

GRAPHICAL ITEM ANALYSIS: defining difficulty, discrimination and guessing rate

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- GIA is an easy-to-use analytical tool -using **SPSS-syntax**- to analyze the **quality of multiple-choice items**.
- *GIA visually displays the relationship between the raw score on a test and the proportions of the correct and incorrect alternatives.*
- *The item properties (difficulty, discrimination and guessing rate) are defined and calculated on the basis of graphs; these values may be compared to the 3 PL-model.*

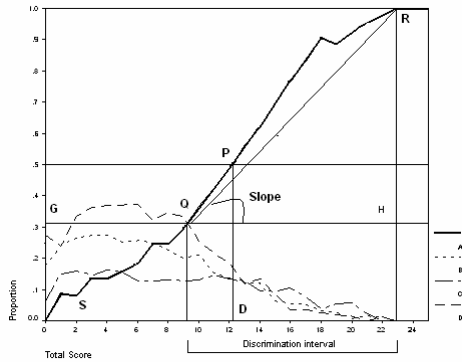


Figure 1: An empirical example of a graph

- The 0.50 proportion line cuts the solid line representing the response proportion of the correct alternative at point **P**. This value of the total score can be considered the item difficulty in GIA at point **D** on the horizontal axis with the value of 12.2.
- The **slope** between a horizontal line and the line between **Q** and **R** expresses the discrimination power of the item.
- The discrimination interval starts at point **Q** and ends at point **R**. Within the discrimination interval, the proportion of students who answer the item correctly increases with a rising higher total score.

GIA2 Discriminating Power =

$1 - \cos(\text{slope}) \sim \text{normalized on the number of items}$

GIA1 Difficulty =

$$\frac{P_{\text{Test Score}}}{\text{Numbers of Test Items}}$$

GIA3 Guessing Rate =

$$\left(\left| \frac{Q}{\text{Proportion}} - \frac{1}{\text{Numbers of Options}} \right| \right) * \left(\frac{\text{Numbers of Options}}{\text{Numbers of Options} - 1} \right)$$

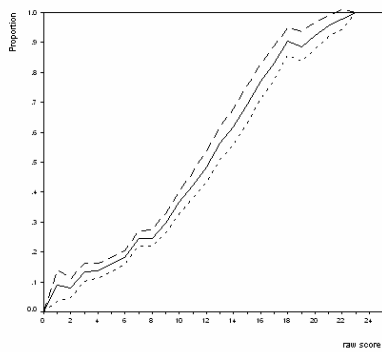


Figure 2 Empirical ICC with 95% reliability interval.

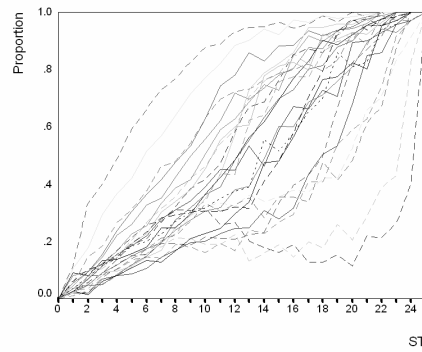


Figure 3 25 ICC's Math-test SSPE-SE Tutkey

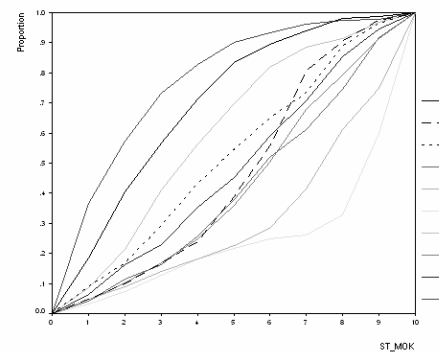


Figure 4 subset of 10 ICC's H = .34 (Mokken-scaling)

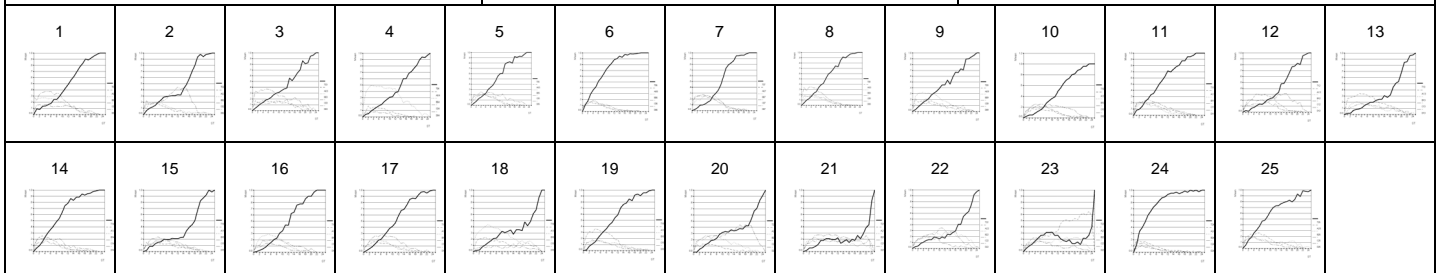


Table: GIA, 3PL and CTT: item properties

A GIA	GM1	GM2	GM3	CTT P-value	Ritem-rest	Mokken Hi	A GIA	GM1	GM2	GM3	CTT P-value	Ritem-rest	Mokken Hi	A GIA	GM1	GM2	GM3	CTT P-value	Ritem-rest	Mokken Hi
B	Bilog 3PL 1	Bilog 3PL 2	Bilog 3PL 3				B	Bilog 3PL 1	Bilog 3PL 2	Bilog 3PL 3				B	Bilog 3PL 1	Bilog 3PL 2	Bilog 3PL 3			
1 A	.50	.28	.10	.34	.43	.23	10 A	.50	.28	.01	.32	.46	.25	19 A	.42	.25	.10	.41	.43	.24
B	1.04	2.70	.20				B	1.06	2.28	.20				B	.81	2.13	.03			
2 A	.62	.36	.24	.32	.34	.18	11 A	.34	.20	.06	.46	.39	.23	20 A	.78	.55	.36	.25	.23	.13
B	1.45	5.28	.30				B	.76	2.01	.14				B	2.27	1.55	.09	.17	.07	.05
3 A	.54	.27	.13	.31	.34	.18	12 A	.62	.37	.03	.24	.42	.24	21 A	.93	.76	.03	.20	.25	.16
B	1.47	2.65	.25				B	1.45	2.76	.20				B	2.95	2.20	.14			
4 A	.58	.33	.26	.29	.38	.20	13 A	.70	.38	.04	.20	.33	.21	22 A	.74	.51	.16	.20	.25	.16
B	1.31	1.99	.19				B	1.08	2.12	.23				B	2.00	2.53	.15			
5 A	.42	.24	.02	.40	.43	.24	14 A	.34	.23	.01	.51	.41	.26	23 A	.97	.94	.22	.23	-.06	-.04
B	.84	2.08	.23				B	.25	1.82	.24				B	-	.35	.16			
6 A	.22	.21	.10	.63	.37	.29	15 A	.74	.27	.04	.23	.30	.18	24 A	.18	.20	.14	.74	.31	.31
B	.10	2.27	.35				B	1.63	3.12	.27				B	-.59	1.54	.17			
7 A	.46	.27	.01	.34	.53	.28	16 A	.50	.28	.01	.32	.48	.26	25 A	.34	.25	.00	.50	.33	.21
B	.78	3.25	.16				B	.98	2.44	.05				B	.30	1.12	.22			
8 A	.38	.24	.07	.43	.42	.24	17 A	.46	.28	.04	.38	.45	.24							
B	.64	2.01	.21				B	.94	2.61	.17										
9 A	.54	.26	.09	.34	.35	.19	18 A	.82	.29	.13	.24	.23	.13							
B	1.28	1.80	.25				B	2.10	1.04	.11										