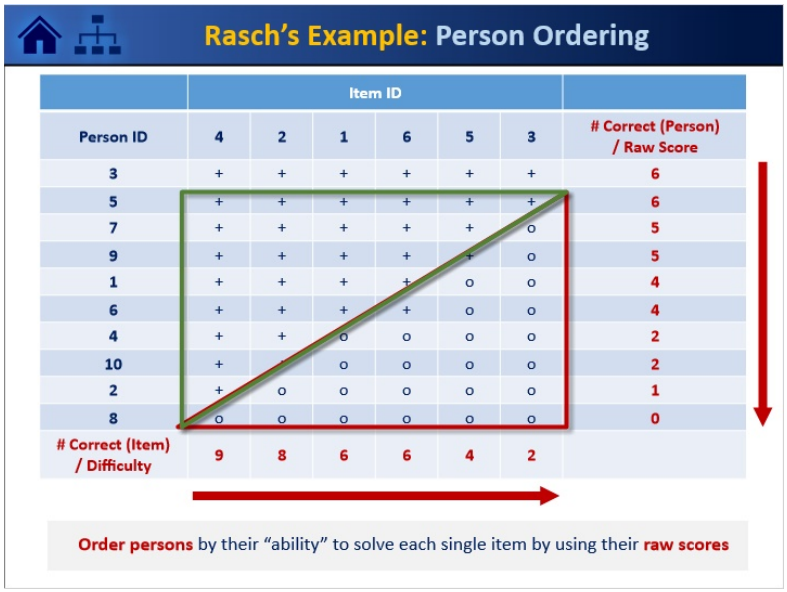


Rasch's Example: Item Ordering

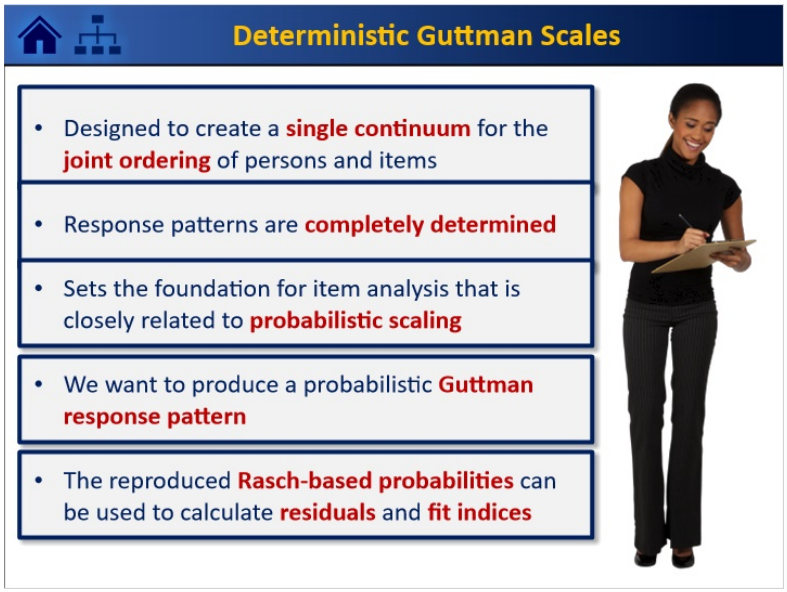
	Item ID						
Person ID	4	2	1	6	5	3	# Correct (Person) / Raw Score
1	+	+	+	+	o	o	4
2	+	o	o	o	o	o	1
3	+	+	+	+	+	+	6
4	+	+	o	o	o	o	2
5	+	+	+	+	+	+	6
6	+	+	+	+	o	o	4
7	+	+	+	+	+	o	5
8	o	o	o	o	o	o	0
9	+	+	+	+	+	o	5
10	+	+	o	o	o	o	2
# Correct (Item) / Difficulty	9	8	6	6	4	2	

Order items according to difficulty by the **number of correct answers** to each item

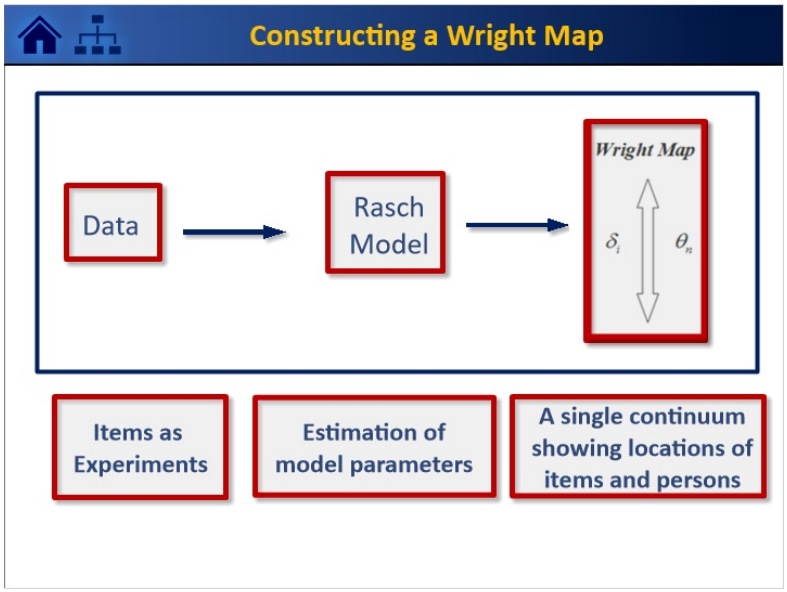
3.6 Rasch's Example III



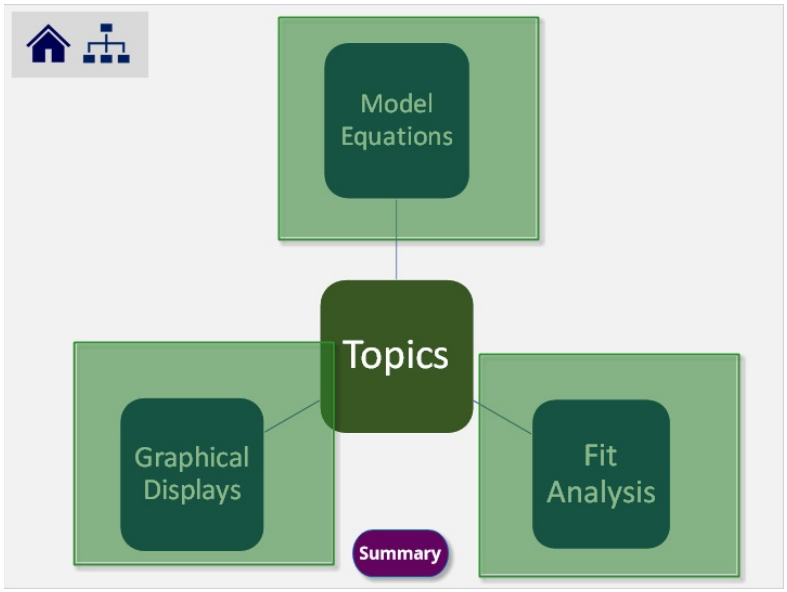
3.7 Guttman Scale



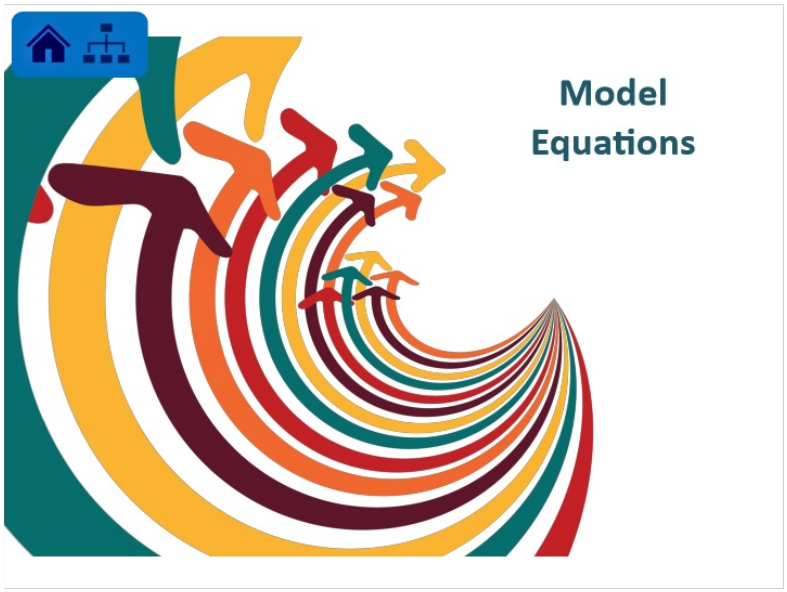
3.8 Constructing a Wright Map



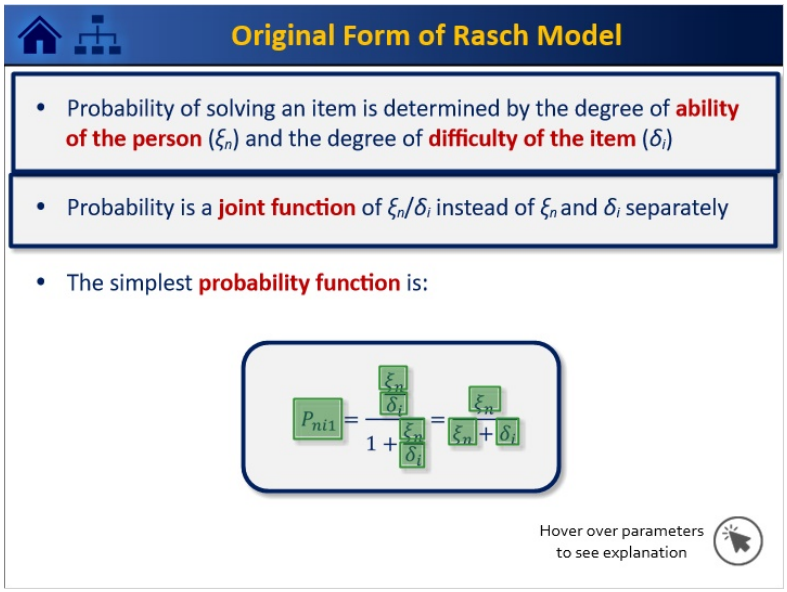
3.9 Topic Selection



3.10 Bookmark: Equations



3.11 Original Form of Rasch Model



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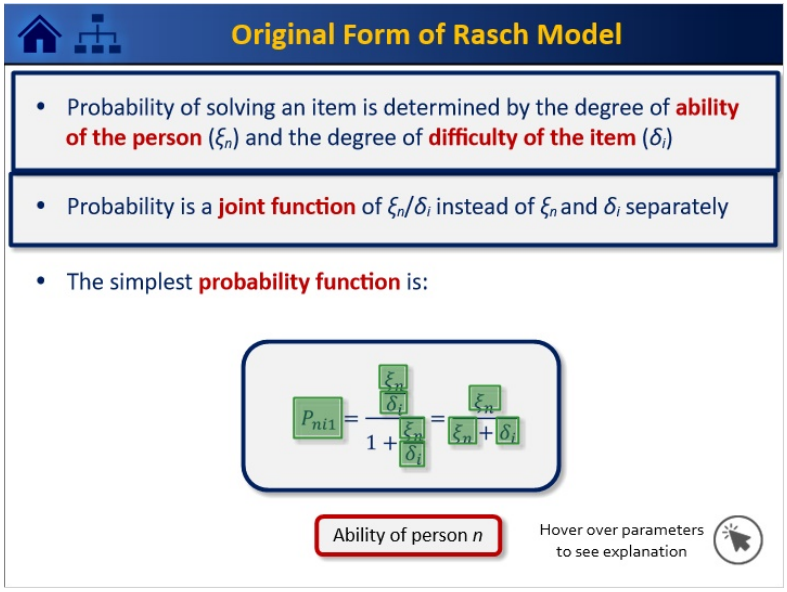
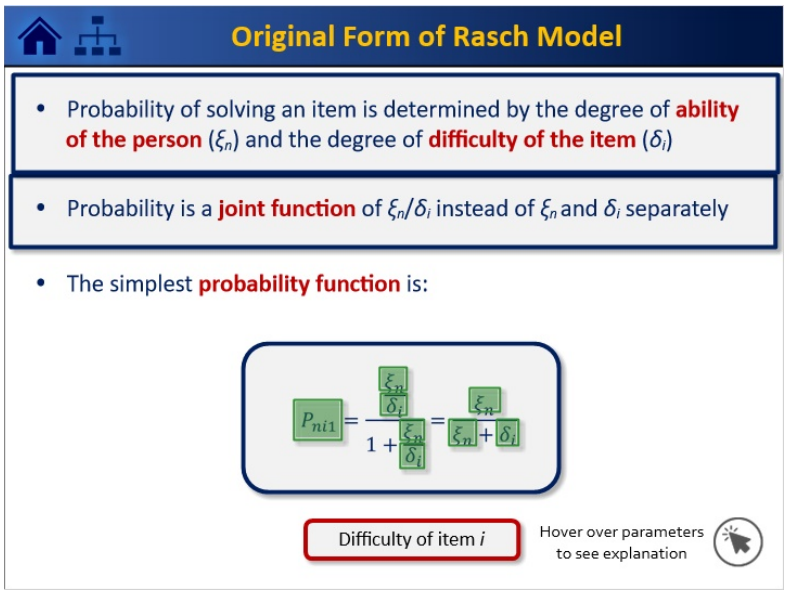


delta (Slide Layer)



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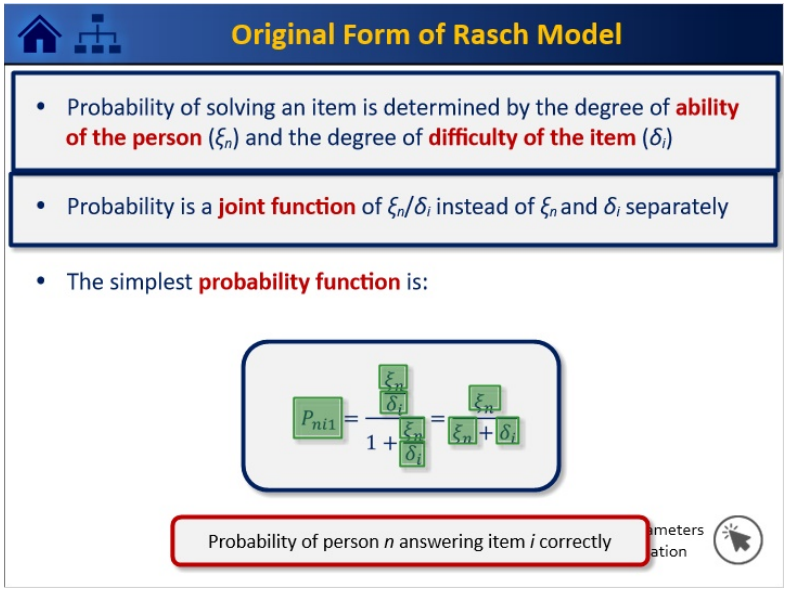
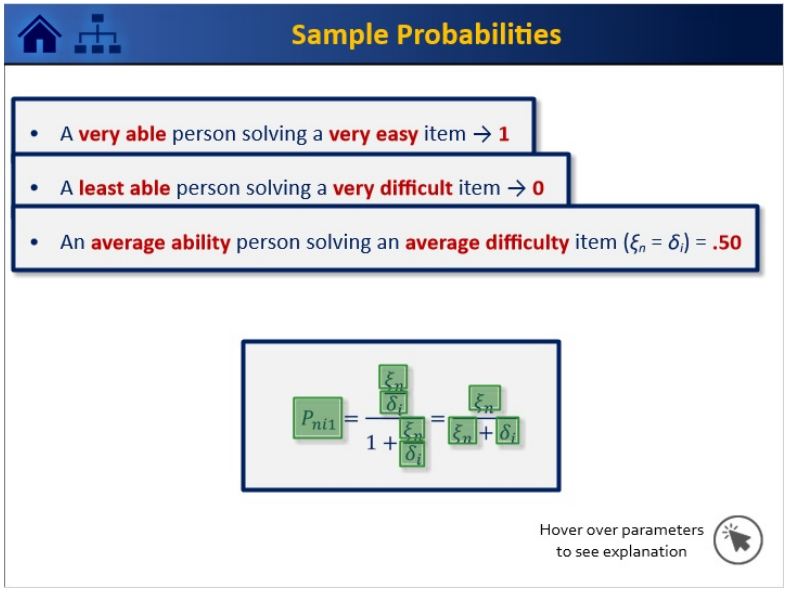
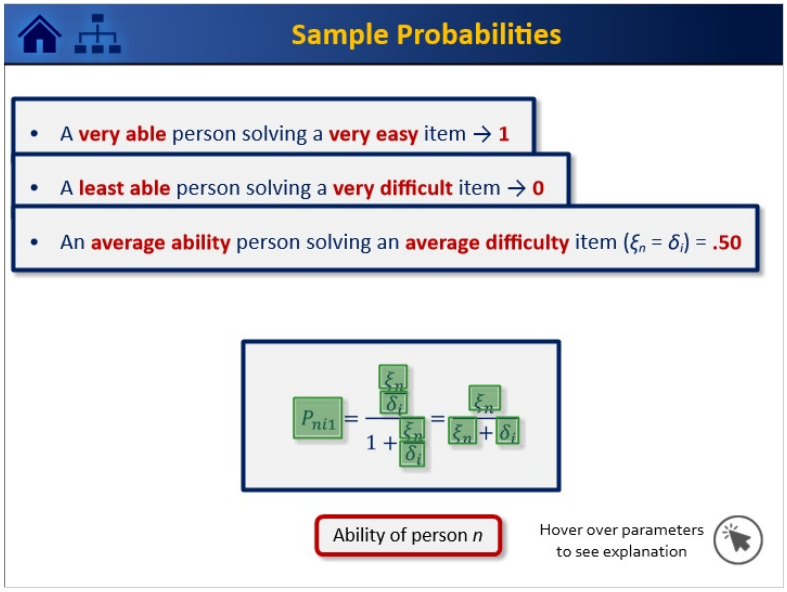


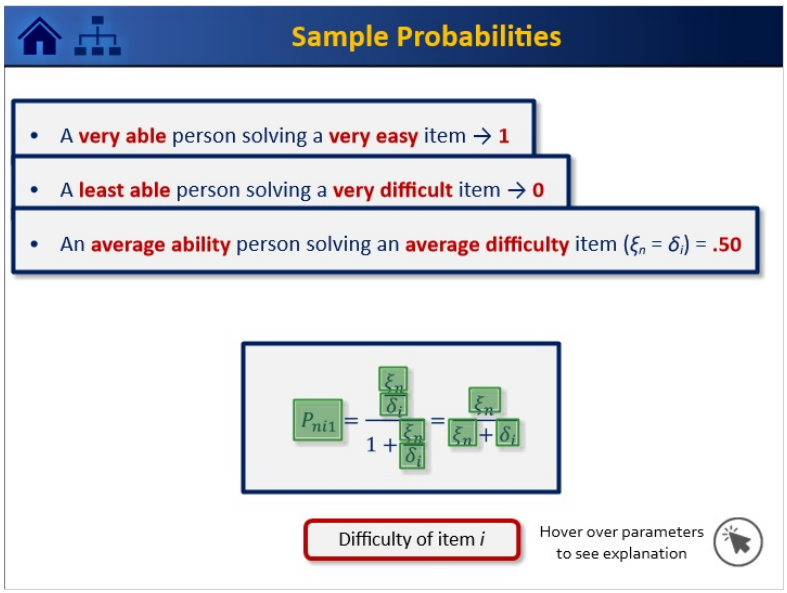
3.12 Original Form of Rasch Model



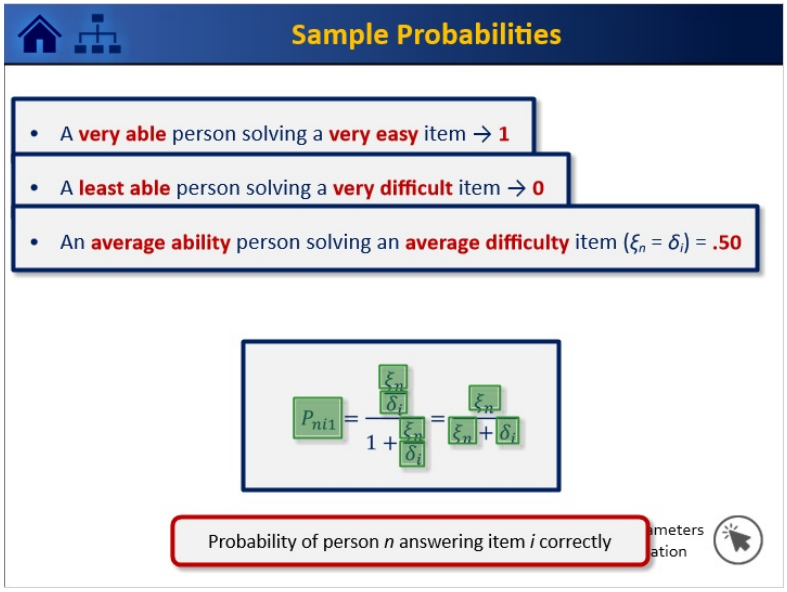
ksi (Slide Layer)



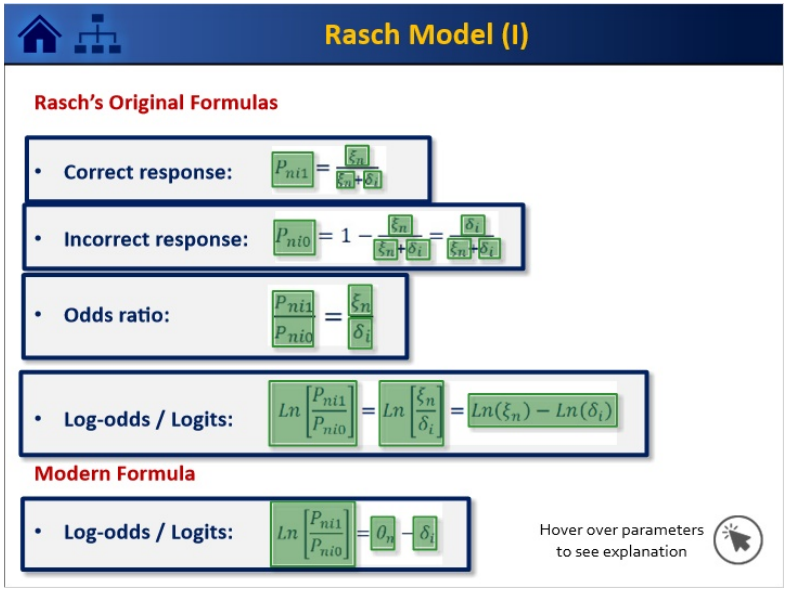
delta (Slide Layer)



Pni1 (Slide Layer)



3.13 Dichotomous Rasch Model I



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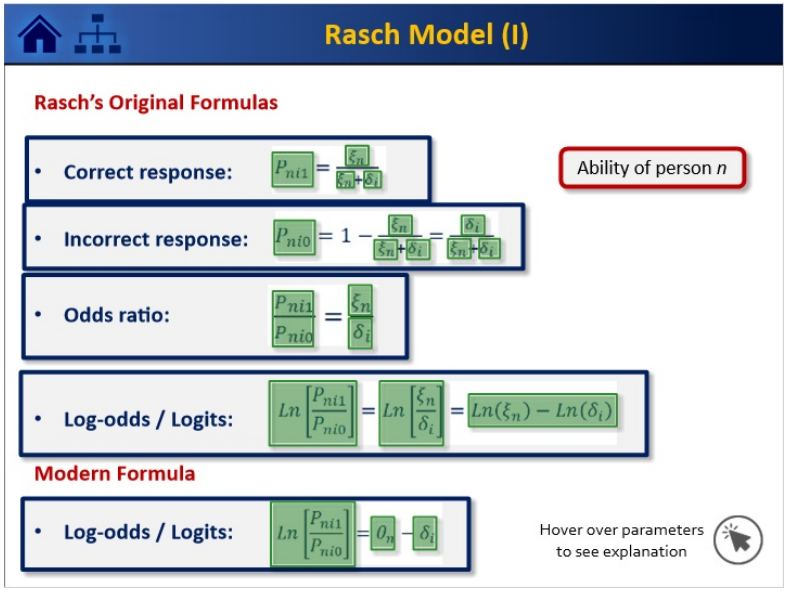

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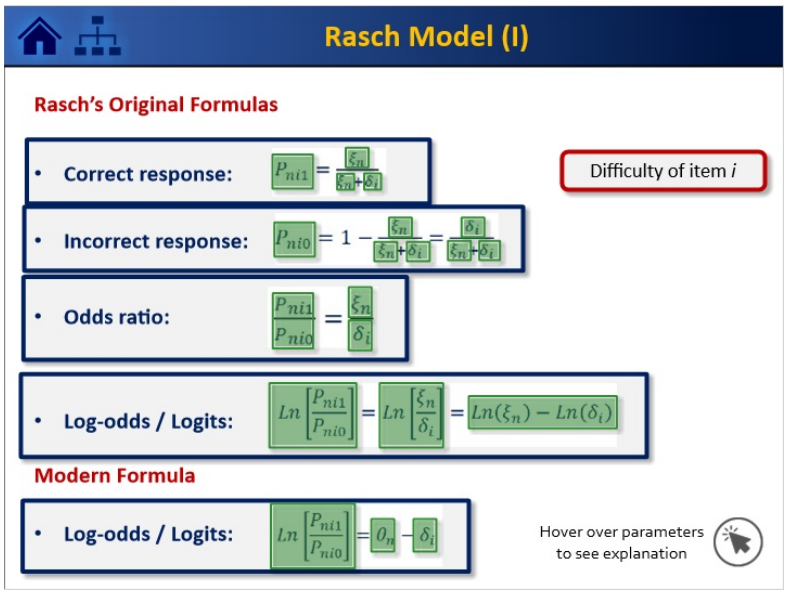

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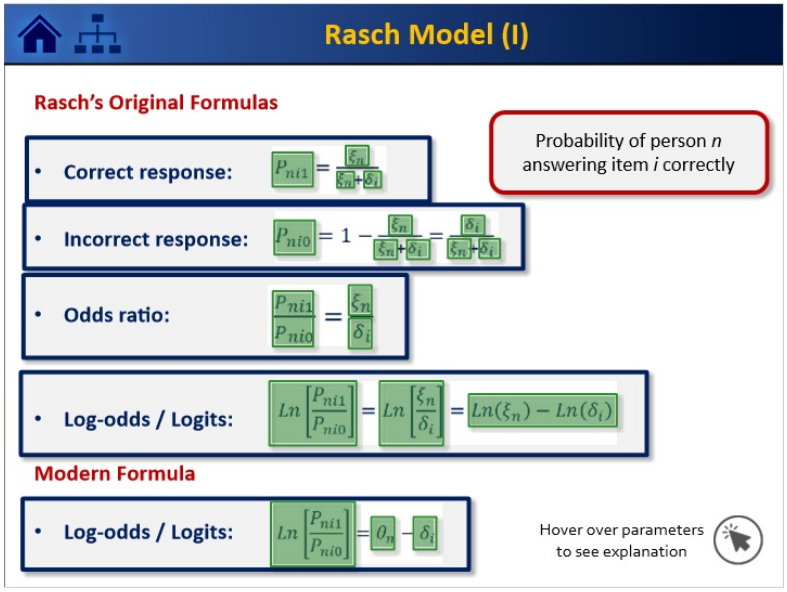
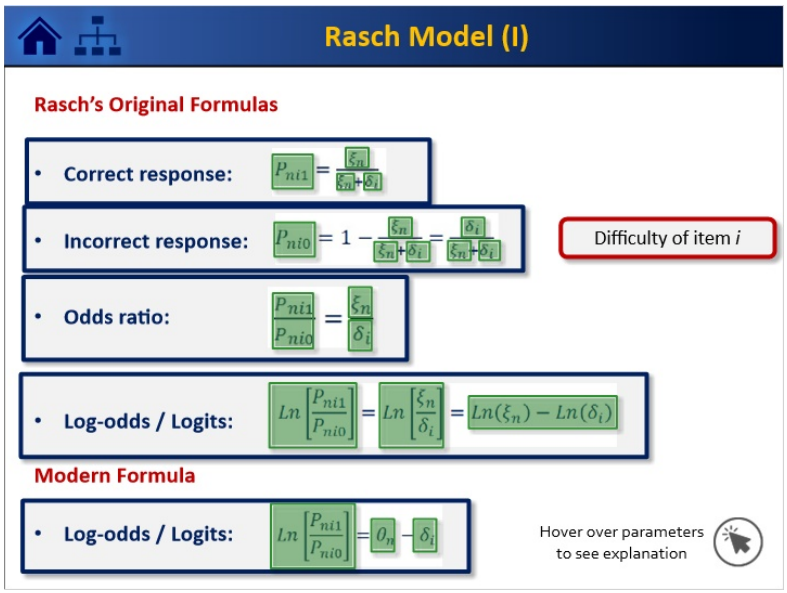


delta-2 (Slide Layer)



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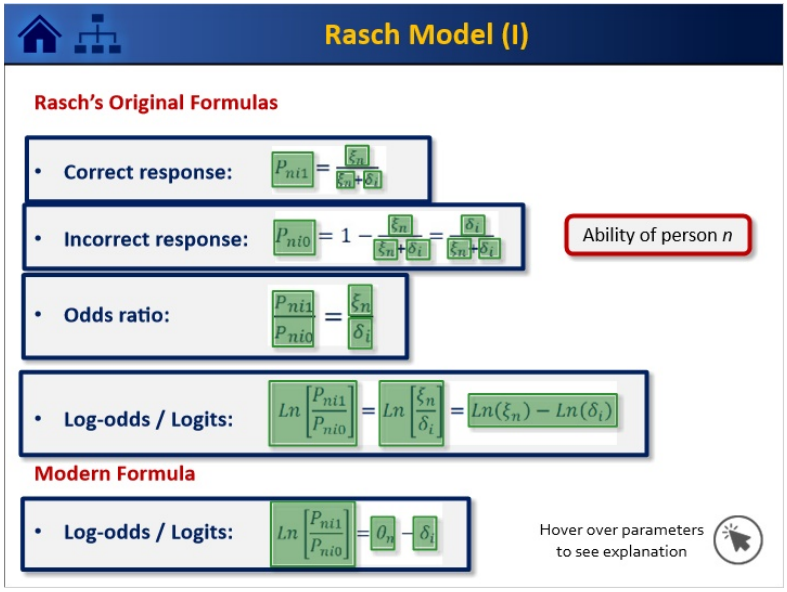
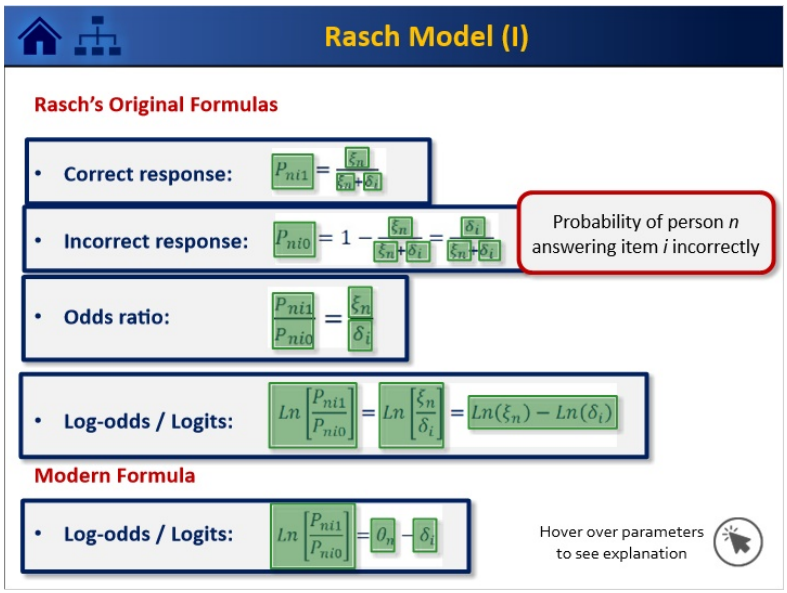
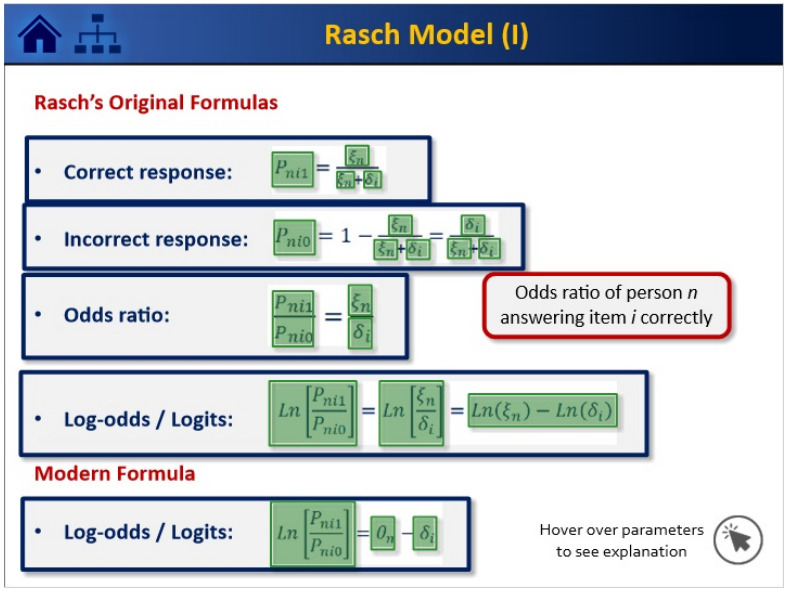


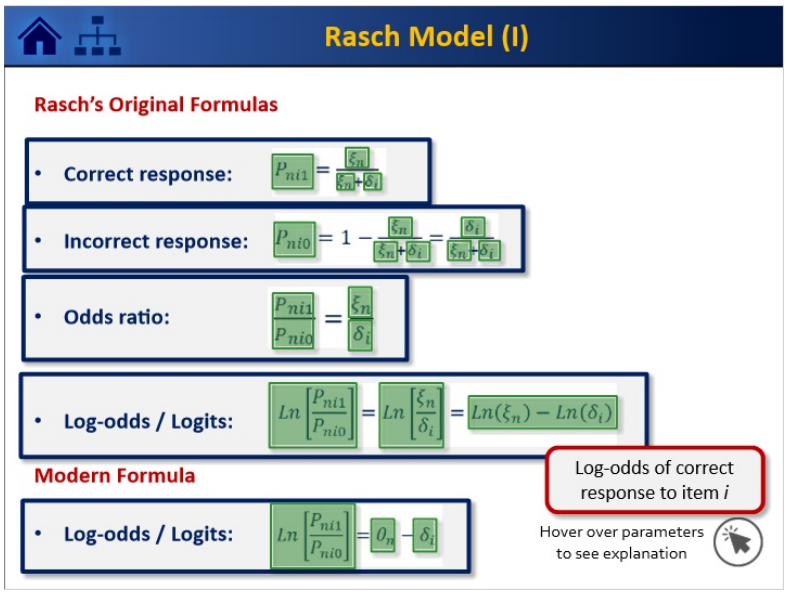
Pni0-2 (Slide Layer)



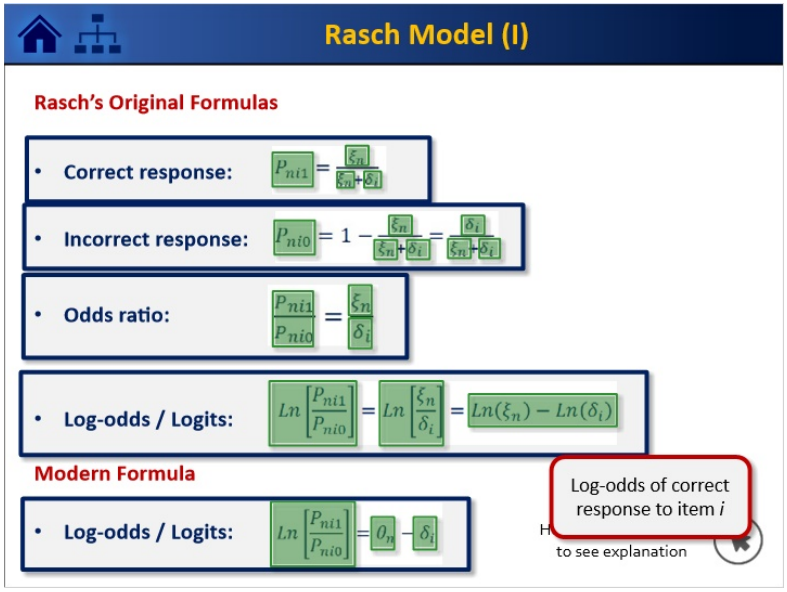
odds-ratio-3 (Slide Layer)



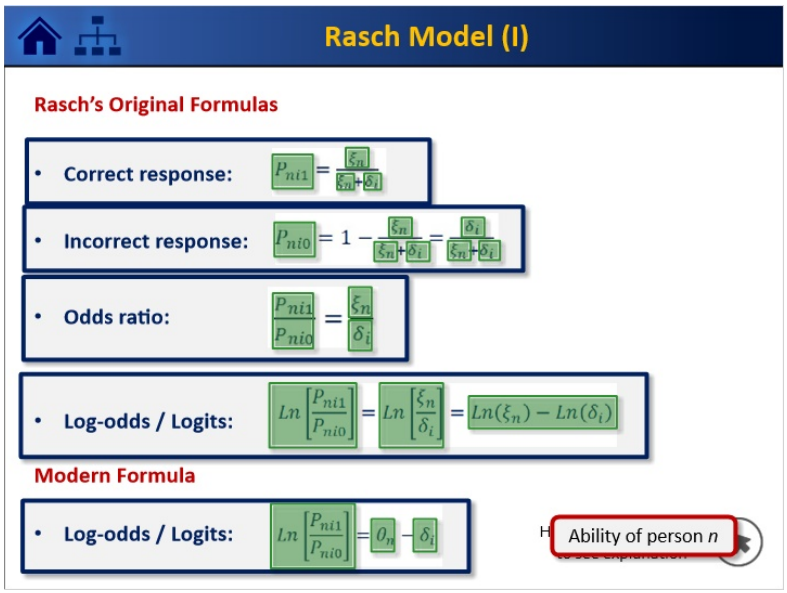
log-odds-4 (Slide Layer)



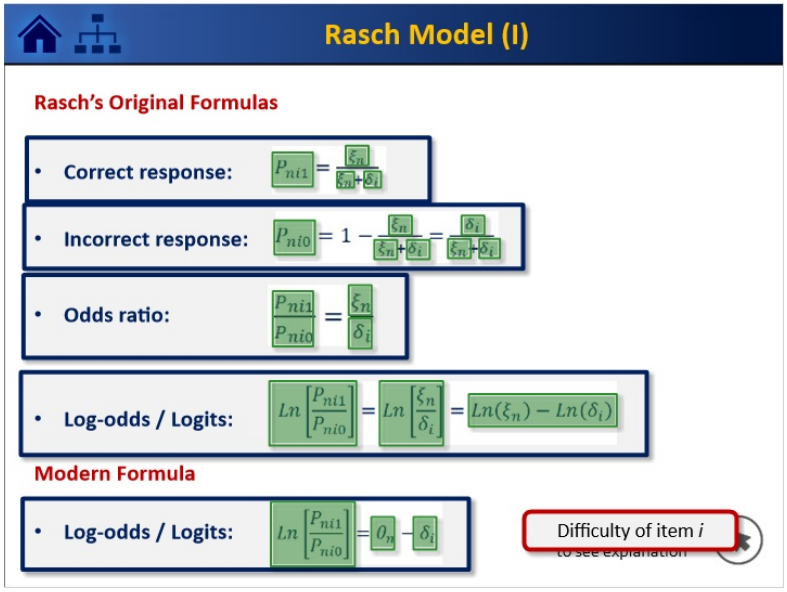
log-odds-5 (Slide Layer)



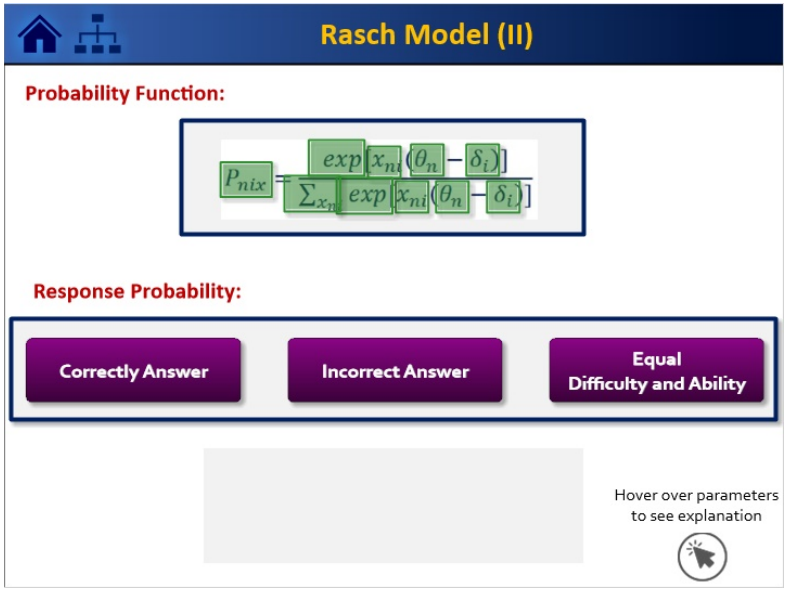
theta-5 (Slide Layer)



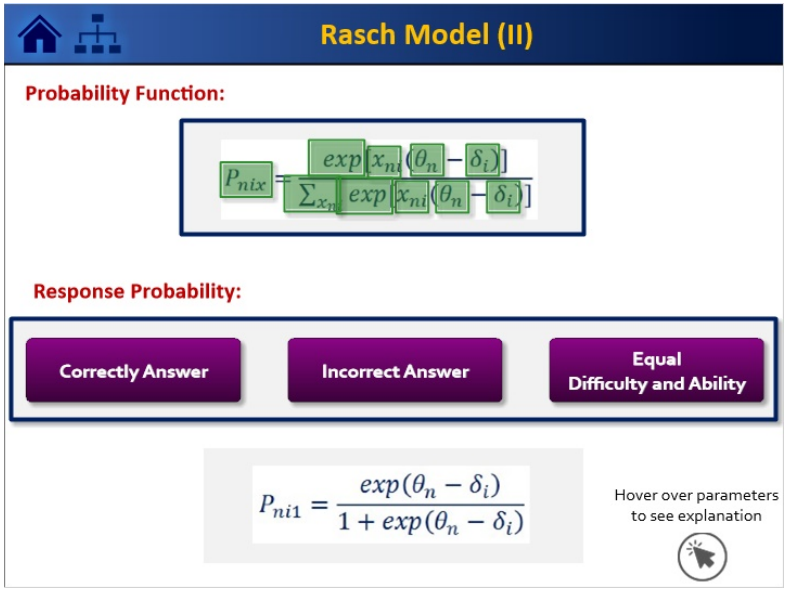
delta-5 (Slide Layer)



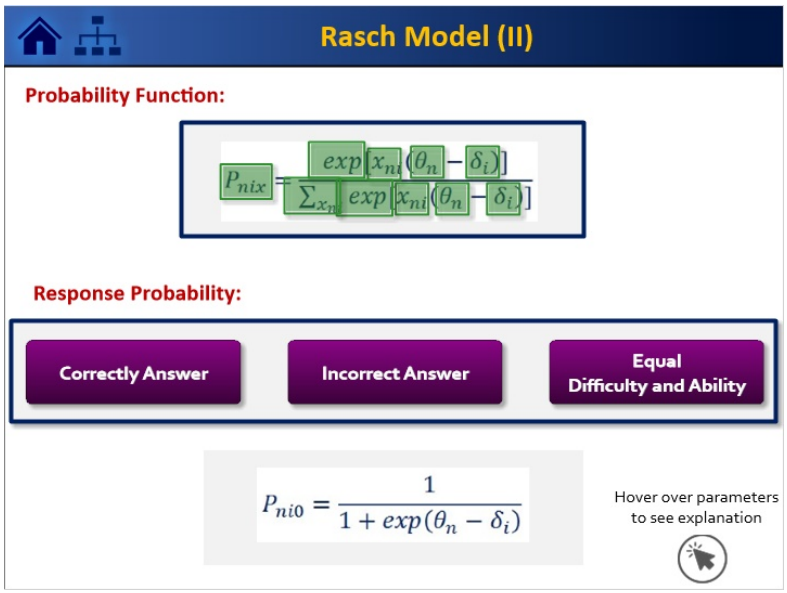
3.14 Dichotomous Rasch Model II



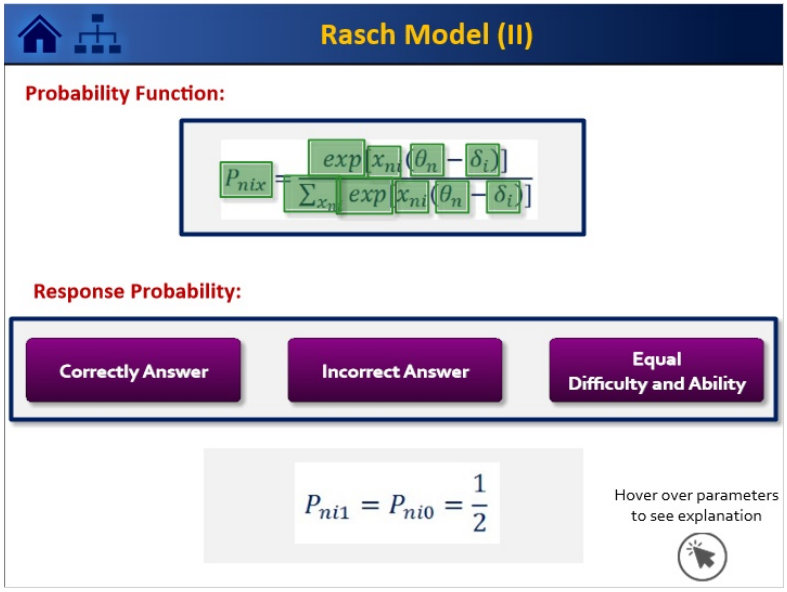
Solving a problem (Slide Layer)



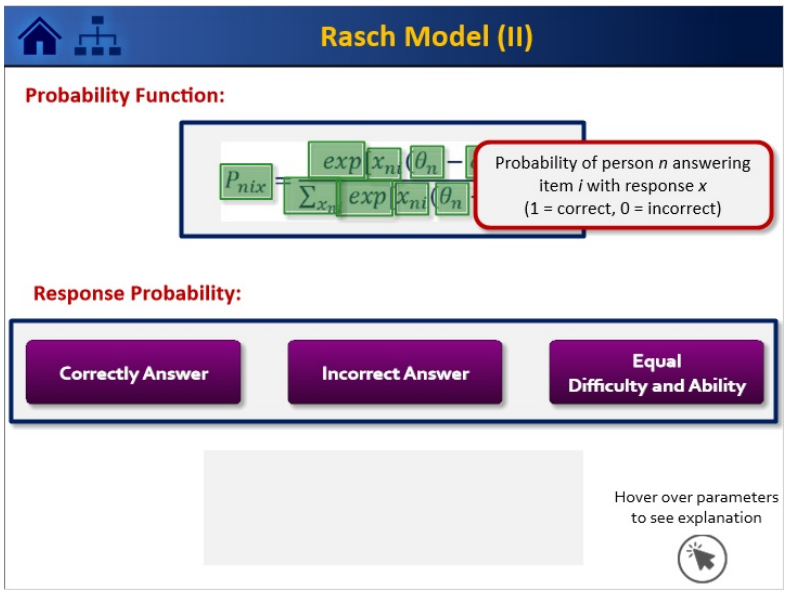
Not solving a problem (Slide Layer)



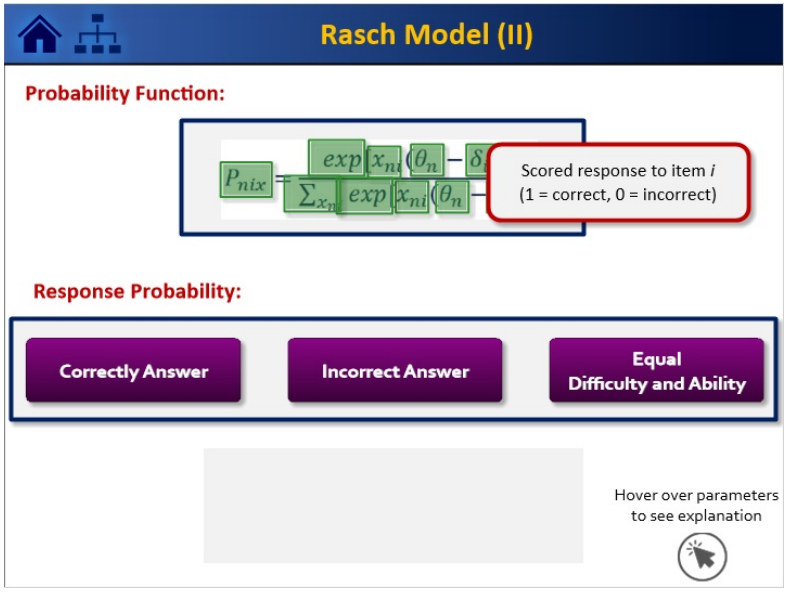
Equal amounts (Slide Layer)



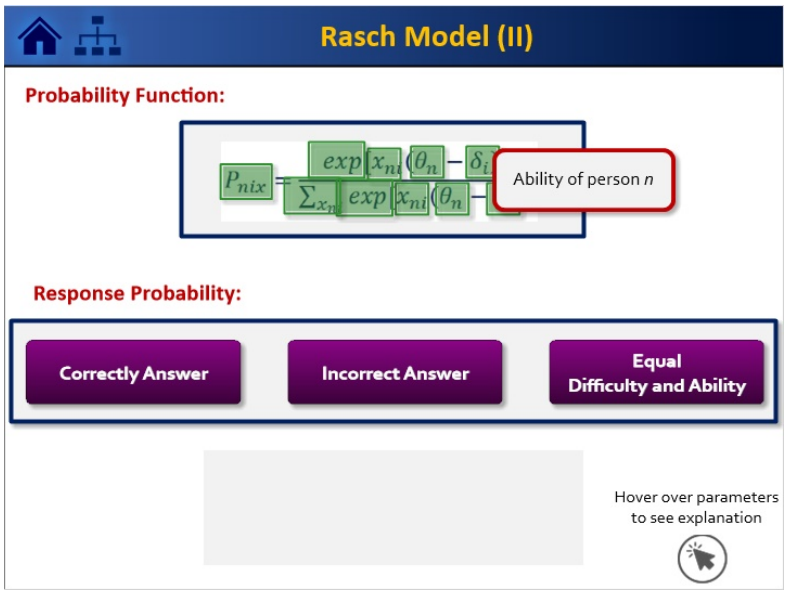
pnix (Slide Layer)



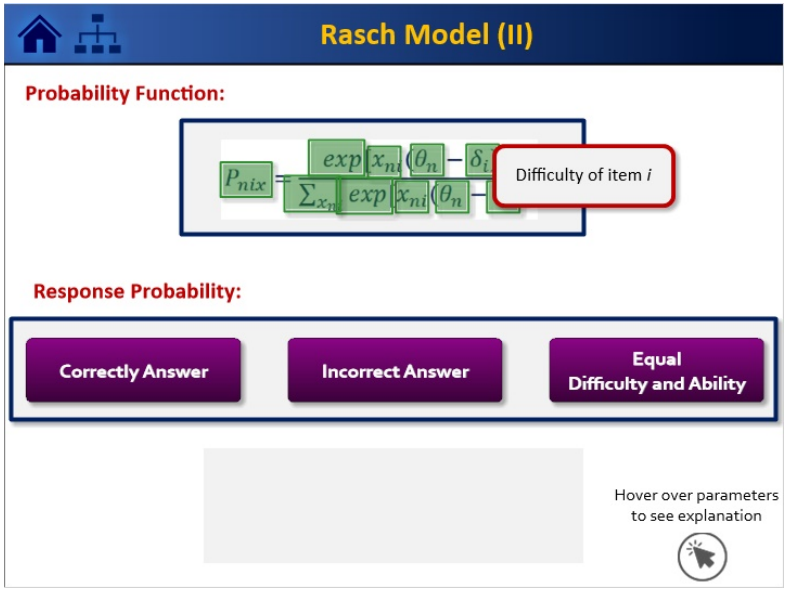
xni (Slide Layer)



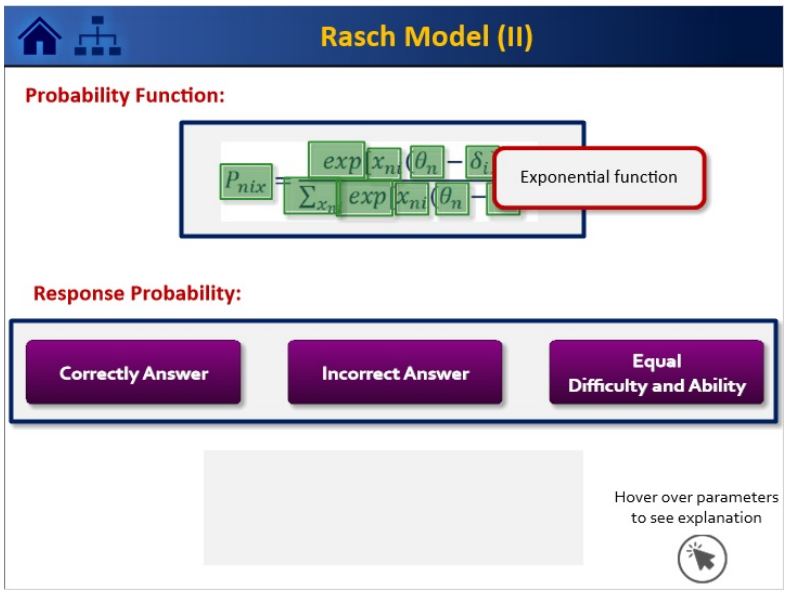
theta (Slide Layer)



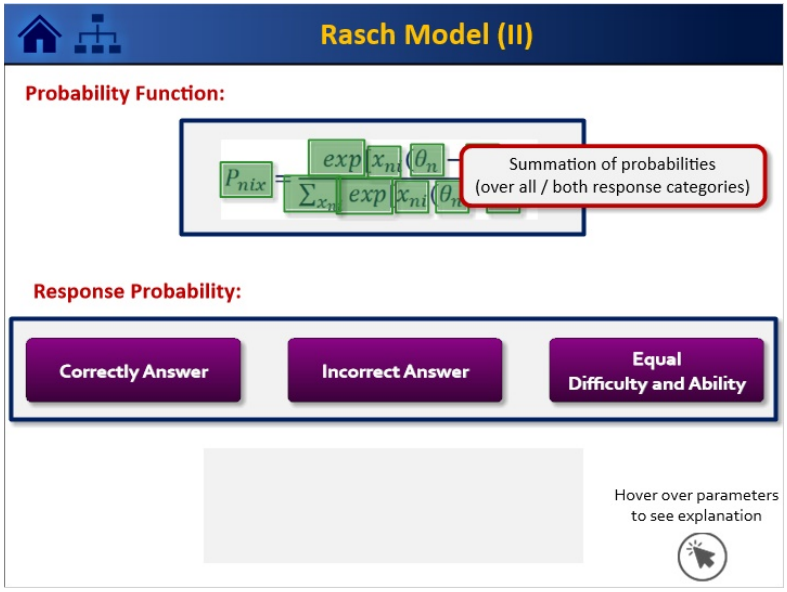
delta (Slide Layer)



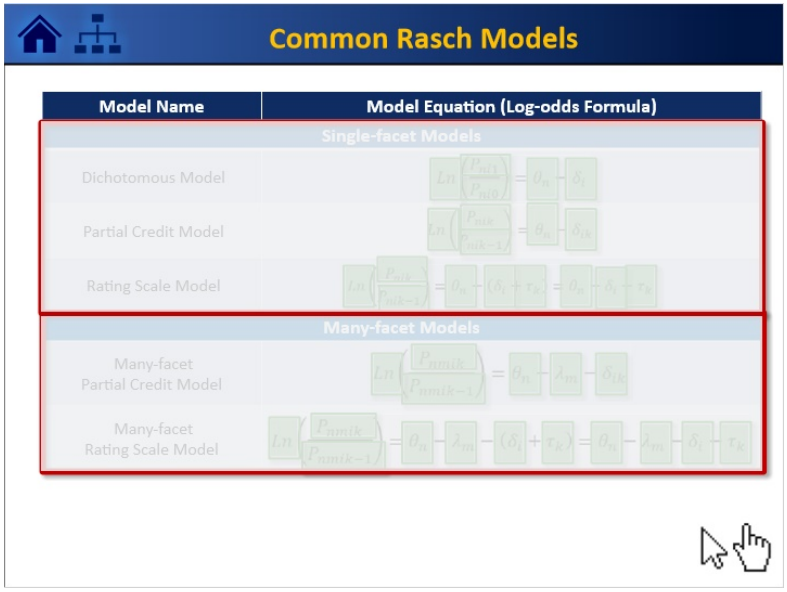
exp (Slide Layer)



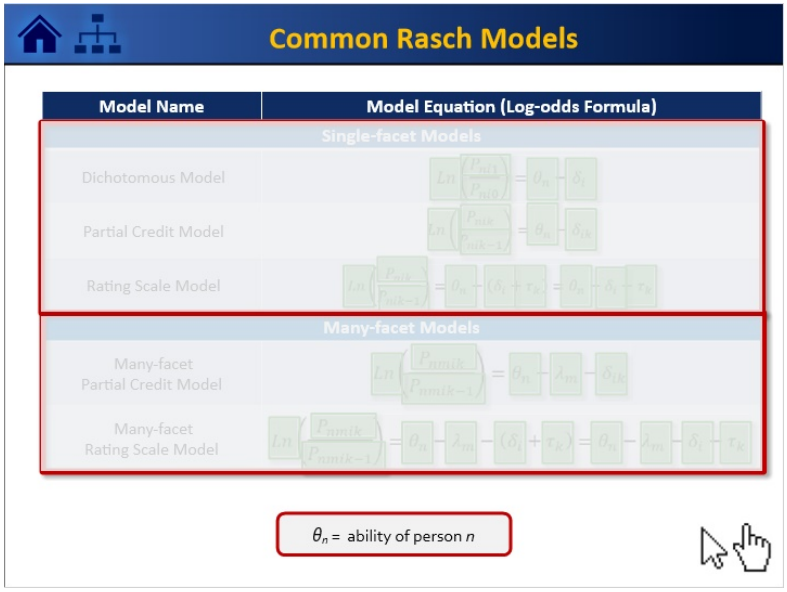
sum (Slide Layer)



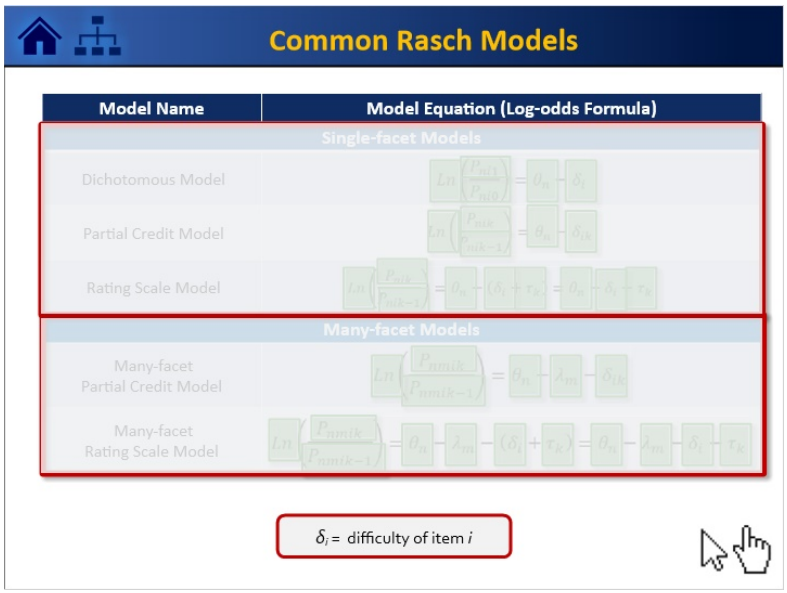
3.15 Commonly Used Rasch Measurement Models



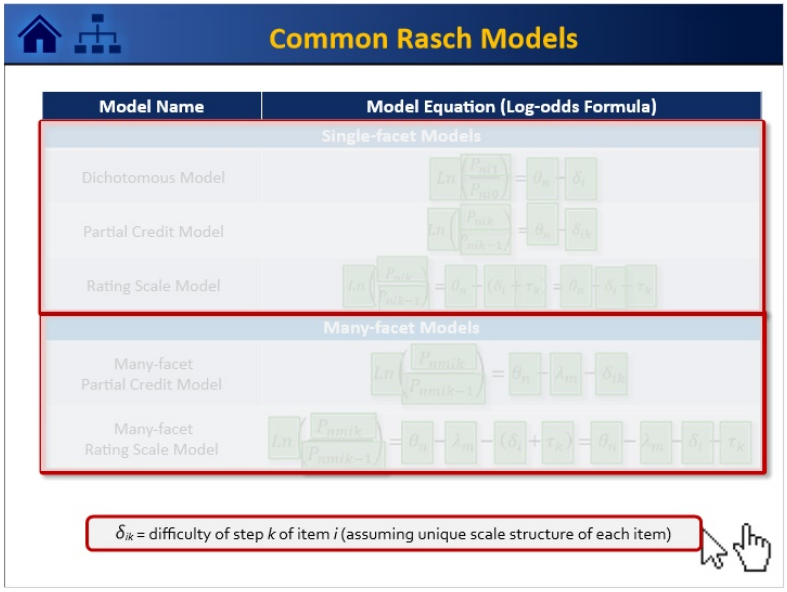
ability (Slide Layer)



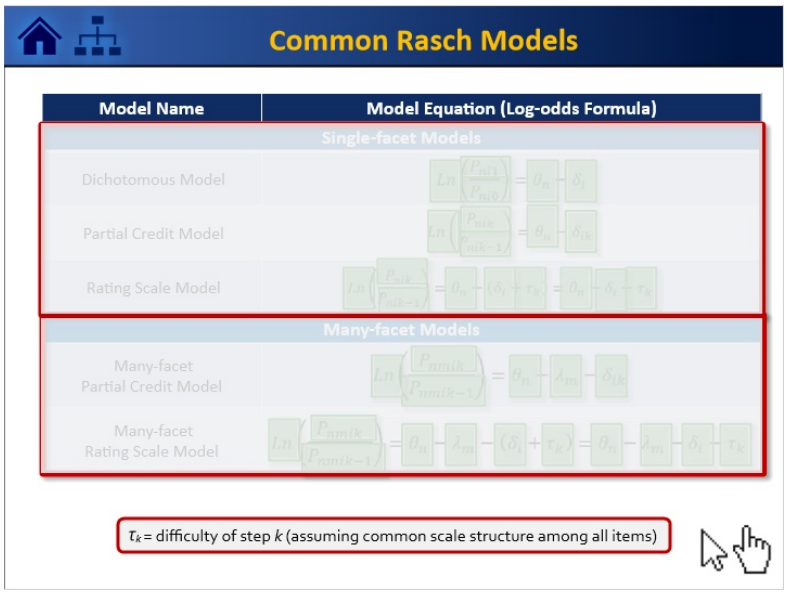
difficulty (Slide Layer)



delta ik (Slide Layer)



tau k (Slide Layer)



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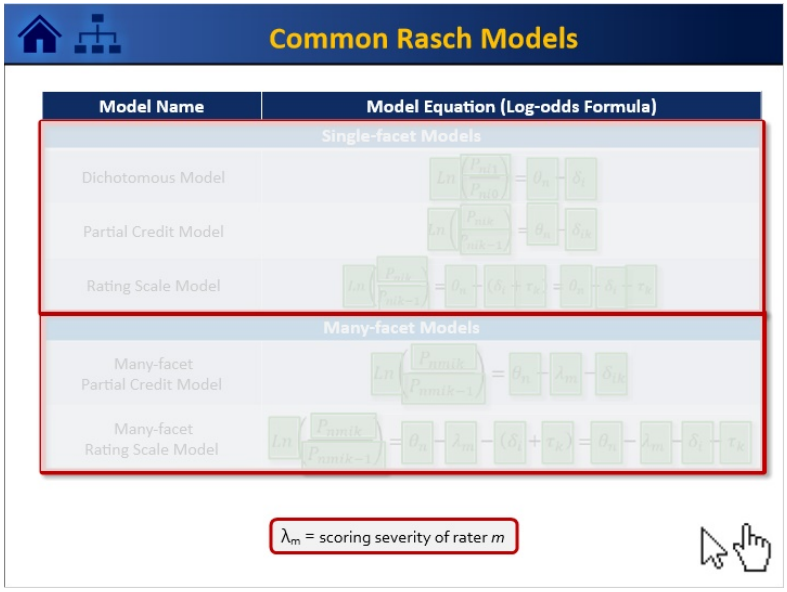
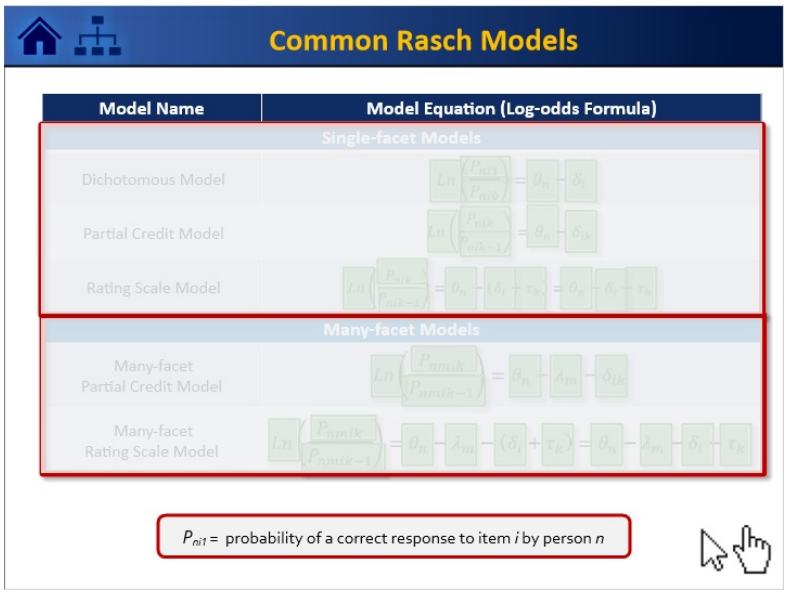
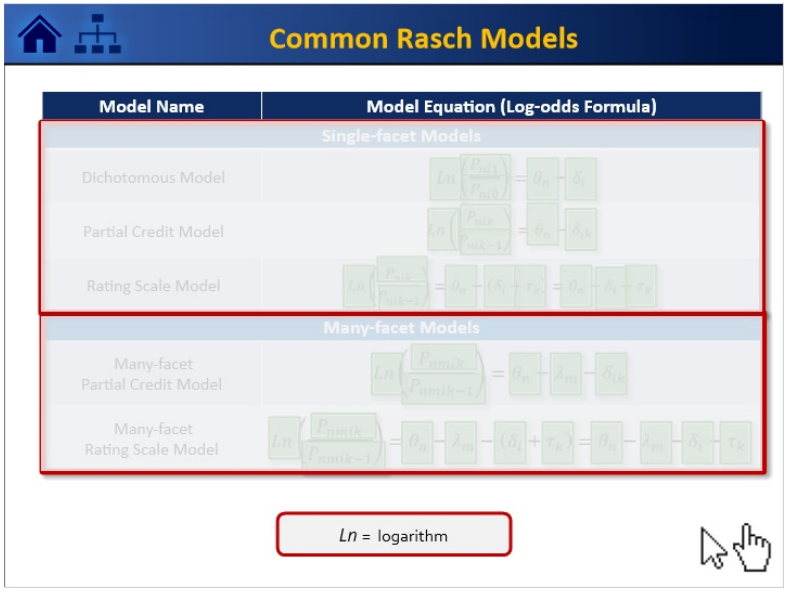


P ni1 (Slide Layer)



log (Slide Layer)



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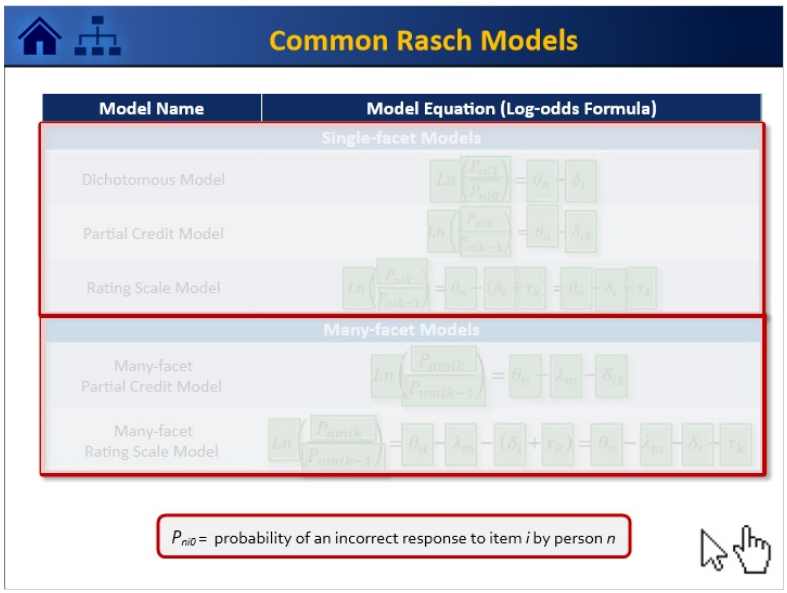

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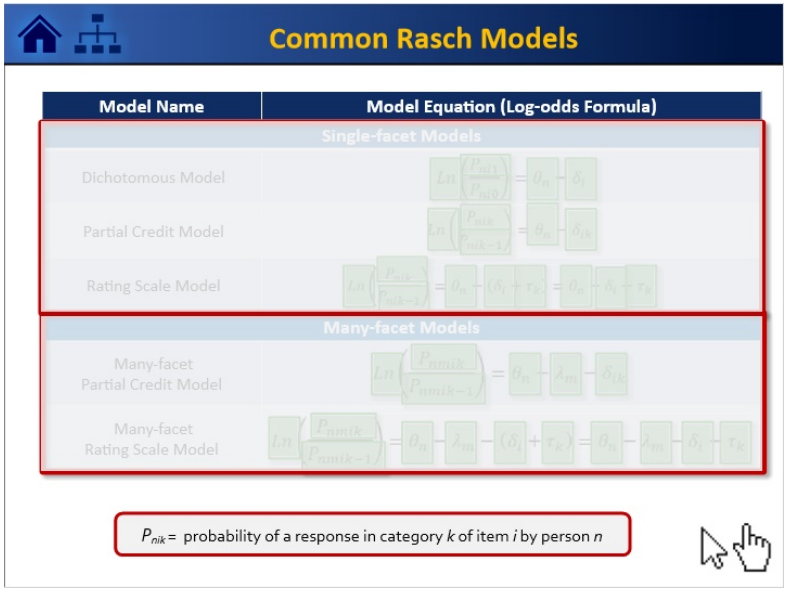
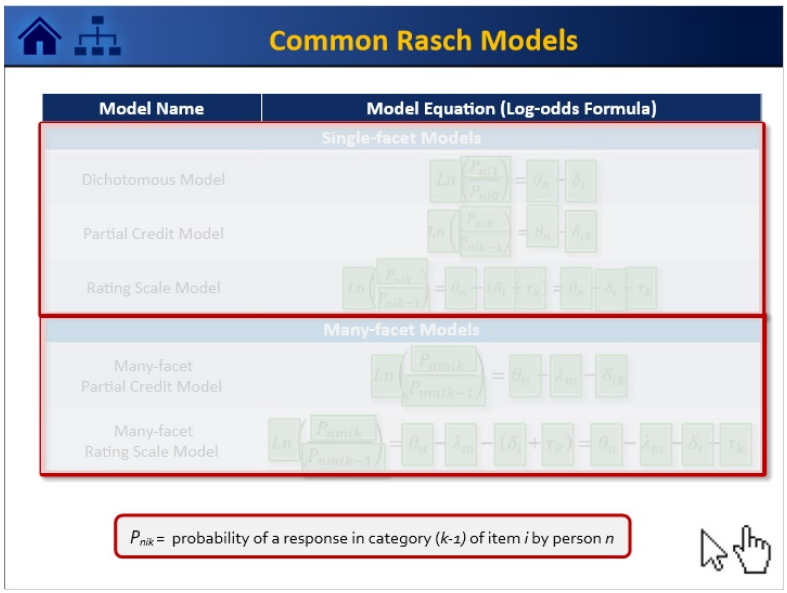


P nik-1 (Slide Layer)



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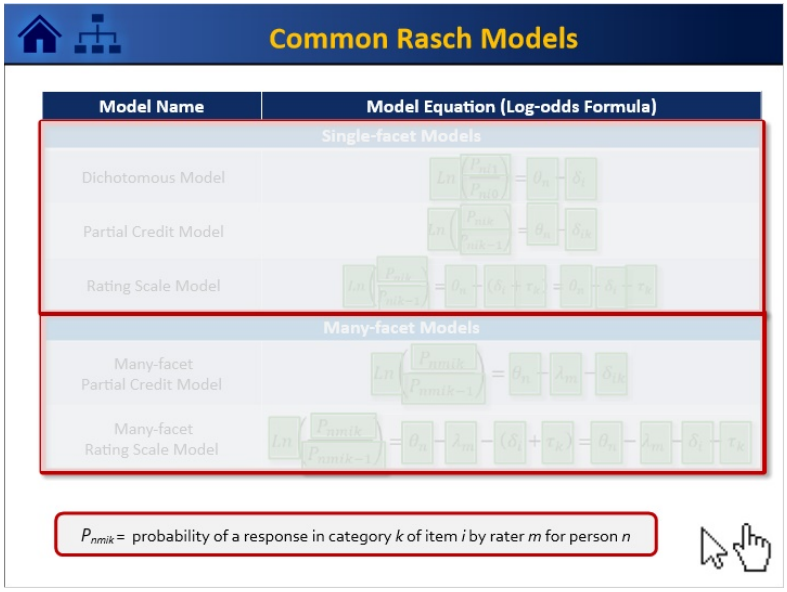
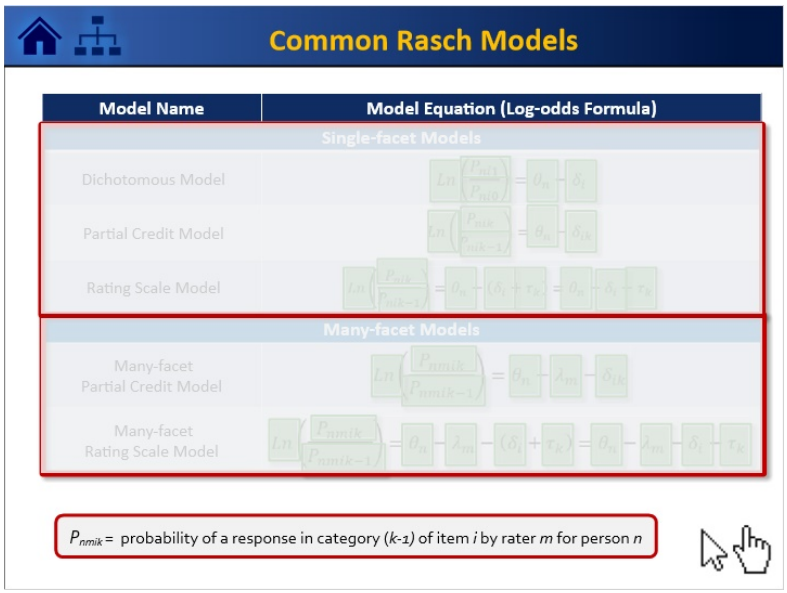
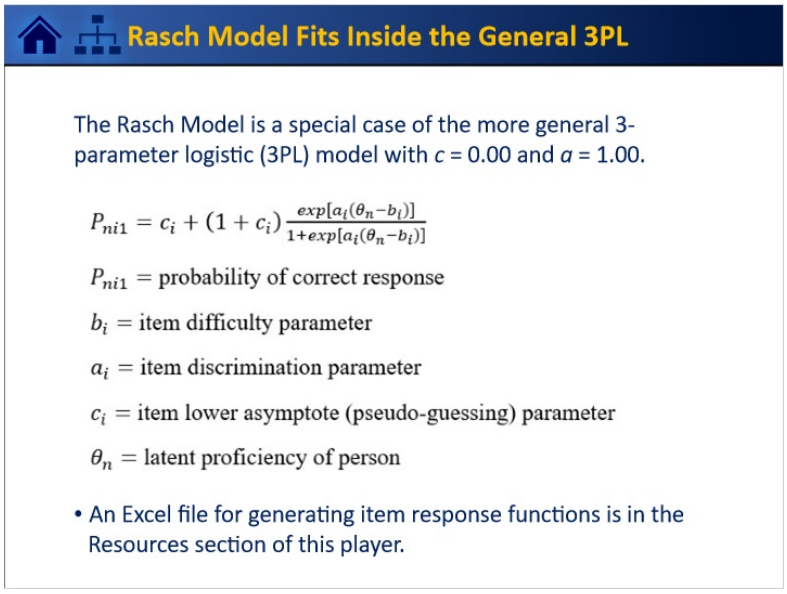


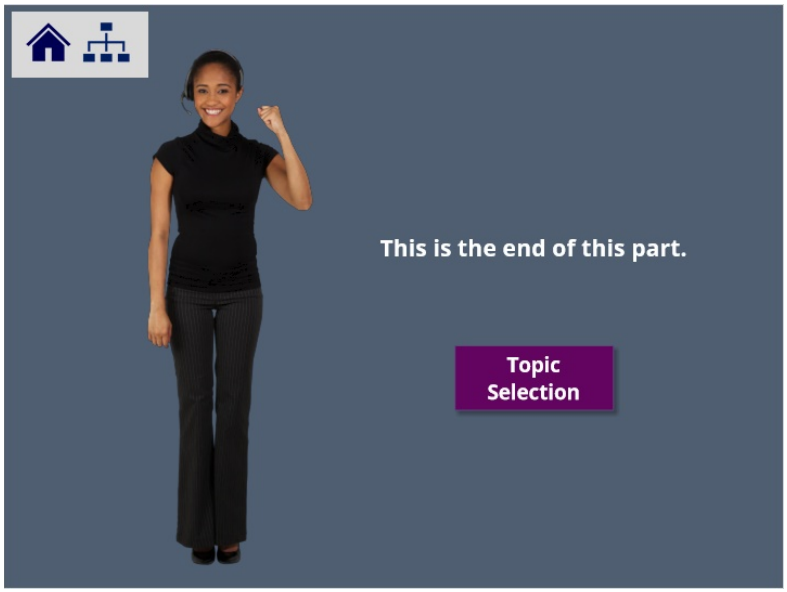
P nmik-1 (Slide Layer)



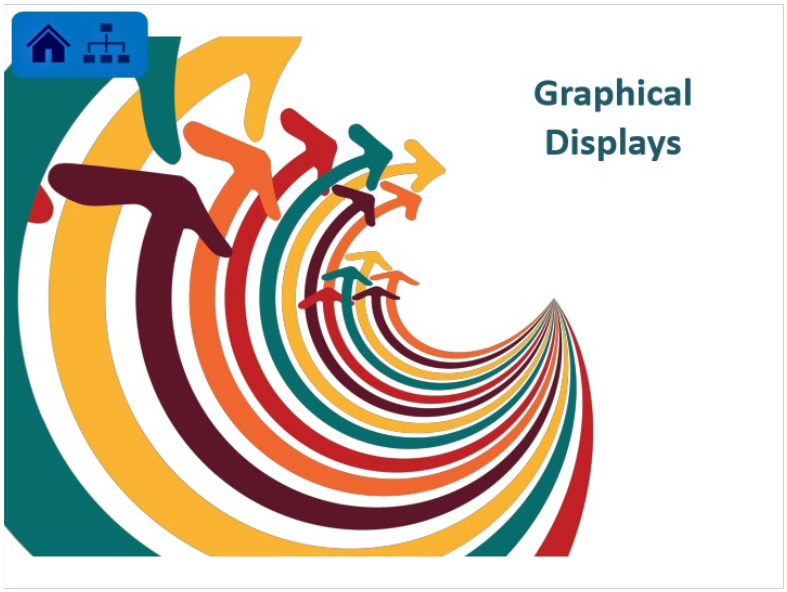
3.16 Rasch Model Fits Inside the General 3PL Model



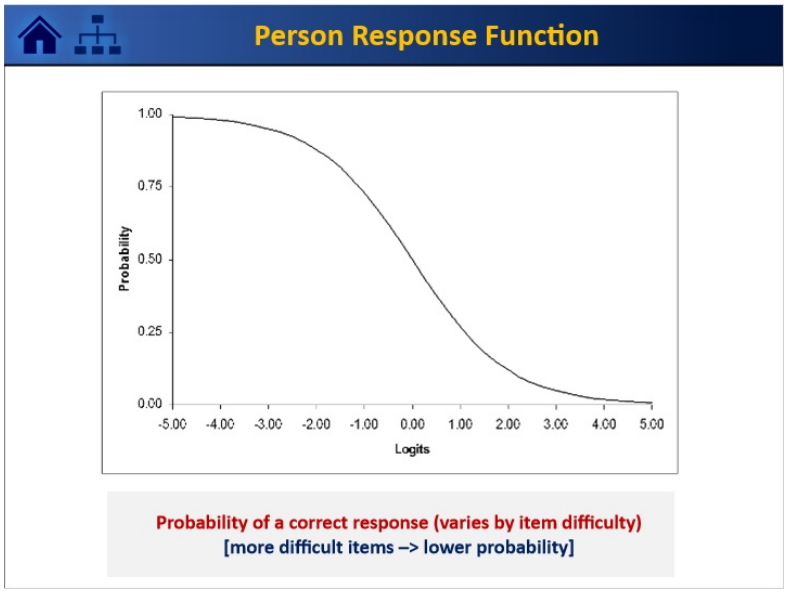
3.17 Bookend: Equations



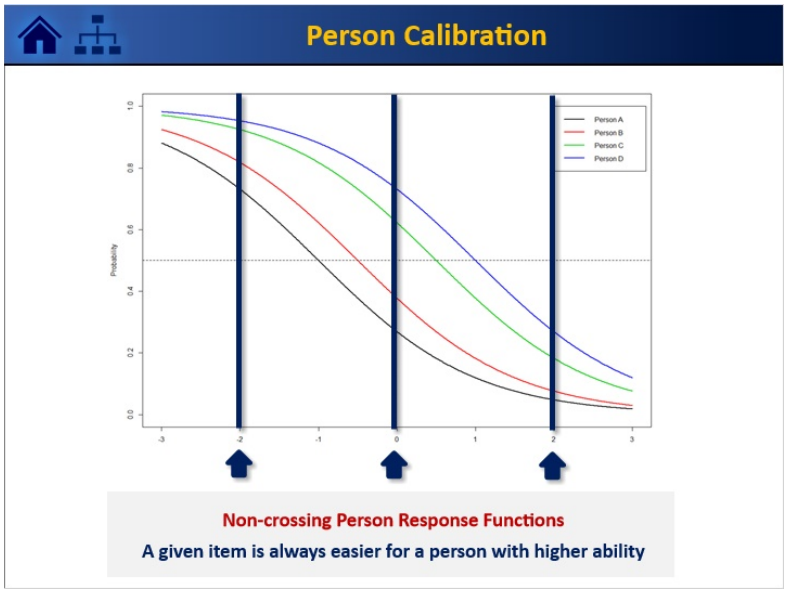
3.18 Bookmark: Graphs



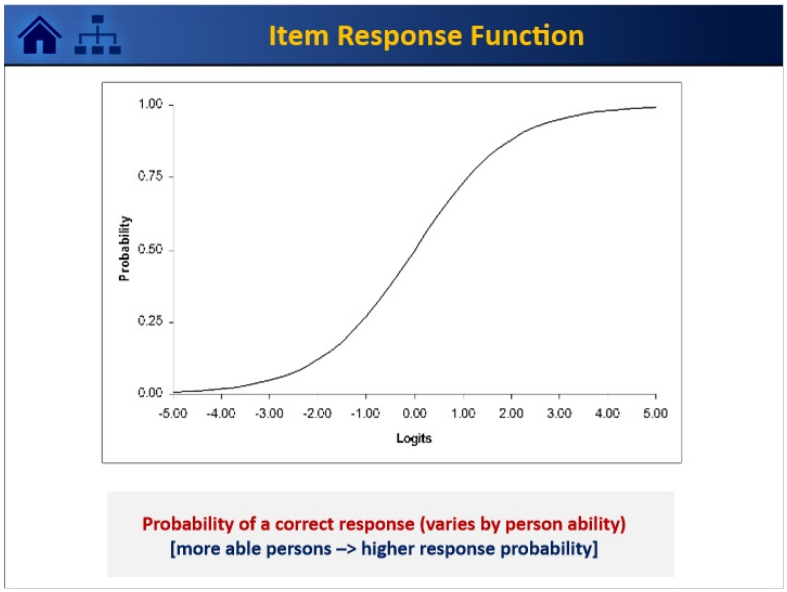
3.19 Person Response Function



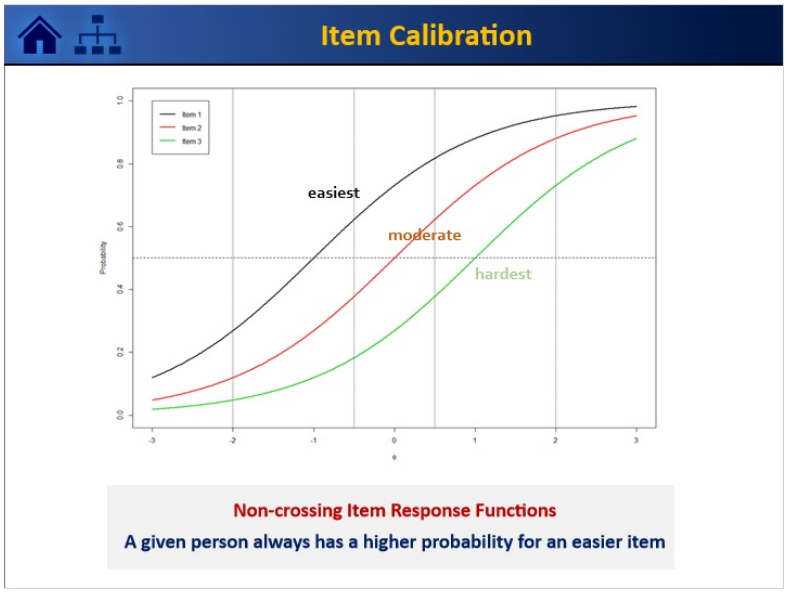
3.20 Person Measurement



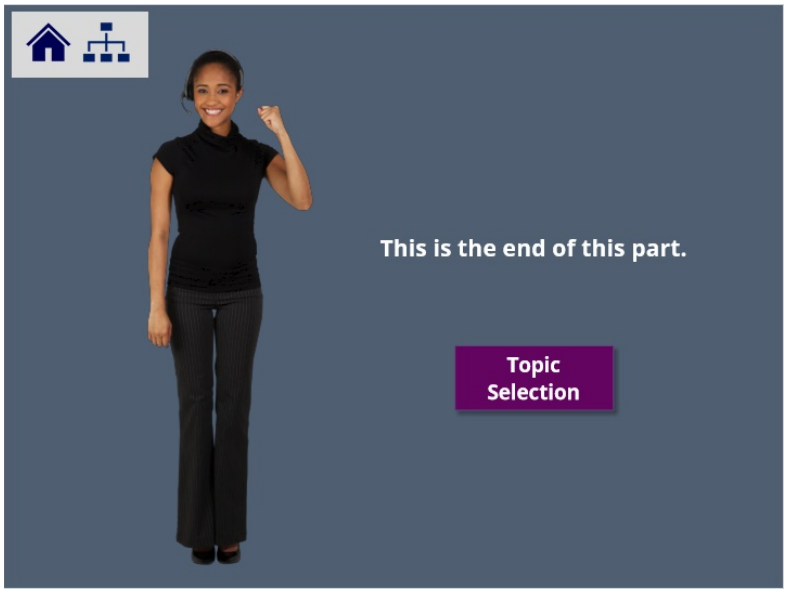
3.21 Item Response Function



3.22 Item Calibration

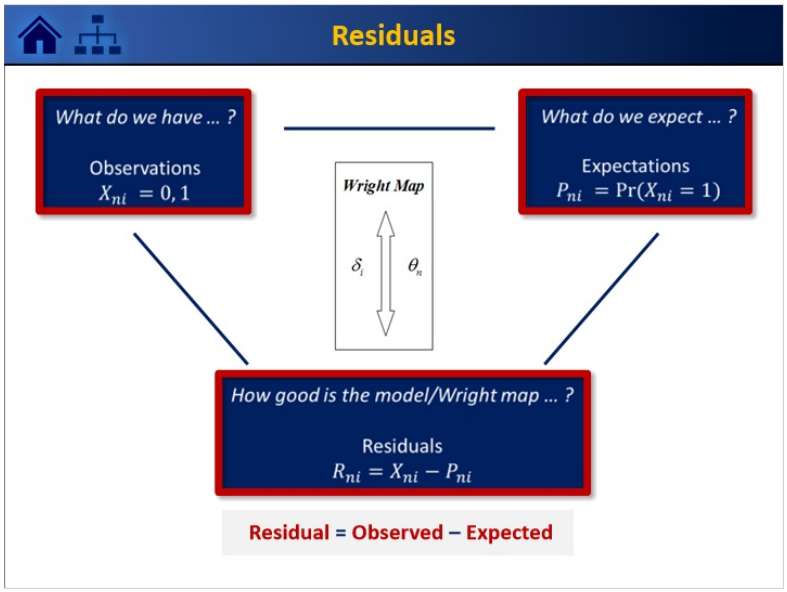


3.23 Bookend: Graphs

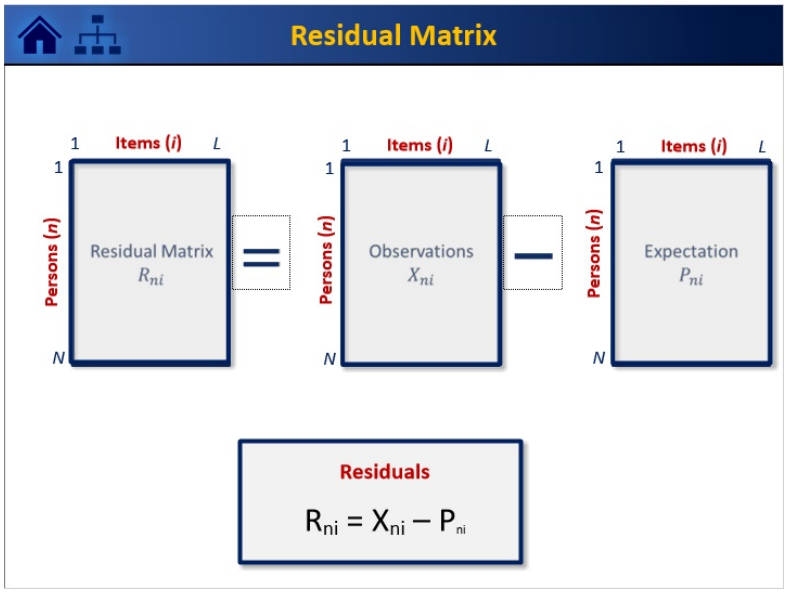


3.24 Bookmark: Fit

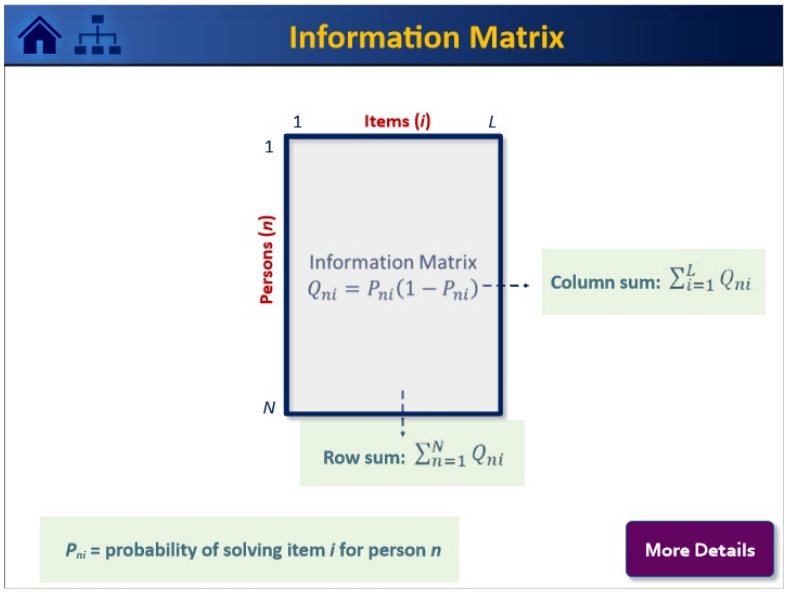
3.25 Residuals



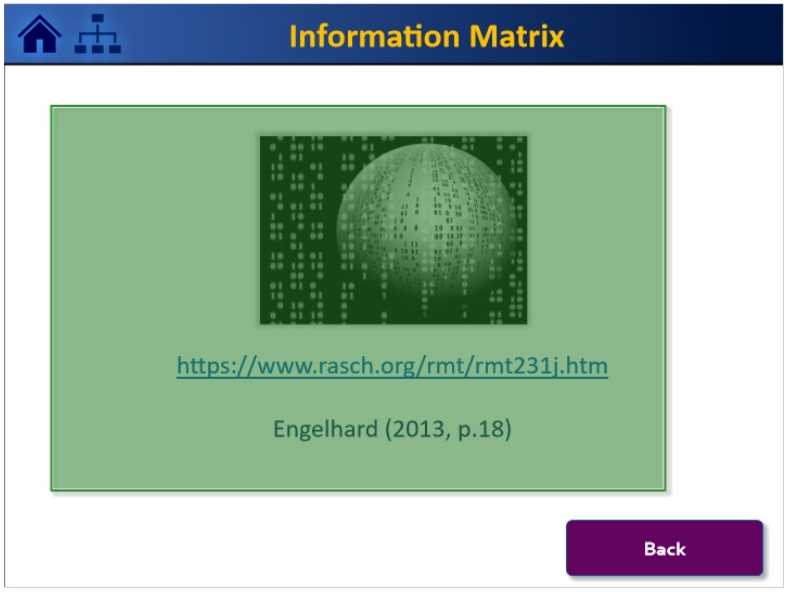
3.26 Residual Matrix



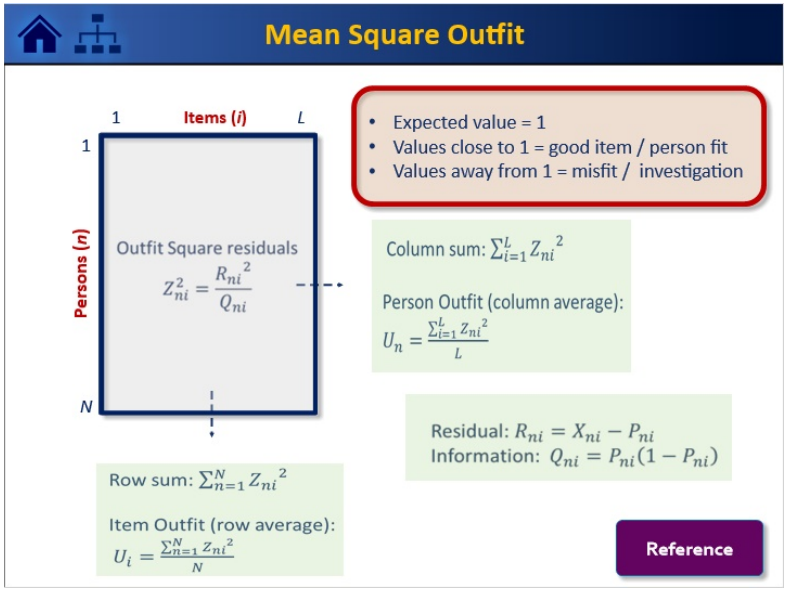
3.27 Information Matrix



References (Slide Layer)



3.28 Mean Square Outfit



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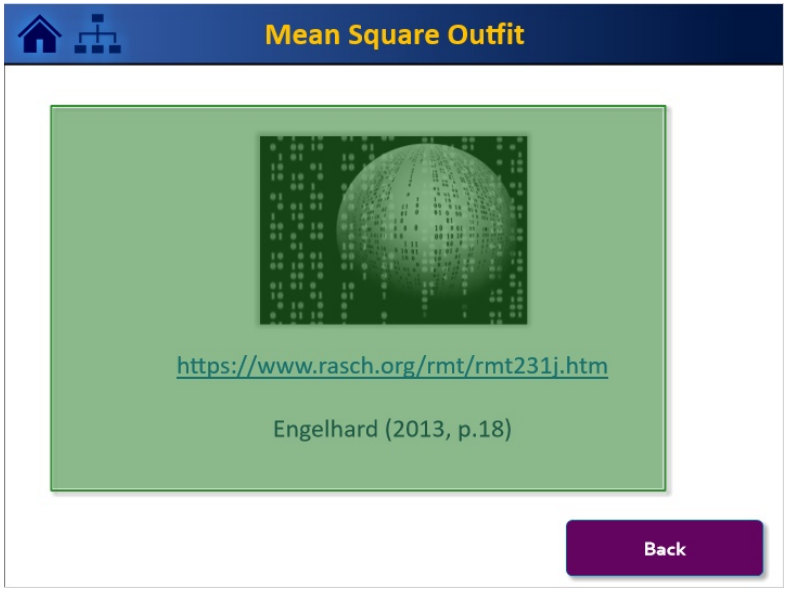
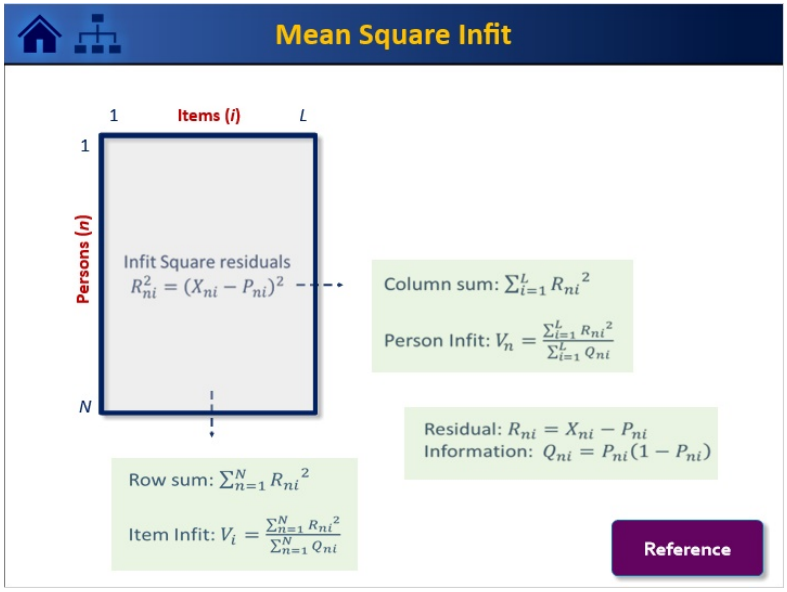
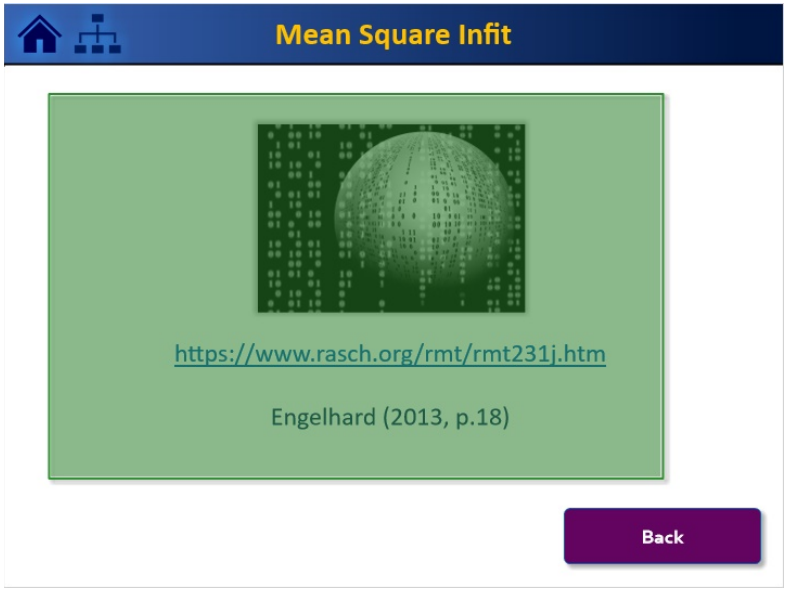


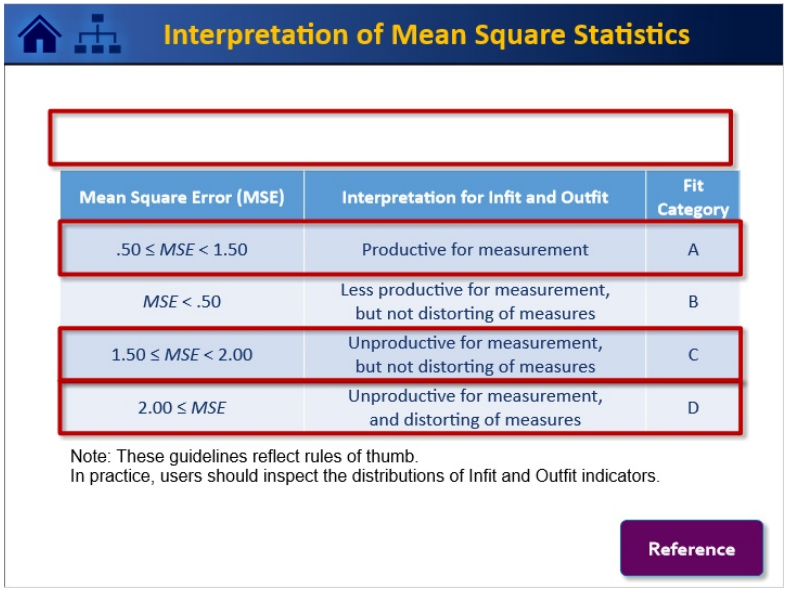
3.29 Mean Square Infit



References (Slide Layer)



3.30 Interpretation of Mean Square Statistics



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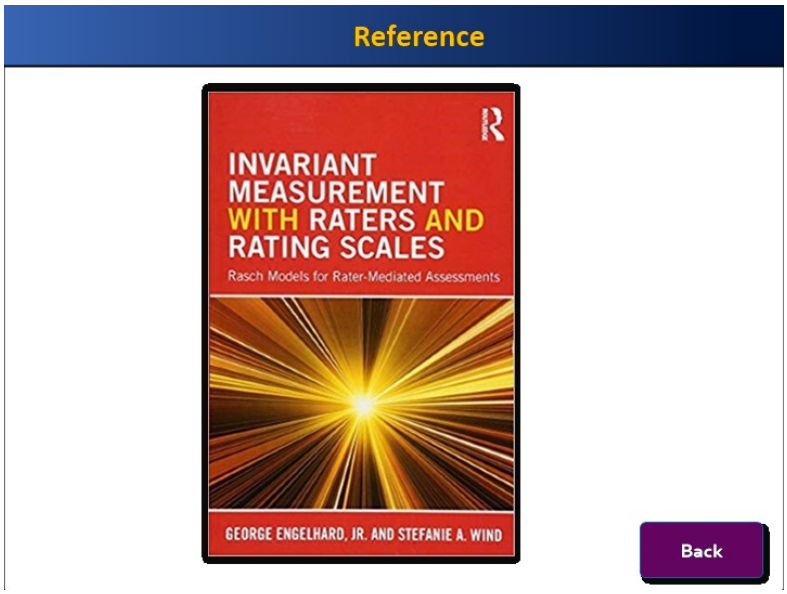
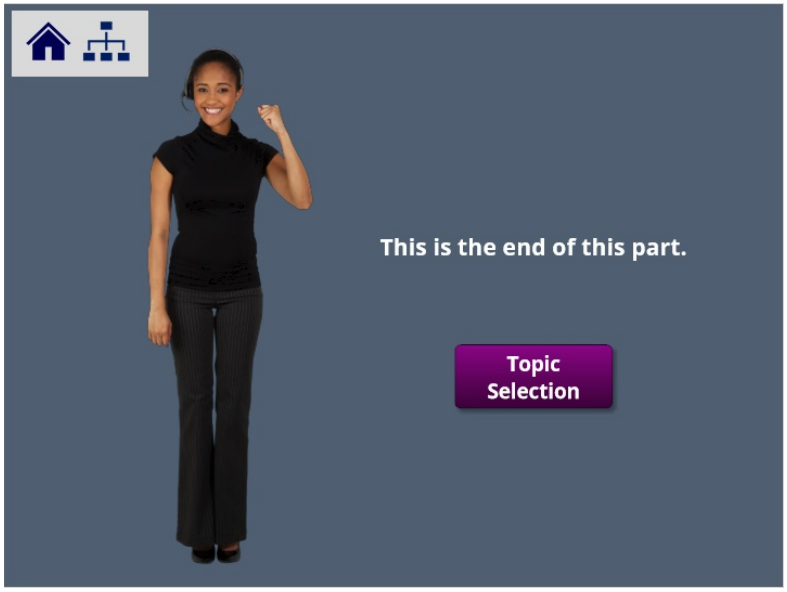
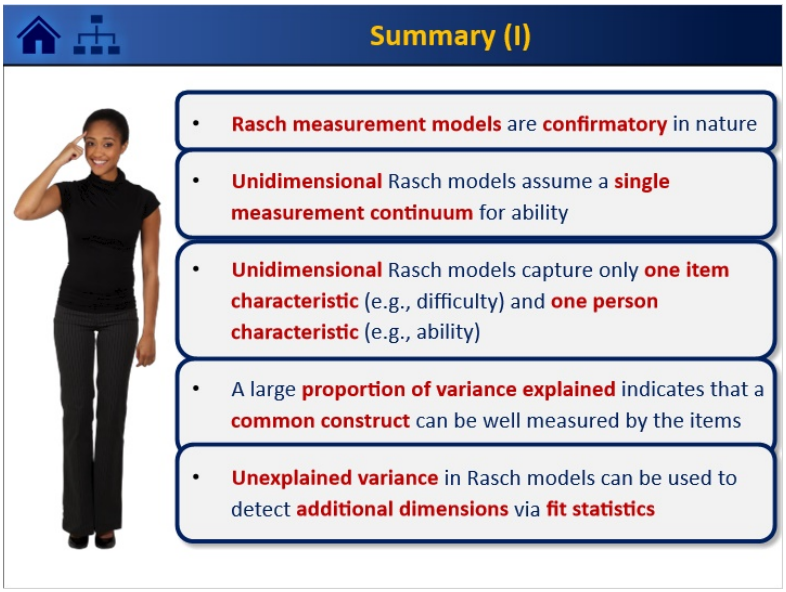


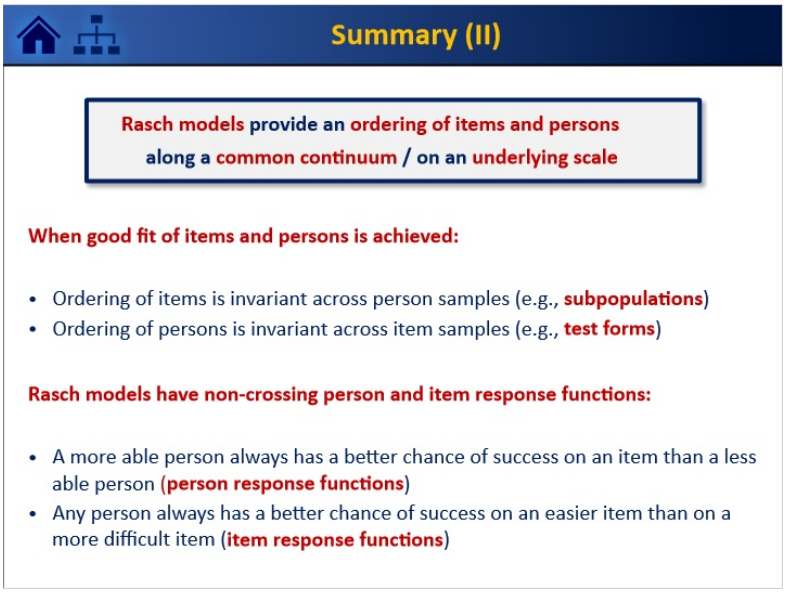
3.31 Bookend: Fit



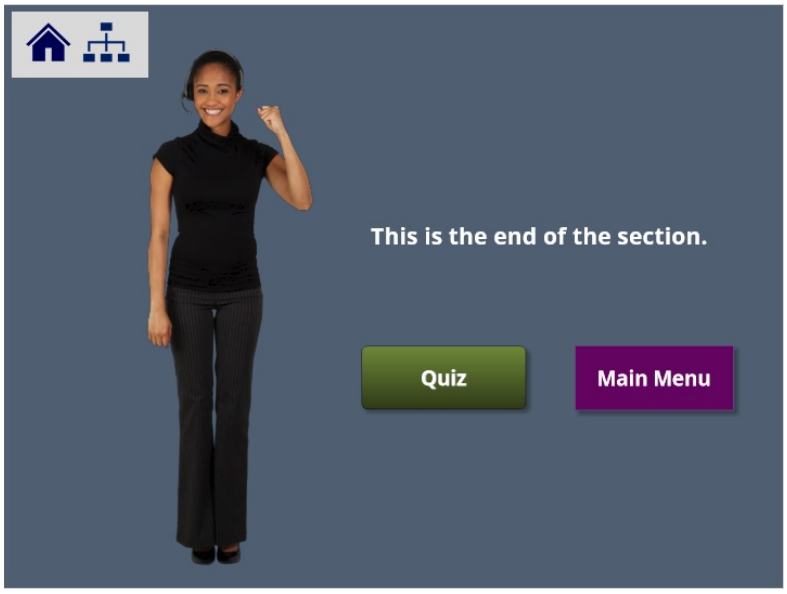
3.32 Summary (I)



3.33 Summary (II)



3.34 Bookend: Section 2

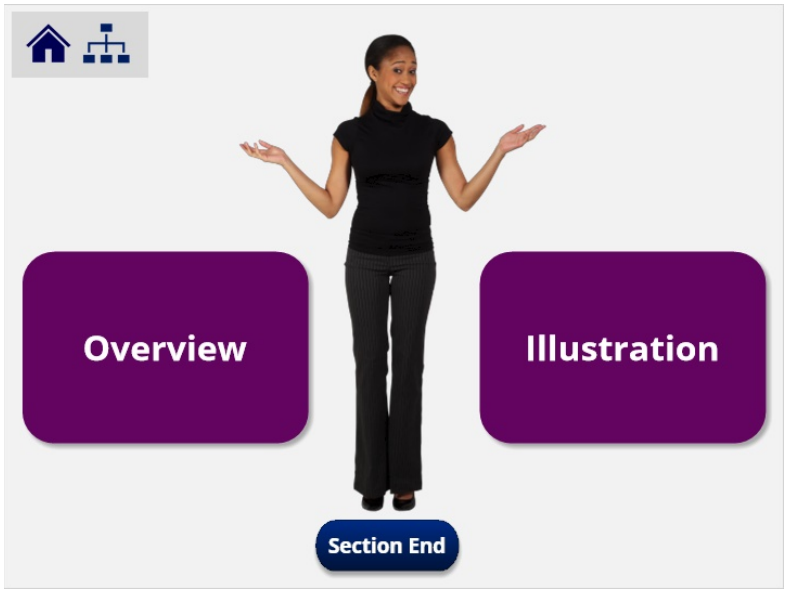


4. Section 3: Creating a Rasch Scale

4.1 Cover: Section 3

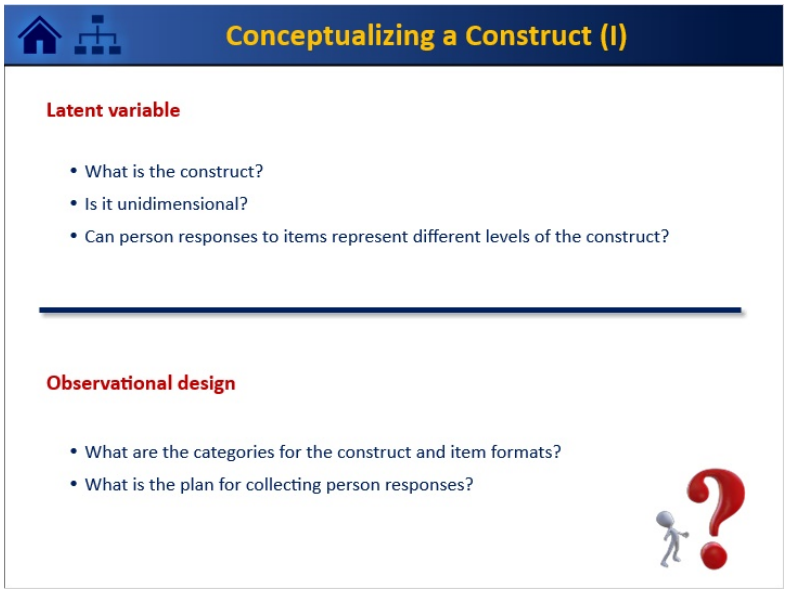
4.2 Objectives: Section 3

4.3 Topic Selection

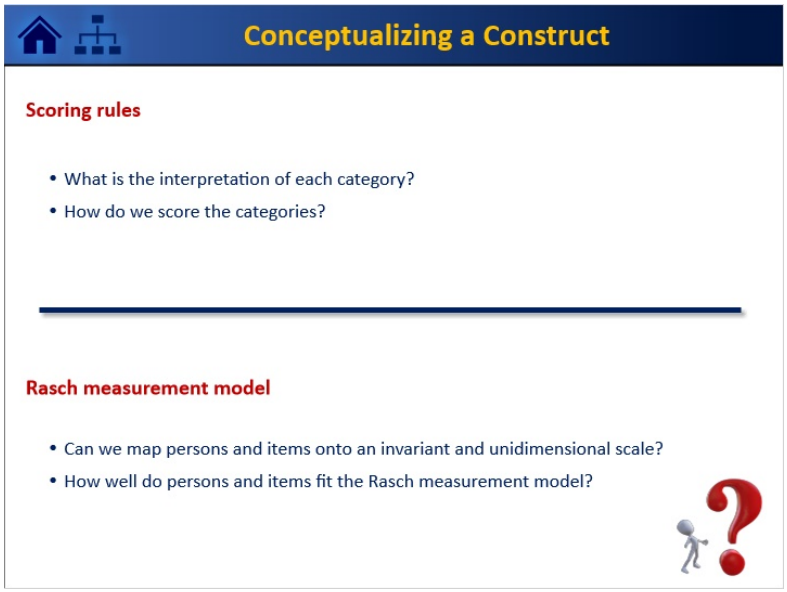


4.4 Bookmark: Overview

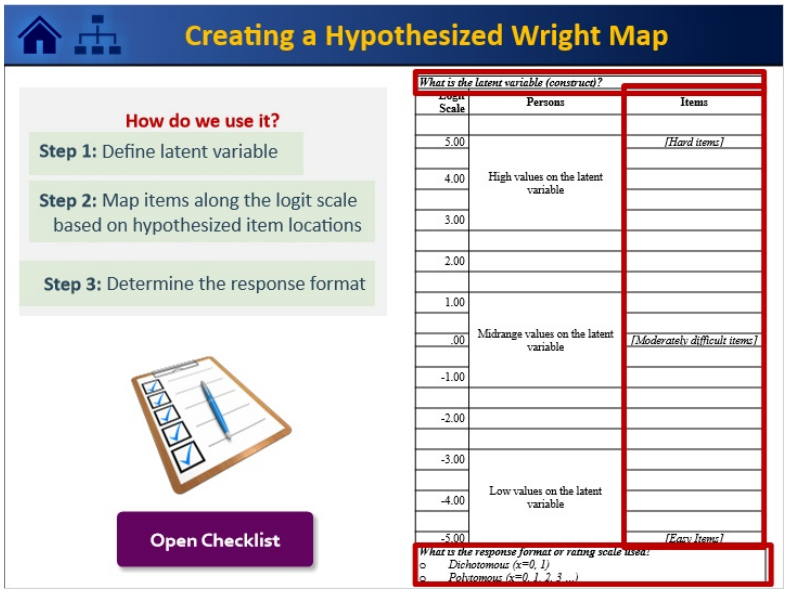
4.5 Conceptualizing a Construct



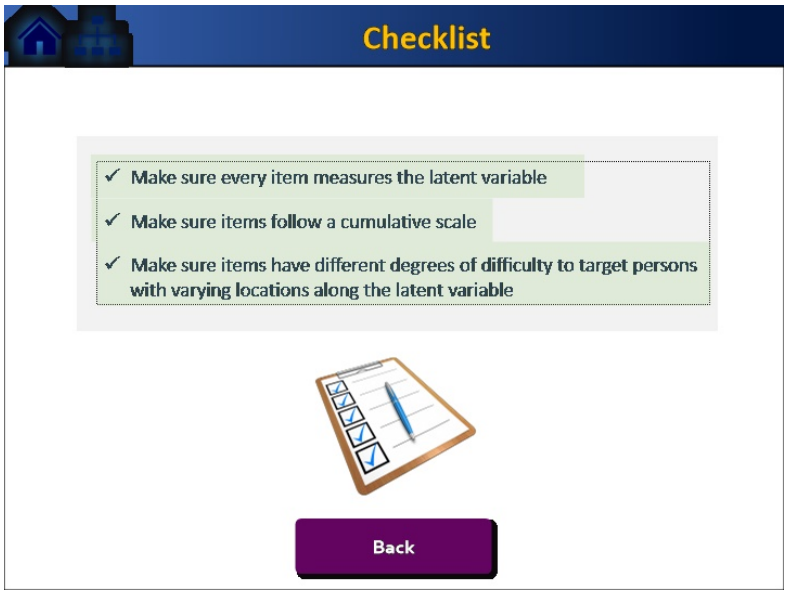
4.6 Conceptualizing a Construct



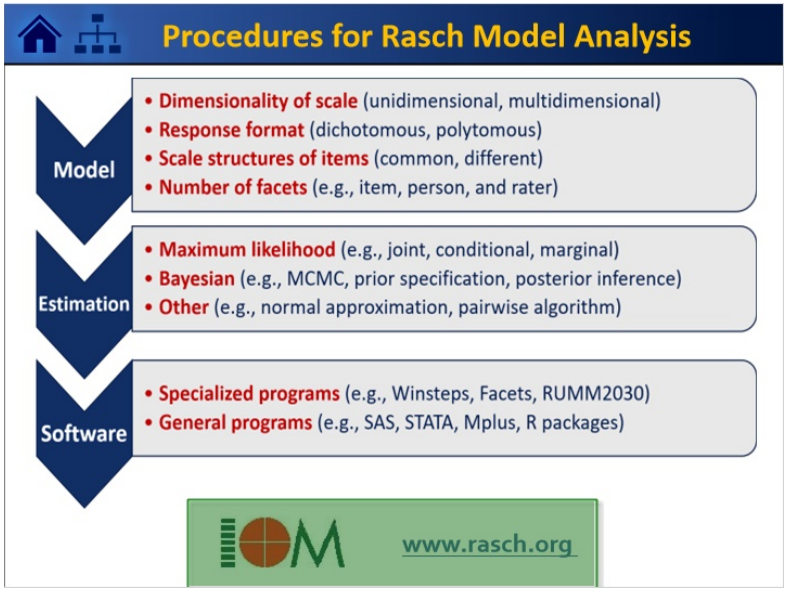
4.7 Creating a Hypothesized Wright Map



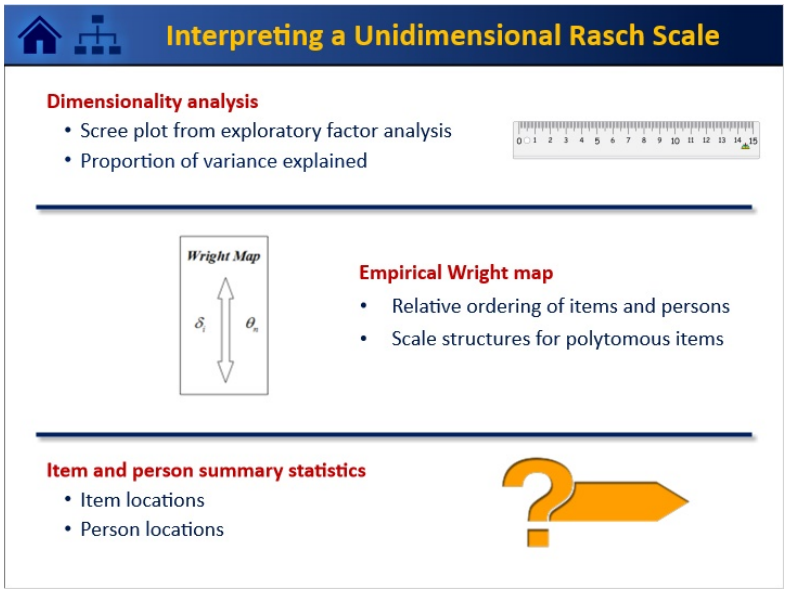
Checklist (Slide Layer)



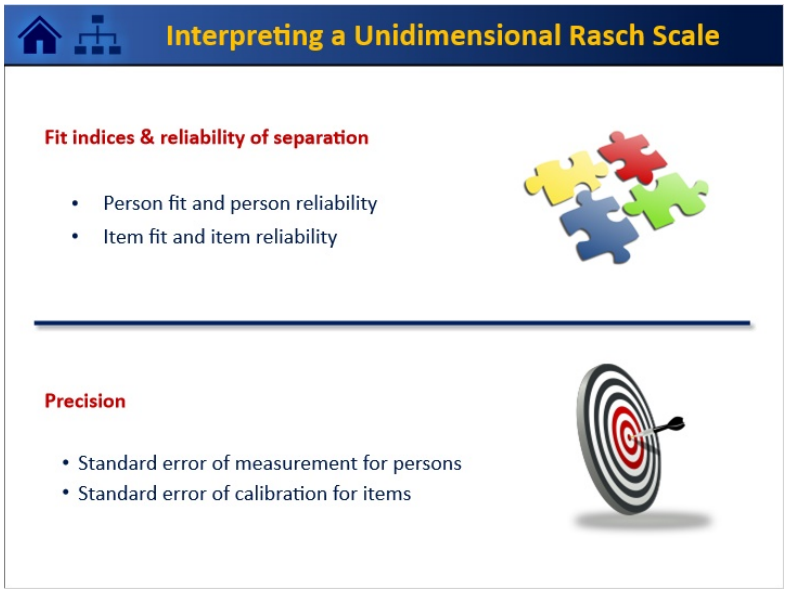
4.8 Procedures for Rasch Model Analysis



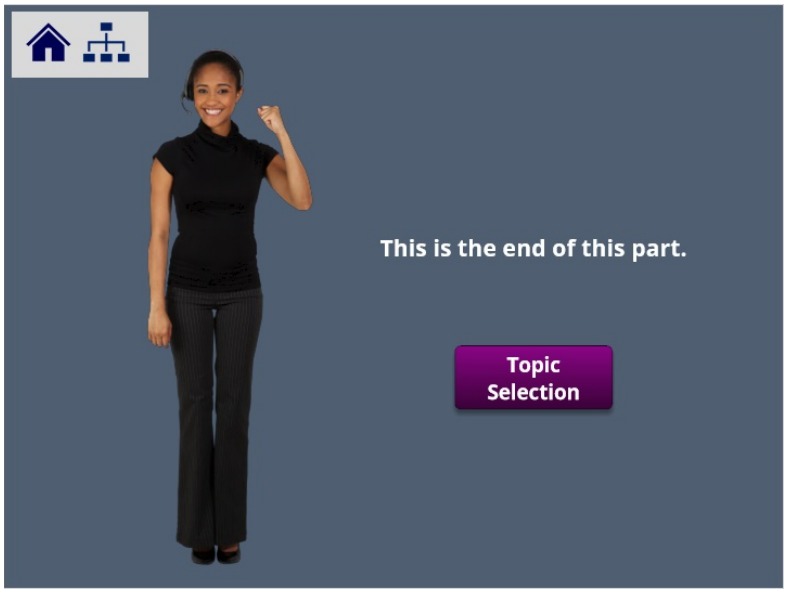
4.9 Interpreting a Unidimensional Rasch Scale



4.10 Interpreting a Unidimensional Rasch Scale

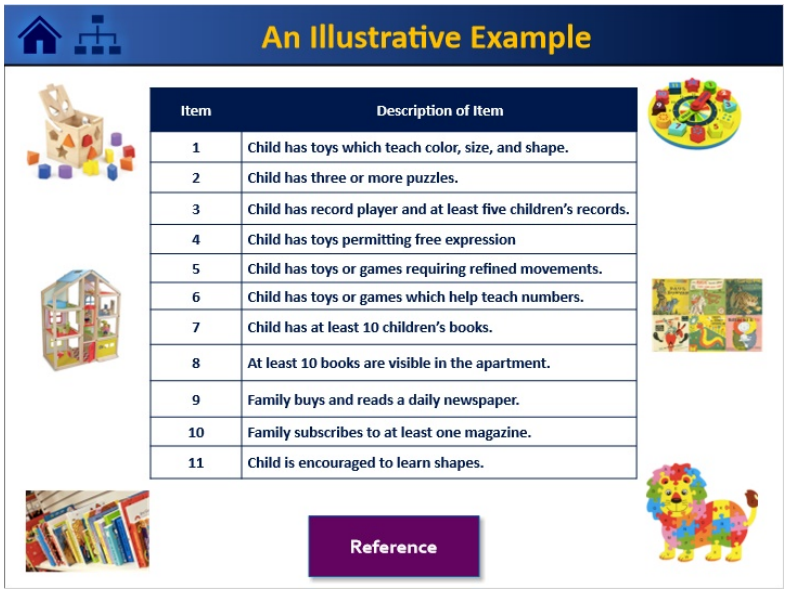


4.11 Bookend: Overview

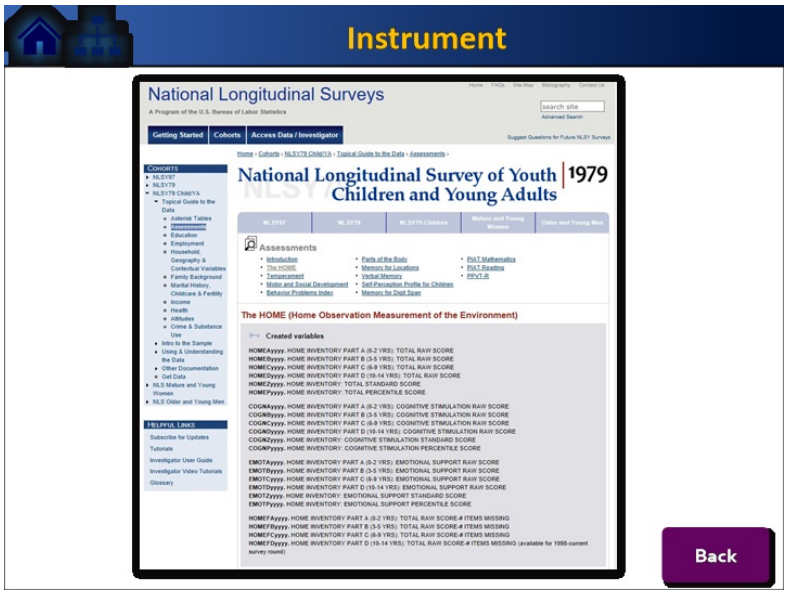


4.12 Bookmark: Illustration

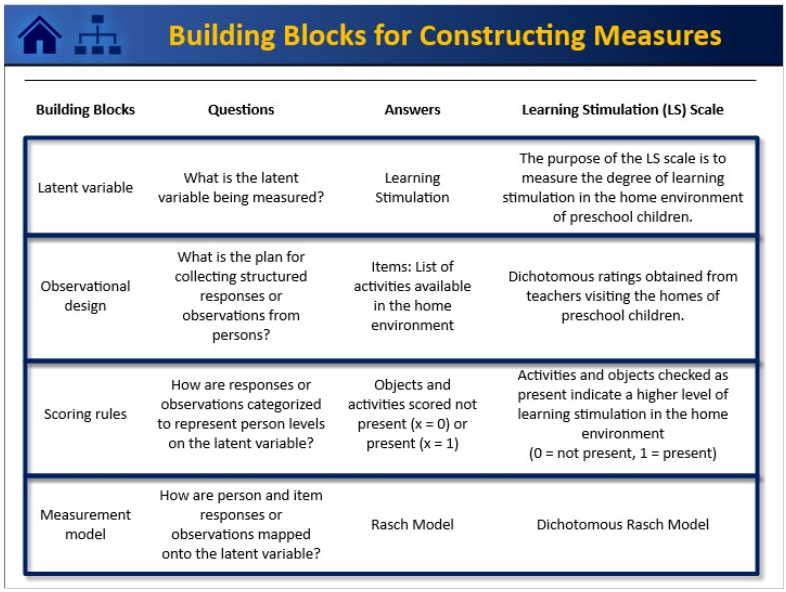
4.13 An Illustrative Example



Instrument (Slide Layer)



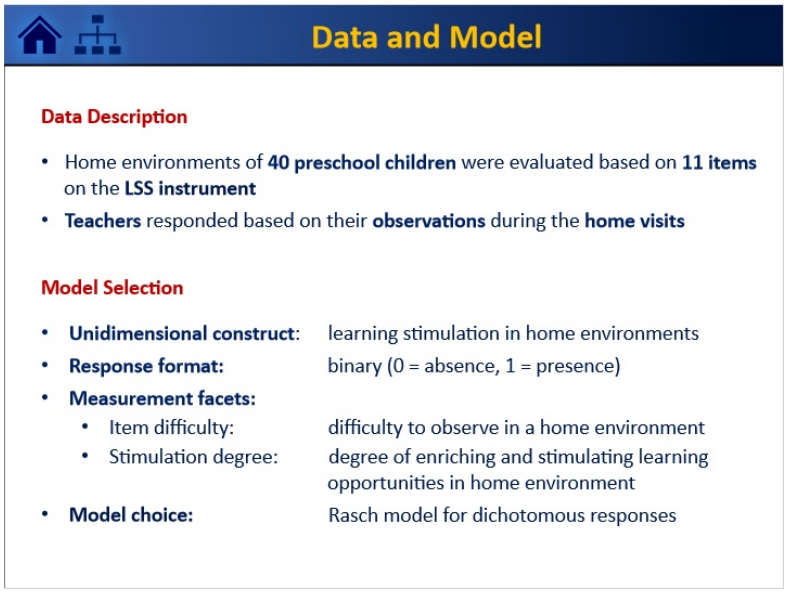
4.14 Building Blocks for Constructing Measures



Building Blocks for Constructing Measures

Building Blocks	Questions	Answers	Learning Stimulation (LS) Scale
Latent variable	What is the latent variable being measured?	Learning Stimulation	The purpose of the LS scale is to measure the degree of learning stimulation in the home environment of preschool children.
Observational design	What is the plan for collecting structured responses or observations from persons?	Items: List of activities available in the home environment	Dichotomous ratings obtained from teachers visiting the homes of preschool children.
Scoring rules	How are responses or observations categorized to represent person levels on the latent variable?	Objects and activities scored not present (x = 0) or present (x = 1)	Activities and objects checked as present indicate a higher level of learning stimulation in the home environment (0 = not present, 1 = present)
Measurement model	How are person and item responses or observations mapped onto the latent variable?	Rasch Model	Dichotomous Rasch Model

4.15 Data Description and Model Selection



Data and Model

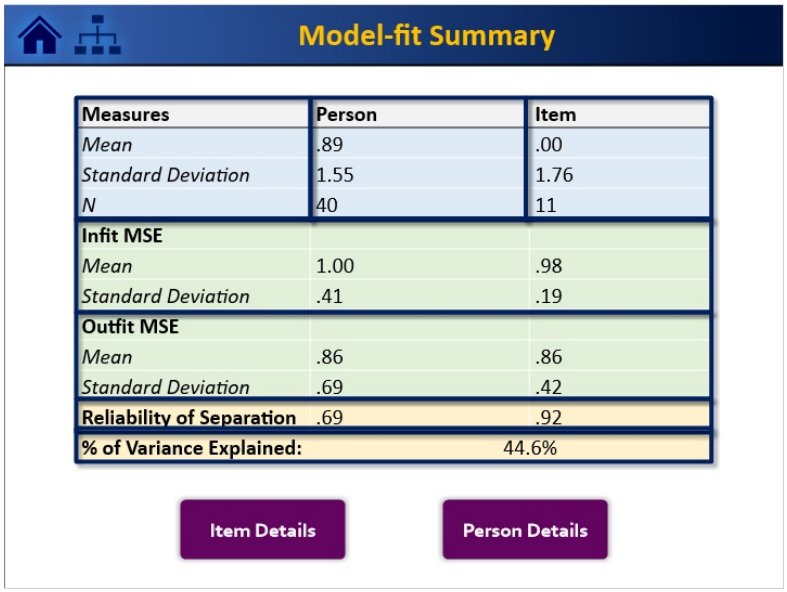
Data Description

- Home environments of **40 preschool children** were evaluated based on **11 items** on the **LSS instrument**
- **Teachers** responded based on their **observations** during the **home visits**

Model Selection

- **Unidimensional construct**: learning stimulation in home environments
- **Response format:** binary (0 = absence, 1 = presence)
- **Measurement facets:**
  - Item difficulty: difficulty to observe in a home environment
  - Stimulation degree: degree of enriching and stimulating learning opportunities in home environment
- **Model choice:** Rasch model for dichotomous responses

4.16 Summary Table

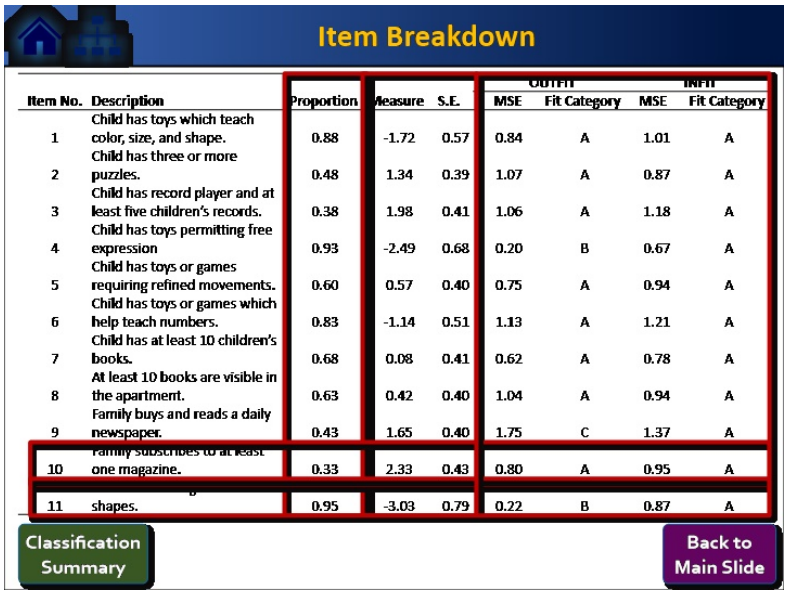


Model-fit Summary

Measures	Person	Item
Mean	.89	.00
Standard Deviation	1.55	1.76
N	40	11
Infit MSE		
Mean	1.00	.98
Standard Deviation	.41	.19
Outfit MSE		
Mean	.86	.86
Standard Deviation	.69	.42
Reliability of Separation	.69	.92
% of Variance Explained:	44.6%	

Item Details Person Details

Item Breakdown (Slide Layer)

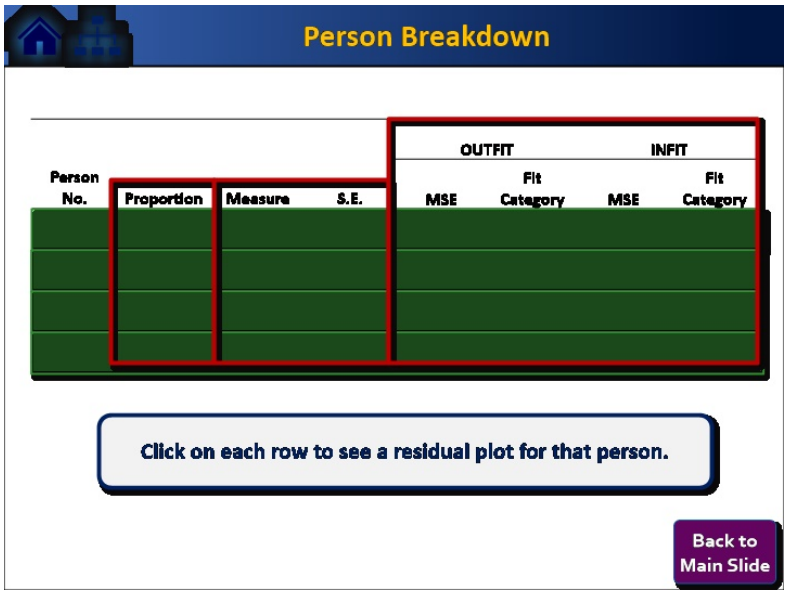


Item Breakdown

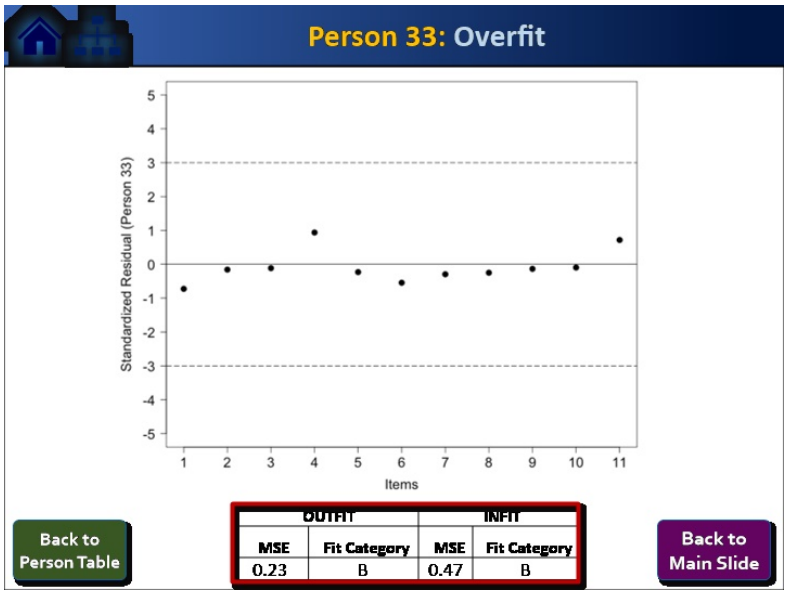
Item No.	Description	Proportion	Measure	S.E.	OUTFIT MSE	OUTFIT Fit Category	INFIT MSE	INFIT Fit Category
1	Child has toys which teach color, size, and shape.	0.88	-1.72	0.57	0.84	A	1.01	A
2	Child has three or more puzzles.	0.48	1.34	0.39	1.07	A	0.87	A
3	Child has record player and at least five children's records.	0.38	1.98	0.41	1.06	A	1.18	A
4	Child has toys permitting free expression	0.93	-2.49	0.68	0.20	B	0.67	A
5	Child has toys or games requiring refined movements.	0.60	0.57	0.40	0.75	A	0.94	A
6	Child has toys or games which help teach numbers.	0.83	-1.14	0.51	1.13	A	1.21	A
7	Child has at least 10 children's books.	0.68	0.08	0.41	0.62	A	0.78	A
8	At least 10 books are visible in the apartment.	0.63	0.42	0.40	1.04	A	0.94	A
9	Family buys and reads a daily newspaper.	0.43	1.65	0.40	1.75	C	1.37	A
10	Family subscribes to at least one magazine.	0.33	2.33	0.43	0.80	A	0.95	A
11	shapes.	0.95	-3.03	0.79	0.22	B	0.87	A

Classification Summary Back to Main Slide

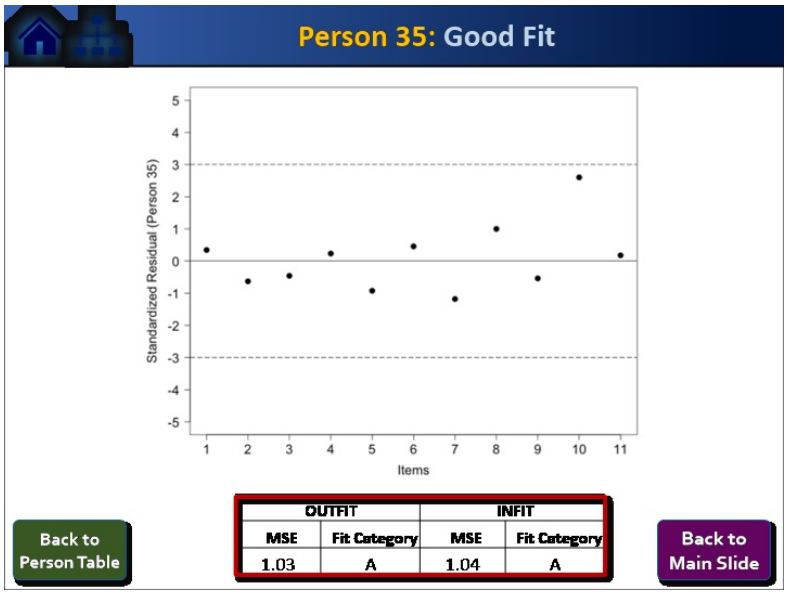
Person Breakdown (Slide Layer)



Person 33 (Slide Layer)

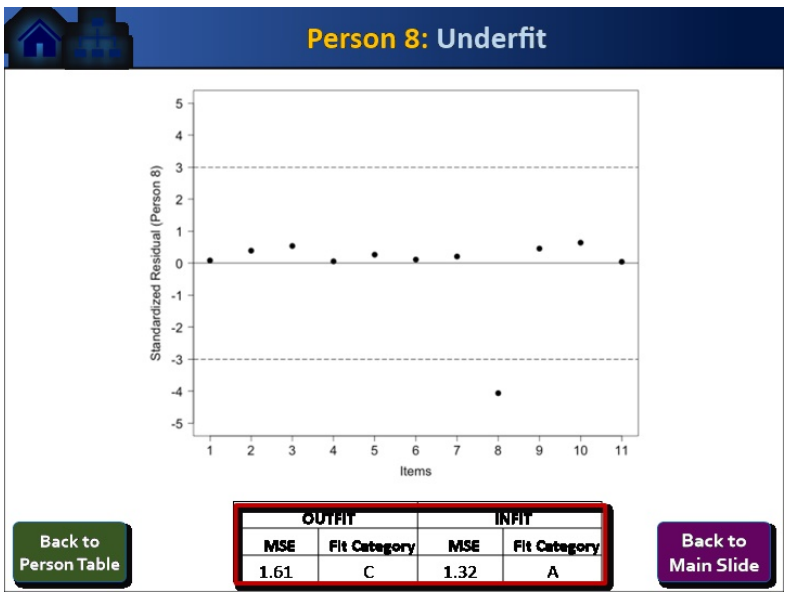


Person 35 (Slide Layer)



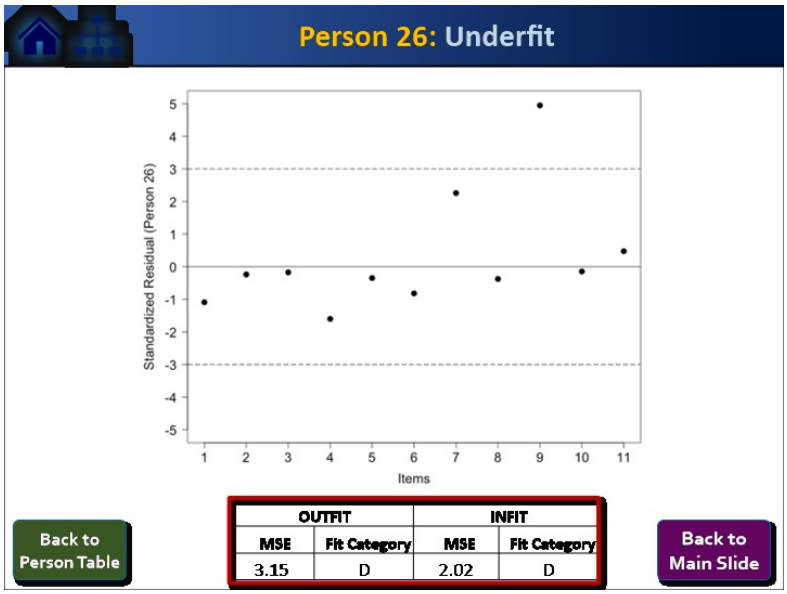
OUTFIT		INFIT	
MSE	Fit Category	MSE	Fit Category
1.03	A	1.04	A

Person 8 (Slide Layer)



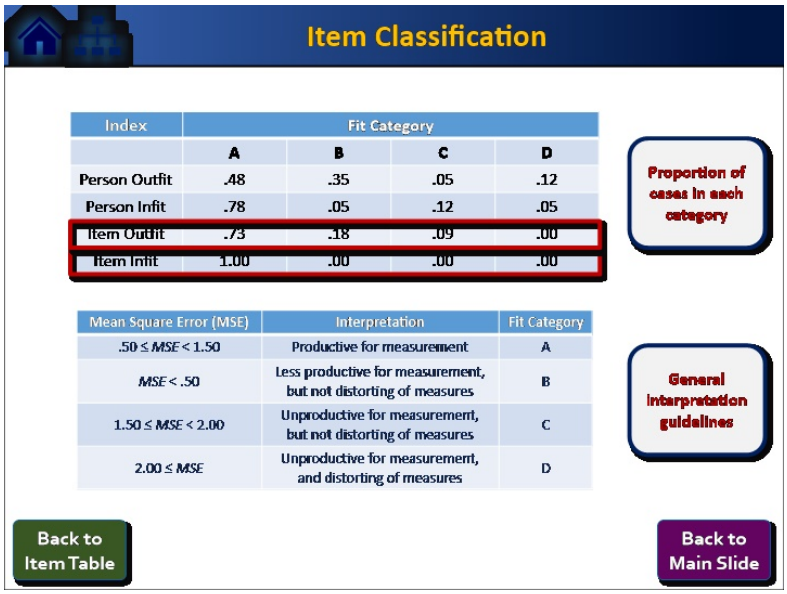
OUTFIT		INFIT	
MSE	Fit Category	MSE	Fit Category
1.61	C	1.32	A

Person 26 (Slide Layer)



OUTFIT		INFIT	
MSE	Fit Category	MSE	Fit Category
3.15	D	2.02	D

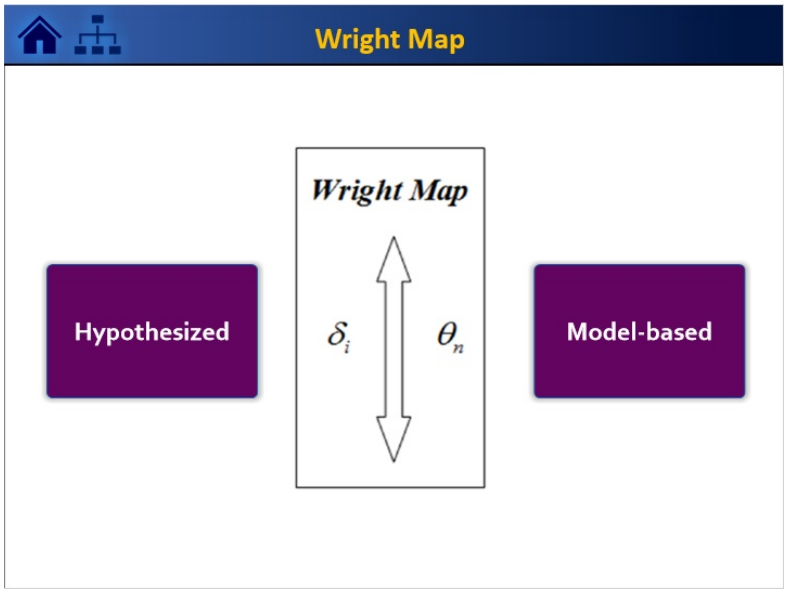
Classification (Slide Layer)



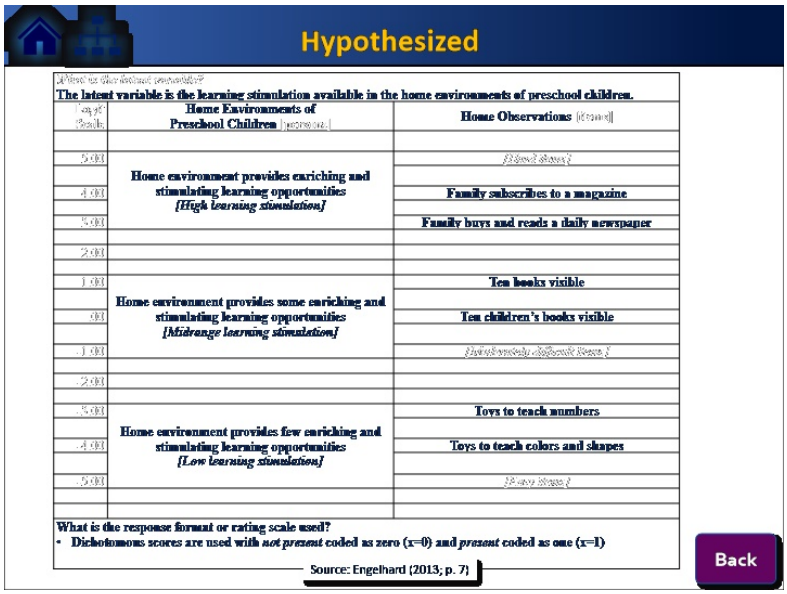
Index	Fit Category			
	A	B	C	D
Person Outfit	.48	.35	.05	.12
Person Infit	.78	.05	.12	.05
Item Outfit	.73	.18	.09	.00
Item Infit	1.00	.00	.00	.00

Mean Square Error (MSE)	Interpretation	Fit Category
.50 ≤ *MSE* < 1.50	Productive for measurement	A
MSE < .50	Less productive for measurement, but not distorting of measures	B
1.50 ≤ *MSE* < 2.00	Unproductive for measurement, but not distorting of measures	C
2.00 ≤ *MSE*	Unproductive for measurement, and distorting of measures	D

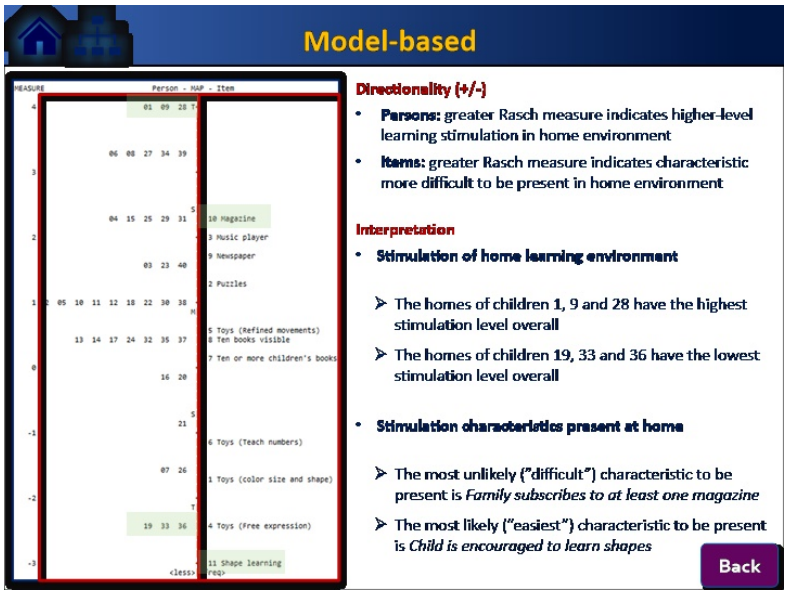
4.17 Untitled Slide



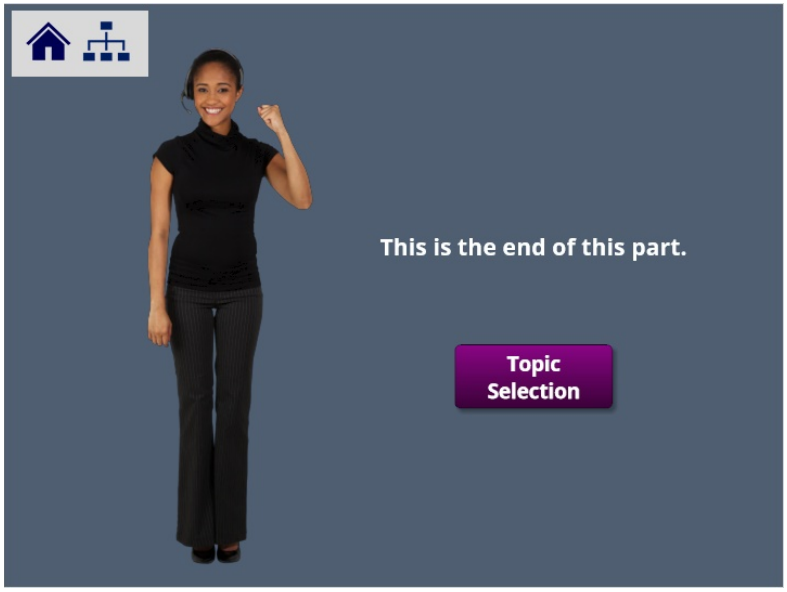
Hypothesized (Slide Layer)



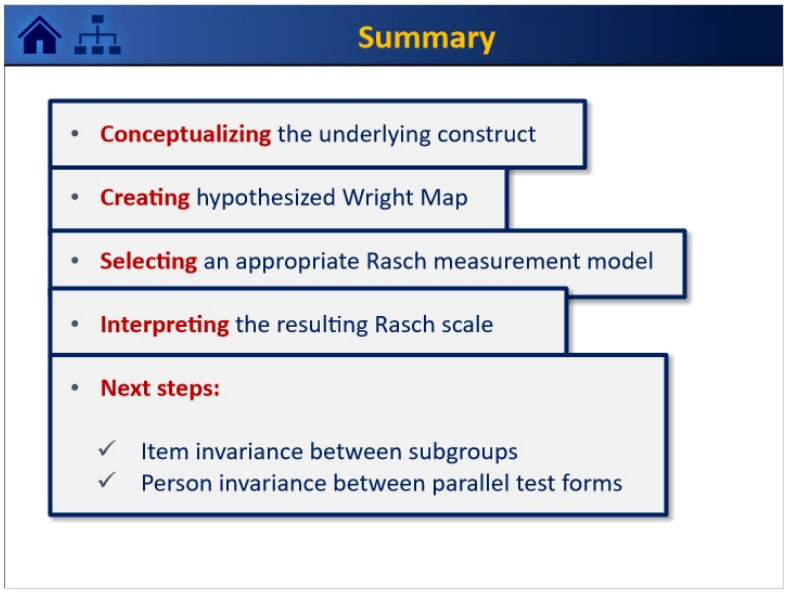
Model-based (Slide Layer)



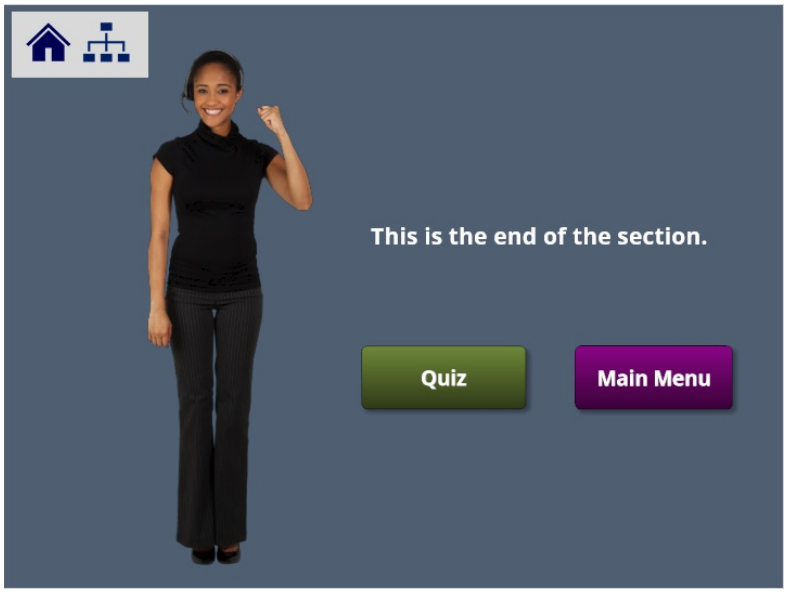
4.18 Bookend: Illustration



4.19 Summary



4.20 Bookend: Section 3



4.21 Module Cover (END)