

# Workshop on ACERConQuest

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# Outline

- Background (M. Wilson)
- Basics (C. Carstensen)
  - Running the program
  - Demo of Rasch, partial credit, rating scale models
  - Graphics package
- Break
- Facets models (M. Wilson)
- Multidimensional & Multilevel models (D. Briggs)
- Lunch
- Participants work with their own data

# Background

- Frustration with complexity of applications versus simplicity of item response models
  - Forced to ignore modeling of certain characteristics due to limits of model
  - E.g.s., different rating scales,  
multiple dimensions  
models that include demographics, etc.

- Development of generalized forms of item response models
  - Bock's "T-contrasts"
  - Random Coefficients Multinomial Logit model
    - RCML, Adams & Wilson, 1996
  - Multidimensional RCML
    - MRCML, Adams, Wilson & Wang, 1997

- Frustrations with standard software
  - Limited to “named” models
    - E.g.s., Rasch, partial credit, rating scale; 2PL, 3PL, graded response, etc.
  - Rasch software criticized for being statistically flawed
    - Joint maximum likelihood estimation

# Innovations of ConQuest

- Design Matrix formulation
  - Allows the specification of all standard Rasch-family models
  - Allows specification of vast number of possible new models
    - Any parameter that can be expressed using a linear combination of the observed values.
    - See formulation and example--later

# Innovations, ctd.

- Multidimensionality
  - Common that instruments are designed with multiple parts, yet analyzed as single dimensions
  - Exploratory item response modeling available, but dimensions are orthogonal (Reckase & McKinley, etc)
  - Confirmatory modeling, with non-orthogonal dimensions, more useable

# Innovations, ctd.

- Latent regression formulation
  - When using measured variables to make decisions, standard practice is to “forget” measurement error!!!
  - Latent regression approach allows one to include the measurement error in the statistical analysis of the decision.

# Innovations, ctd.

- Model specification language
  - Rasch:  $\text{item}$
  - partial credit:  $\text{item} + \text{step} * \text{item}$
  - rating scale:  $\text{item} + \text{step}$
  - facets:  $\text{item} + \text{rater} + \text{item} * \text{rater}$

# RCML formulation

Suppose we have  $I$  items indexed  $i=1,\dots,I$  and each item has  $K_i$  response alternatives.

We use the vector valued random variable  $\mathbf{X}_i$  to indicate the  $K_i$  responses to item  $i$ . That is  $\mathbf{X}_i=(X_{i1},X_{i2},\dots,X_{iK_i})'$ ,

where

$$X_{ij} = \begin{cases} 1 & \text{if response to item } i \text{ is in category } j \\ 0 & \text{otherwise} \end{cases}$$

By collecting the  $\mathbf{X}_i$  together into a single vector we define the vector valued random variable  $\mathbf{X}=(\mathbf{X}'_1,\mathbf{X}'_2,\dots,\mathbf{X}'_I)'$  which we call the response pattern.

The item parameters are given by the vector

$$\xi' = (\xi_1, \xi_2, \dots, \xi_s).$$

Linear combinations of these parameters are defined by design vectors

$$\mathbf{a}'_{ik}, (i=1, \dots, I; k=1, \dots, K_i)$$

which can be denoted collectively by the design matrix  $\mathbf{A}$ .

Score or “performance level” of the observed response in category  $j$  of item  $i$ :  $b_{ij}$

$$\mathbf{b} = (b_{11}, b_{12}, \dots, b_{1K_1}, b_{21}, \dots, b_{2K_2}, \dots, b_{IK_I})'$$

Latent attribute parameter,  $\theta$

Population distribution given by the density function  $g(\theta; \alpha)$  where  $\alpha$  is used to indicate a vector of parameters that characterizes the distribution.

RCML item response probability model:

$$\Pr(X_{ij}=1|\theta) = \frac{\exp(b_{ij}\theta + \mathbf{a}'_k \xi)}{\sum_{k=1}^{K_i} \exp(b_{ik}\theta + \mathbf{a}'_k \xi)}, \quad (1)$$

Response vector probability model:

$$\Pr(\mathbf{X}=\mathbf{x}|\theta) = \pi_{\mathbf{X}|\theta} = \Psi(\theta, \xi) \exp\{\mathbf{x}'(\mathbf{b}\theta + \mathbf{A}\xi)\} \quad (2)$$

where

$$\Psi(\theta, \xi) = \left( \prod_{i=1}^I \sum_{k=1}^{K_i} \exp(b_{ik}\theta + \mathbf{a}'_k \xi) \right)^{-1}$$

Marginal probability:

$$f(\mathbf{x} ; \mathbf{A}, \xi, \alpha) = \int_{\theta} \pi_{\mathbf{X}|\theta} g(\theta ; \alpha) d\theta. \quad (3)$$

# Estimation

- Marginal Maximum Likelihood
- Normal distribution
  - Gaussian quadrature
  - Multidimensional: monte carlo available
- Histogram distribution
- Person estimation:
  - EAP, ML, WLE, Plausible values

# Example Design Matrix

Without constraints

item	response	parameters				
		$\delta_1$	$\delta_2$	$\delta_3$	$\delta_4$	$\delta_5$
1	0	0	0	0	0	0
1	1	1	0	0	0	0
2	0	0	0	0	0	0
2	1	0	1	0	0	0
3	0	0	0	0	0	0
3	1	0	0	1	0	0
4	0	0	0	0	0	0
4	1	0	0	0	1	0
5	0	0	0	0	0	0
5	1	0	0	0	0	1

$$P(X_i = 0) = \frac{\exp(0 \cdot \theta - 0 \cdot \delta_i)}{D}$$

$$P(X_i = 1) = \frac{\exp(1 \cdot \theta - 1 \cdot \delta_i)}{D}$$

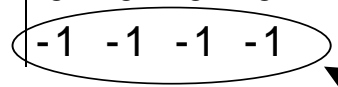
Coefficient for  $\theta$  is contained in score vector

# Adding Constraints

With constraints

item	response	parameters			
		$\delta_1$	$\delta_2$	$\delta_3$	$\delta_4$
1	0	0	0	0	0
1	1	1	0	0	0
2	0	0	0	0	0
2	1	0	1	0	0
3	0	0	0	0	0
3	1	0	0	1	0
4	0	0	0	0	0
4	1	0	0	0	1
5	0	0	0	0	0
5	1	-1	-1	-1	-1

$$\delta_5 = -\delta_1 - \delta_2 - \delta_3 - \delta_4$$



# The ConQuest Models

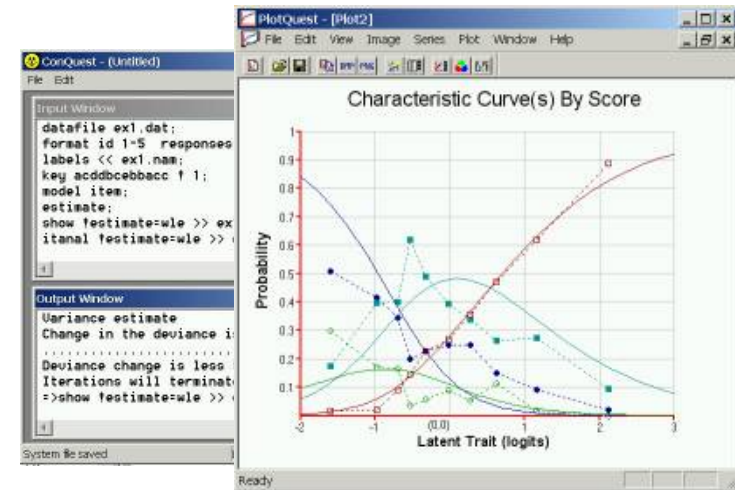
- Rasch, partial credit, rating scale
- LLTM, multifaceted models (incl. DIF)
- Multidimensional models
- Latent regression models
- User-defined models

# The Basics

Introduction to the ConQuest  
Software

# Two ConQuest versions

- Gui
  - More user-friendly windows application
  - Plot feature



- Console
  - Faster, especially for multi-dimensional analyses

```
Ausw2@len C:\conquest\jena\console.exe
Iteration: 46 .....
Deviance = 13274.87603

Variance Estimate:
Dimension 1    0.86590

Mean:
Dimension 1    1.07014

Maximum changes:
Item parameter estimates ==> 0.00016
Mean estimate           ==> 0.00000
Variance estimate       ==> 0.00002
Change in the deviance is 0.00008

.....
Deviance change is less than convergence criterion
Iterations will terminate
Calculating fit statistics

Fit: 75%

->show festimate=we >> ex1.shw;
File ex1.shw already exists. Replace?
Enter Y for Ok or N to cancel
```

# ConQuest Logic — 1

- Location of data
  - data file
- Content of data
  - codes
  - format
- Request analysis
  - model
  - estimate
- Ask to see outcomes of analysis
  - Show
  - Itanal

# ConQuest Logic — 2

- Command argument ! Option >> redirection;
  - **title** sample ConQuest Analysis;
  - **recode** (a,b,c,w,x)(2,1,0,0,0)!items(4);
  - **show** !estimates=latent >> ex2a.shw;
  - **itanal** >> itanal.dat;

# Example ConQuest — 1

```
datafile ex1.dat;  
format id 1-5  responses 12-23;  
labels << ex1.nam;  
key acddbcebbacc ! 1;  
model item;  
estimate;  
Show !estimate=wle >> ex1.shw;  
Itanal !estimate=wle >> ex1.itn;
```

# Ex1.dat

12135	accdbcebdacc
11792	ddadccdbbacd
40016	acdabaeadacd
655	acdccccecbaca
31140	eccdbcebbacb
40513	adddbcebbacc
1042	acdc bcebbacd
975	abddbcebbacc

# Example ConQuest — 1

```
datafile ex1.dat;  
format id 1-5  responses 12-23;  
labels << ex1.nam;  
key acddbcebbacc ! 1;  
model item;  
estimate;  
Show !estimate=wle >> ex1.shw;  
Itanal !estimate=wle >> ex1.itn;
```

# Ex1.nam

====> item

1	BSMMA01
2	BSMMA02
3	BSMMA03
4	BSMMA04
5	BSMMA05
6	BSMMA06
7	BSMSA07
8	BSMSA08
9	BSMSA09
10	BSMSA10
11	BSMSA11
12	BSMSA12

# Example ConQuest — 1

```
datafile ex1.dat;  
format id 1-5  responses 12-23;  
labels << ex1.nam;  
key acddbcebbacc ! 1;  
model item;  
estimate;  
Show !estimate=wle >> ex1.shw;  
Itanal !estimate=wle >> ex1.itn;
```

## SUMMARY OF THE ESTIMATION

Estimation method was: Gauss-Hermite Quadrature with 15 nodes

Assumed population distribution was: Gaussian

Constraint was: DEFAULT

The Data File: ex1.dat

The format: id 1-5 responses 12-23

The regression model:

Grouping Variables:

**The item model: item**

**Sample size: 1000**

**Final Deviance: 13274.876**

**Total number of estimated parameters: 13**

The number of iterations: 46

Termination criteria: Max iterations=200, Parameter Change= 0.00010  
Deviance Change= 0.00010

Iterations terminated because the deviance convergence criteria was reached

Random number generation seed: 1.00000

Number of nodes used when drawing PVs: 2000

Number of nodes used when computing fit: 1000

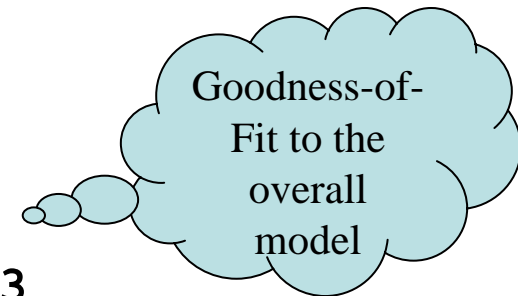
Number of plausible values to draw: 5

Maximum number of iterations without a deviance improvement: 20

Maximum number of Newton steps in M-step: 10

Value for obtaining finite MLEs for zero/perfects: 0.30000

key 1 scored as 1: acddbcebbacc



# Ex1.shw - 2

TERM 1: item

VARIABLES		UNWEIGHTED FIT			
item	ESTIMATE	ERROR <sup>^</sup>	MNSQ	CI	T
1	BSMMA01	0.364	0.050	0.88 ( 0.91, 1.09)	-2.9
2	BSMMA02	-0.177	0.052	1.05 ( 0.91, 1.09)	1.0
3	BSMMA03	-0.024	0.051	0.86 ( 0.91, 1.09)	-3.2
4	BSMMA04	0.837	0.049	0.98 ( 0.91, 1.09)	-0.3
5	BSMMA05	1.179	0.049	1.08 ( 0.91, 1.09)	1.7
6	BSMMA06	-0.313	0.052	1.01 ( 0.91, 1.09)	0.1
7	BSMSA07	-0.391	0.053	1.03 ( 0.91, 1.09)	0.7
..... •					
12	BSMSA12	0.707*	0.172	0.98 ( 0.91, 1.09)	-0.4

# Ex1.shw - 3

=====  
REGRESSION COEFFICIENTS

Regression Variable

CONSTANT                      1.070 ( 0.029)

-----  
=====  
COVARIANCE/CORRELATION MATRIX

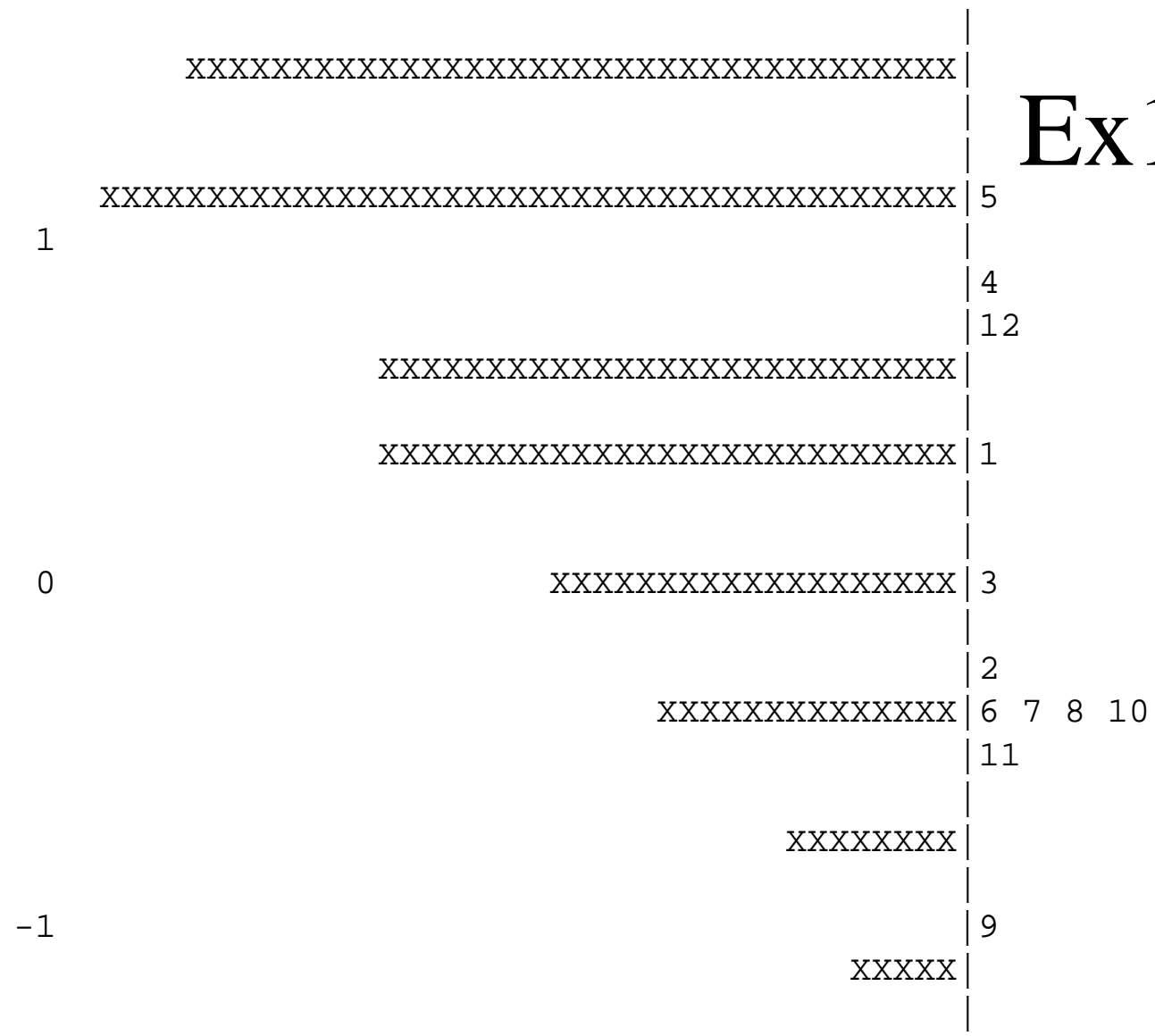
Dimension

Dimension 1

-----  
Variance                              0.866  
-----

MAP OF WLE ESTIMATES AND RESPONSE MODEL PARAMETER ESTIMATES

=====



# Ex1.shw - 4

=====

Each 'X' represents 4.3 cases

# Ex1.itn - 1

Item 2

-----

item:2 (BSMMA02)

Cases for this item 1000 Discrimination 0.47  
Item Threshold(s) -0.18 Weighted MNSQ 0.98  
Item Delta(s) -0.18

-----

Label	Score	Count	% of tot	Pt Bis	t (p)	WLEAvg:1
M	0.00	5	0.50	-0.10	-3.03(.002)	-0.45
a	0.00	59	5.90	-0.23	-7.51(.000)	0.07
b	0.00	152	15.20	-0.31	-10.32(.000)	0.27
c	1.00	743	74.30	0.47	16.62(.000)	1.33
d	0.00	41	4.10	-0.16	-4.97(.000)	0.24
e		0	0.00	NA	NA (.000)	NA

=====

# Rasch, partial credit and rating scale models

# Partial Credit Model -- 1

$$X_{ni} = \begin{cases} m_i - 1 & \text{if the response is in the top category} \\ \vdots & \\ 0 & \text{if the response is in the bottom category} \end{cases}$$

Write  $\pi_{ni,t} = \Pr(X_{ni} = t; \theta_n, \delta_i)$

# Partial Credit Model -- 2

$$\frac{\pi_{ni,t}}{\pi_{ni,t-1} + \pi_{ni,t}} = \frac{\exp(\theta_n - \delta_{it})}{1 + \exp(\theta_n - \delta_{it})}$$

$$\sum_{t=0}^{m_i} \pi_{ni,t} = 1$$

# Partial Credit Model -- 3

$$\pi_{ni,t} = \frac{\exp\left(t\theta_n - \sum_{s=0}^t \delta_{is}\right)}{\sum_{s=0}^{m_i} \exp\sum_{k=0}^s (\theta_n - \delta_{ik})}$$

where  $\mathring{a}_{t=0}^{m_i} x^\circ 1$  and  $d_{i0}^\circ 0$

# Partial Credit Model -- 4

$$\pi_{ni,0} = \frac{1}{1 + \exp(\theta_n - \delta_{i1}) + \exp(2\theta_n - \delta_{i1} - \delta_{i2}) + \exp(3\theta_n - \delta_{i1} - \delta_{i2} - \delta_{i3})}$$

$$\pi_{ni,1} = \frac{\exp(\theta_n - \delta_{i1})}{1 + \exp(\theta_n - \delta_{i1}) + \exp(2\theta_n - \delta_{i1} - \delta_{i2}) + \exp(3\theta_n - \delta_{i1} - \delta_{i2} - \delta_{i3})}$$

$$\pi_{ni,2} = \frac{\exp(2\theta_n - \delta_{i1} - \delta_{i2})}{1 + \exp(\theta_n - \delta_{i1}) + \exp(2\theta_n - \delta_{i1} - \delta_{i2}) + \exp(3\theta_n - \delta_{i1} - \delta_{i2} - \delta_{i3})}$$

$$\pi_{ni,3} = \frac{\exp(3\theta_n - \delta_{i1} - \delta_{i2} - \delta_{i3})}{1 + \exp(\theta_n - \delta_{i1}) + \exp(2\theta_n - \delta_{i1} - \delta_{i2}) + \exp(3\theta_n - \delta_{i1} - \delta_{i2} - \delta_{i3})}$$

# Partial Credit Model with another parameterization

$$d_{it} = d_{i\cdot} + t_{is}$$

$$P_{ni,t} = \frac{\exp\left(-\sum_{s=0}^{m_i} \delta_s (q_n - d_{i\cdot} - t_{is})\right)}{\sum_{s=0}^{m_i} \exp\left(-\sum_{k=0}^s \delta_k (q_n - d_{i\cdot} - t_{ik})\right)}$$

with  $t_{i0} = 0$  and  $\sum_{s=1, \dots, m_i} \delta_s t_{is} = 0$  through  $t_{im_i} = \sum_{s=1}^{m_i-1} \delta_s t_{is}$

# Partial Credit Model

with  $d_i + t_{is}$  parameterization - 2

$$P_{ni,0} = \frac{1}{1 + \exp(q_n - d_i - t_{i1}) + \exp(2q_n - 2d_i - t_{i1} - t_{i2}) + \exp(3q_n - 3d_i - t_{i1} - t_{i2} - t_{i3})}$$

$$P_{ni,1} = \frac{\exp(q_n - d_i - t_{i1})}{1 + \exp(q_n - d_i - t_{i1}) + \exp(2q_n - 2d_i - t_{i1} - t_{i2}) + \exp(3q_n - 3d_i - t_{i1} - t_{i2} - t_{i3})}$$

$$P_{ni,2} = \frac{\exp(2q_n - 2d_i - t_{i1} - t_{i2})}{1 + \exp(q_n - d_i - t_{i1}) + \exp(2q_n - 2d_i - t_{i1} - t_{i2}) + \exp(3q_n - 3d_i - t_{i1} - t_{i2} - t_{i3})}$$

$$P_{ni,3} = \frac{\exp(3q_n - 3d_i)}{1 + \exp(q_n - d_i - t_{i1}) + \exp(2q_n - 2d_i - t_{i1} - t_{i2}) + \exp(3q_n - 3d_i - t_{i1} - t_{i2} - t_{i3})}$$

# Partial Credit Model

with  $d_i + t_{is}$  parameterization - 3

Item	cat.	p1	p2		p3	p4	p5	p6	p7	p8
1	0									
	1	-1			-1					
	2	-2			-1	-1				
	3	-3								
2	0									
	1		-1				-1			
	2		-2				-1	-1		
	3		-3							
3	0									
	1	1	1						-1	
	2	2	2						-1	-1
	3	3	3							

Design  
matrix

# Example for partial Credit analysis

responses of 582 teachers to 10 items, some listed below.  
Likert-style response format coded as 1, agree as 2,  
uncertain as 3, disagree as 4, and strongly disagree as 5.

1. A bilingual teaching program is only successful when curriculum materials are adequate.
  2. A bilingual teaching program should not be implemented before there are enough bilingual teachers.
  3. A bilingual teaching program requires adequate resources.
  4. The staff's commitment to bilingual teaching is essential if bilingual teaching is to succeed.
- ...

# Example for partial Credit analysis

```
Title Bilingual Program - Partial credit analysis;  
datafile ex2.dat;  
format responses 9-18;  
codes 0,1,2,3,4;  
recode (1,2,3,4,5) (3,2,1,0,0);  
labels << ex2.nam;  
model item + item*step;  
estimate;  
show !estimate=WLE >> ex2.shw;  
itanal !estimate=WLE >> ex2.itn;  
export designmatrix >> ex2.des;
```

# Rating Scale Model

$$\delta_{it} = \delta_{i\bullet} + \tau_t$$

$$\pi_{ni,t} = \frac{\exp\left(t(\theta_n - \delta_{i\bullet}) - \sum_{s=0}^t \tau_s\right)}{\sum_{s=0}^{m_i} \exp\sum_{k=0}^s (\theta_n - \delta_{i\bullet} - \tau_s)}$$

$$\sum_{t=1}^{m_i} \tau_t \equiv 0$$

# Rating Scale Model -- 2

$$\pi_{ni,0} = \frac{1}{1 + \exp(\theta_n - \delta_{i\bullet} - \tau_1) + \exp(2\theta_n - 2\delta_{i\bullet} - \tau_1 - \tau_2) + \exp(3\theta_n - 3\delta_{i\bullet} - \tau_1 - \tau_2 - \tau_3)}$$

$$\pi_{ni,1} = \frac{\exp(\theta_n - \delta_{i\bullet} - \tau_1)}{1 + \exp(\theta_n - \delta_{i\bullet} - \tau_1) + \exp(2\theta_n - 2\delta_{i\bullet} - \tau_1 - \tau_2) + \exp(3\theta_n - 3\delta_{i\bullet} - \tau_1 - \tau_2 - \tau_3)}$$

$$\pi_{ni,2} = \frac{\exp(2\theta_n - 2\delta_{i\bullet} - \tau_1 - \tau_2)}{1 + \exp(\theta_n - \delta_{i\bullet} - \tau_1) + \exp(2\theta_n - 2\delta_{i\bullet} - \tau_1 - \tau_2) + \exp(3\theta_n - 3\delta_{i\bullet} - \tau_1 - \tau_2 - \tau_3)}$$

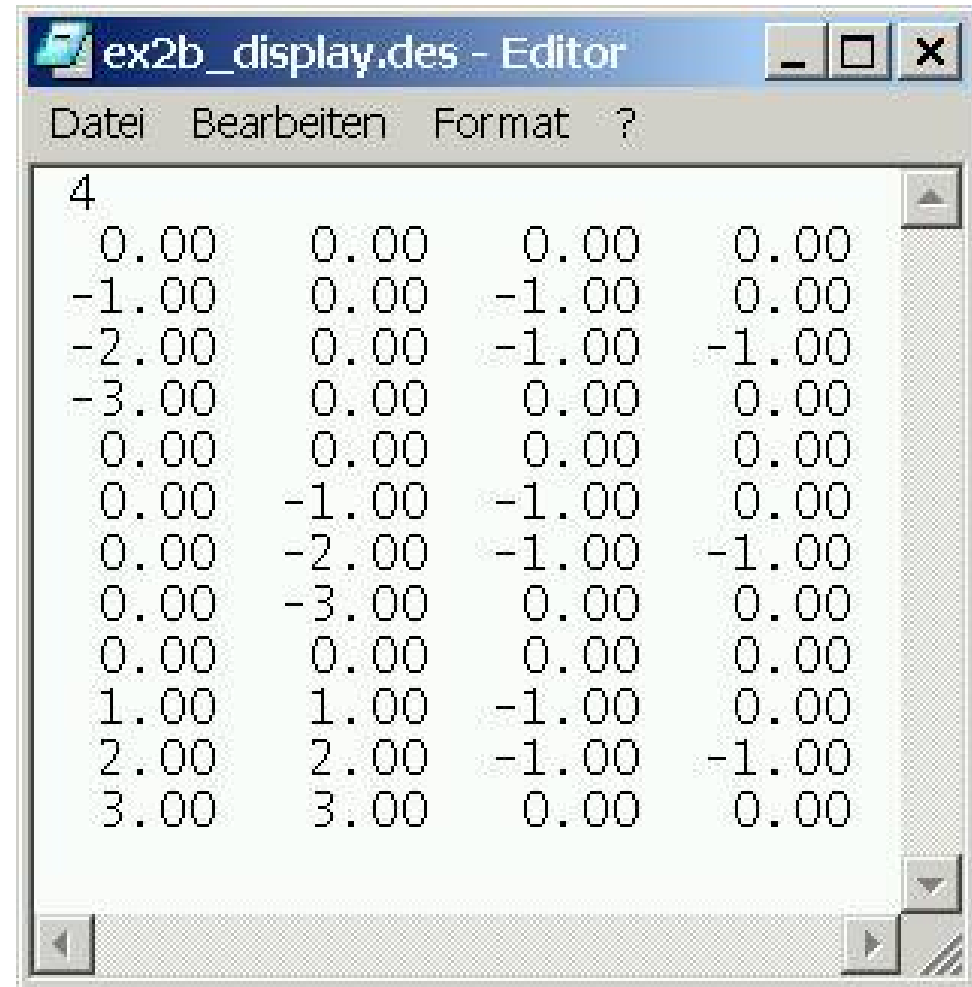
$$p_{ni,3} = \frac{\exp(3q_n - 3d_{i\bullet})}{1 + \exp(q_n - d_{i\bullet} - t_1) + \exp(2q_n - 2d_{i\bullet} - t_1 - t_2) + \exp(3q_n - 3d_{i\bullet} - t_1 - t_2 - t_3)}$$

# Example 2 – Rating Scale analysis

```
Title Bilingual Program - Rating Scale analysis;  
datafile ex2.dat;  
format responses 9-18;  
codes 0,1,2,3,4;  
recode (1,2,3,4,5) (3,2,1,0,0);  
labels << ex2.nam;  
model item + step;  
estimate;  
show !estimate=WLE >> ex2b.shw;  
itanal !estimate=WLE >> ex2b.itn;  
export designmatrix >> ex2b.des;
```

# Rating Scale Model - 3

Item	cat.	p1	p2	p3	p4
1	0				
	1	-1	-1		
	2	-2	-1	-1	
2	3	-3			
	0				
	1		-1	-1	
3	2		-2	-1	-1
	3		-3		
	0				
3	1	1	1	-1	
	2	2	2	-1	-1
	3	3	3		



The screenshot shows a text editor window with the title "ex2b\_display.des - Editor". The window contains a 4x4 grid of numerical values. The first row is labeled "4" in the first column. The values in the grid are:

4	0.00	0.00	0.00	0.00
	-1.00	0.00	-1.00	0.00
	-2.00	0.00	-1.00	-1.00
	-3.00	0.00	0.00	0.00
	0.00	0.00	0.00	0.00
	0.00	-1.00	-1.00	0.00
	0.00	-2.00	-1.00	-1.00
	0.00	-3.00	0.00	0.00
	0.00	0.00	0.00	0.00
	1.00	1.00	-1.00	0.00
	2.00	2.00	-1.00	-1.00
	3.00	3.00	0.00	0.00

# Fit of Parameters/Items

mean square of standardized residual

$$z_{pn} = \frac{x_{pn} - p_{pn}}{\sqrt{\text{var}(x_{pn} - p_{pn})}}$$

$$MNSQ_p = \frac{1}{N} \sum_{n=1}^N (z_{pn})^2$$

for any response model *parameter*  $p$ , student  $n$ , with  
 $x_{pn}$  observed responses and  
 $p_{pn}$  expected response probability

# Fit – 2

„item“ fit

	i	i'	i''
min theta	0	0	1
	0	0	0
...	0	1	1
	0	0	1
thetas	1	1	0
ordered	1	0	1
	1	1	1
...	1	1	0
	1	1	1
max theta	1	1	0

data matrix

„parameter“ fit

Item cat.	p1	p2	p3	p4
1	0			
	1	1		
2	0			
	1	1		
3	0			
	1		1	
4	0			
	1			1

design matrix

# Fit – 3

*parameter fit*

*parameter set fit*

Item	cat.	p1	p2	p3	p4	p5	p6	p1&2	p3&4
1	0								
	1	1						1	
2	0								
	1		1					1	
3	0								
	1			1		1			1
	2			2					2
4	0								
	1				1		1		1
	2				2				2

New  
feature in  
ConQuest  
2.0

design matrix

fit design matrix

# Some new features in ConQuest 2.0

## **Estimation**

- Fit by user defined fit design matrix
- Simulation study by syntax (“simulate” command)

## **Other improvements in version 2.0**

A complete account of additions and improvements is given in the file “changes.txt”. Some of them are listed here:

- Summary output gives much more details on settings and estimation
- Plausible values and EAP are compute for students without response data using background variables if available
- A “set constraint=none” option is available
- Fit and SE are computed for constrained items
- Item analysis output includes Mean and SD of ability for students in each category
- Item analysis available in compressed form (to be read by other software)

# Some new features in ConQuest 2.0

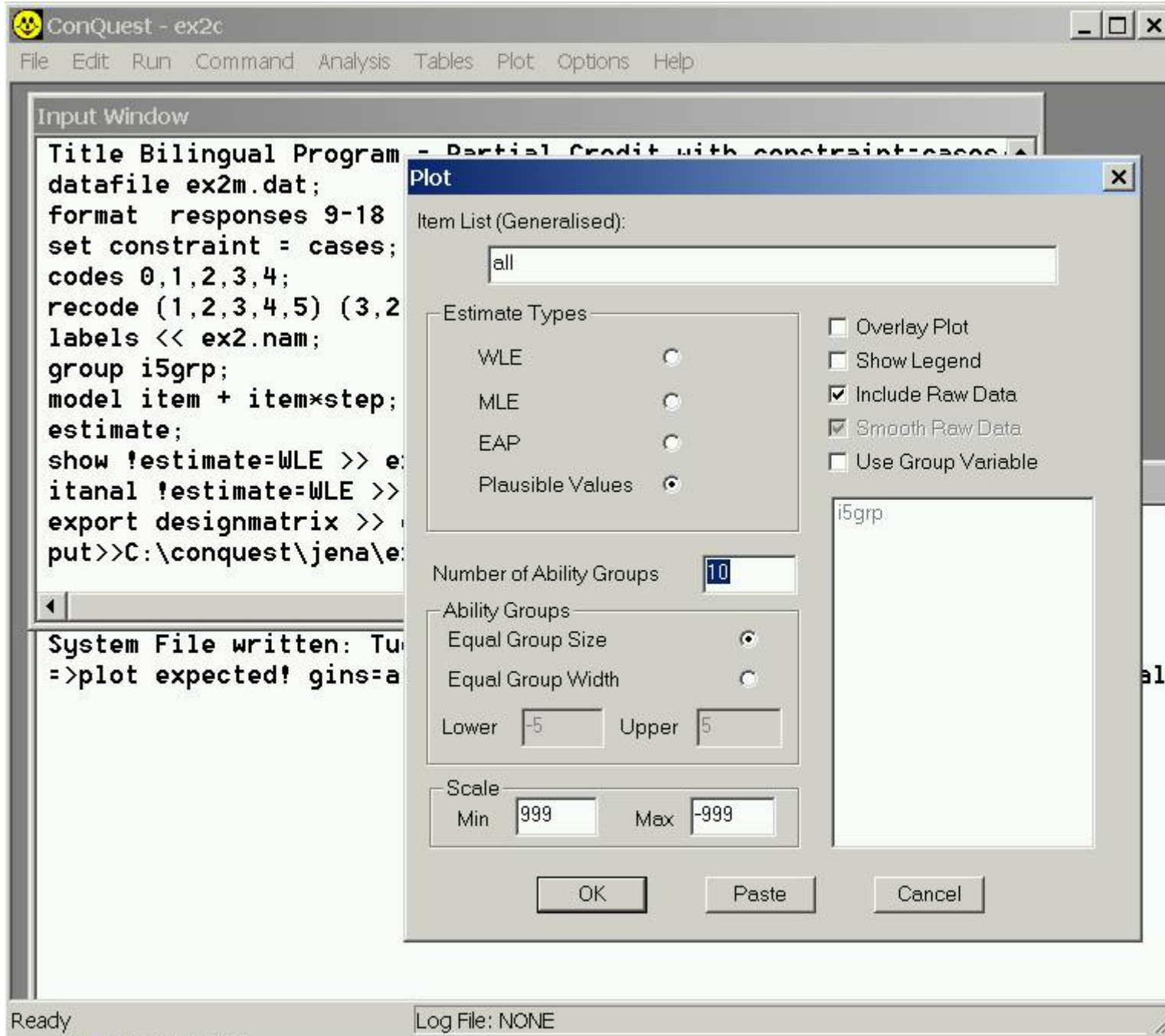
## **Table output**

- Latent variable descriptives (MLE, WLE, EAP & combined PVs)
  - Mean and variance
  - Percentiles
  - Bands
- Delta parameters file
- Raw score & logit equivalence table

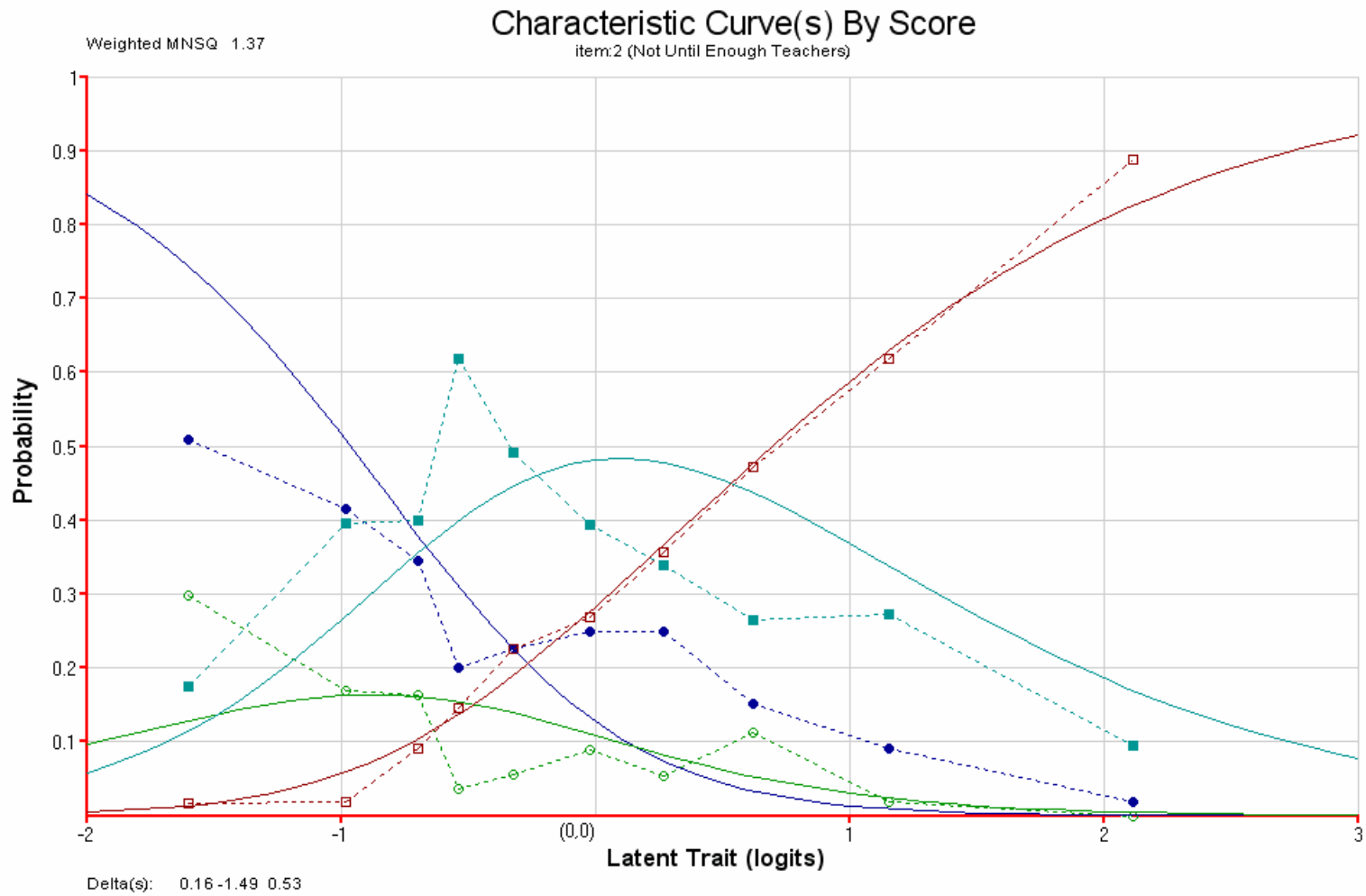
## **Graph curves**

- Item characteristic by category
- Item characteristic by score
- Cumulative item characteristic curves (thurstonian thresholds)
- Expected item score curves
- Item information curves
- Test information curve
- Test characteristic curve

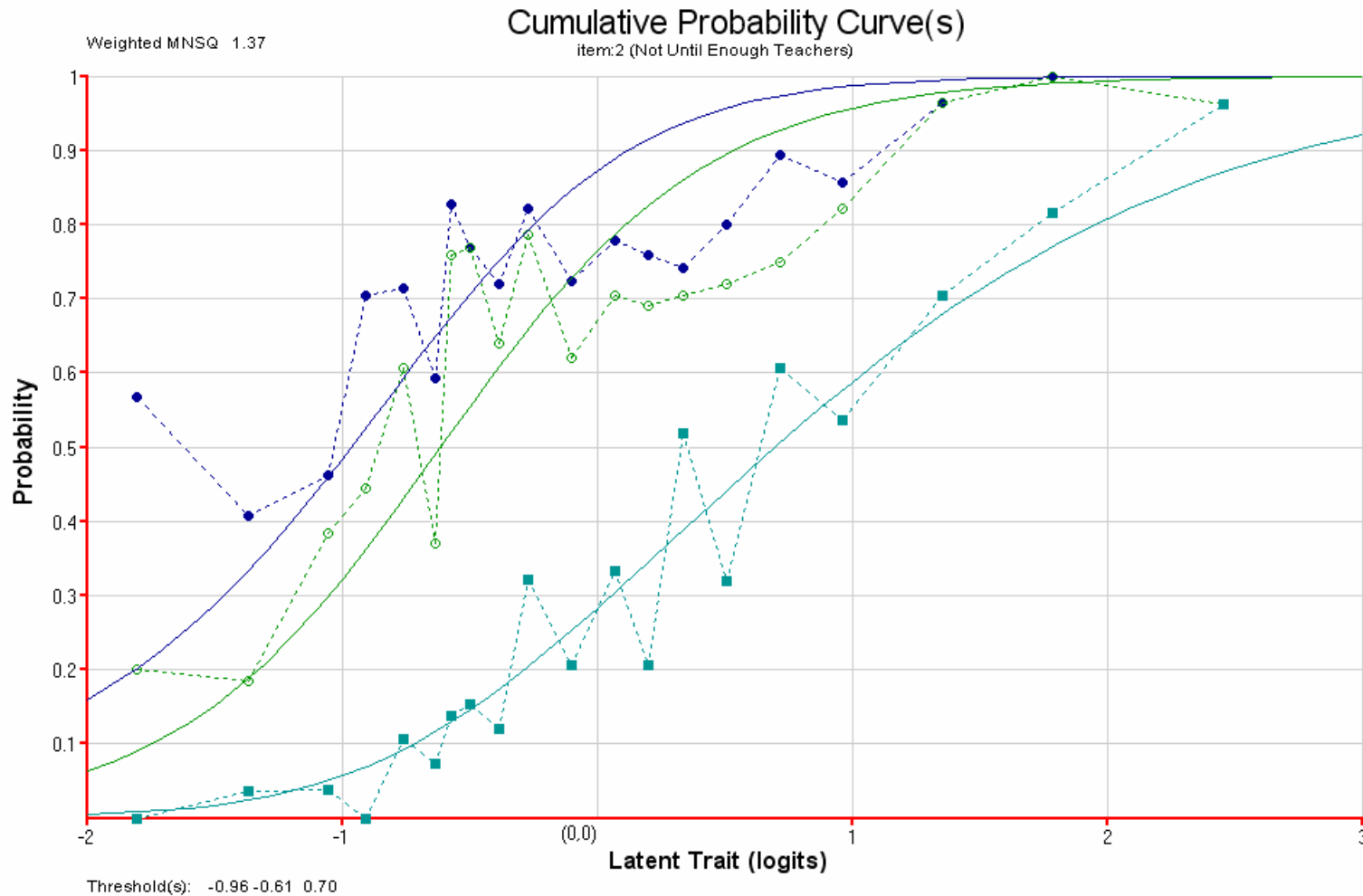
# Graphical Output



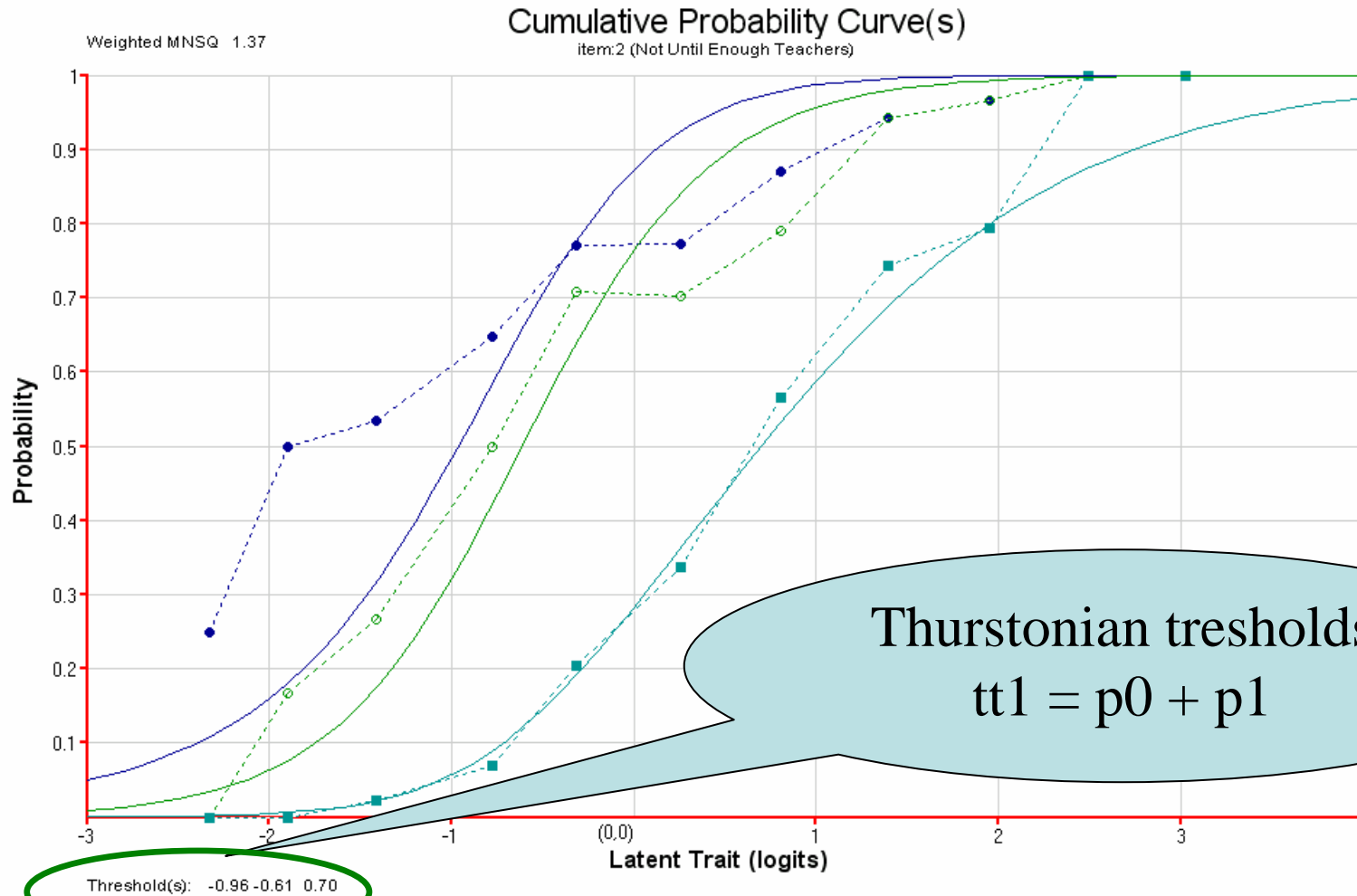
# ICC



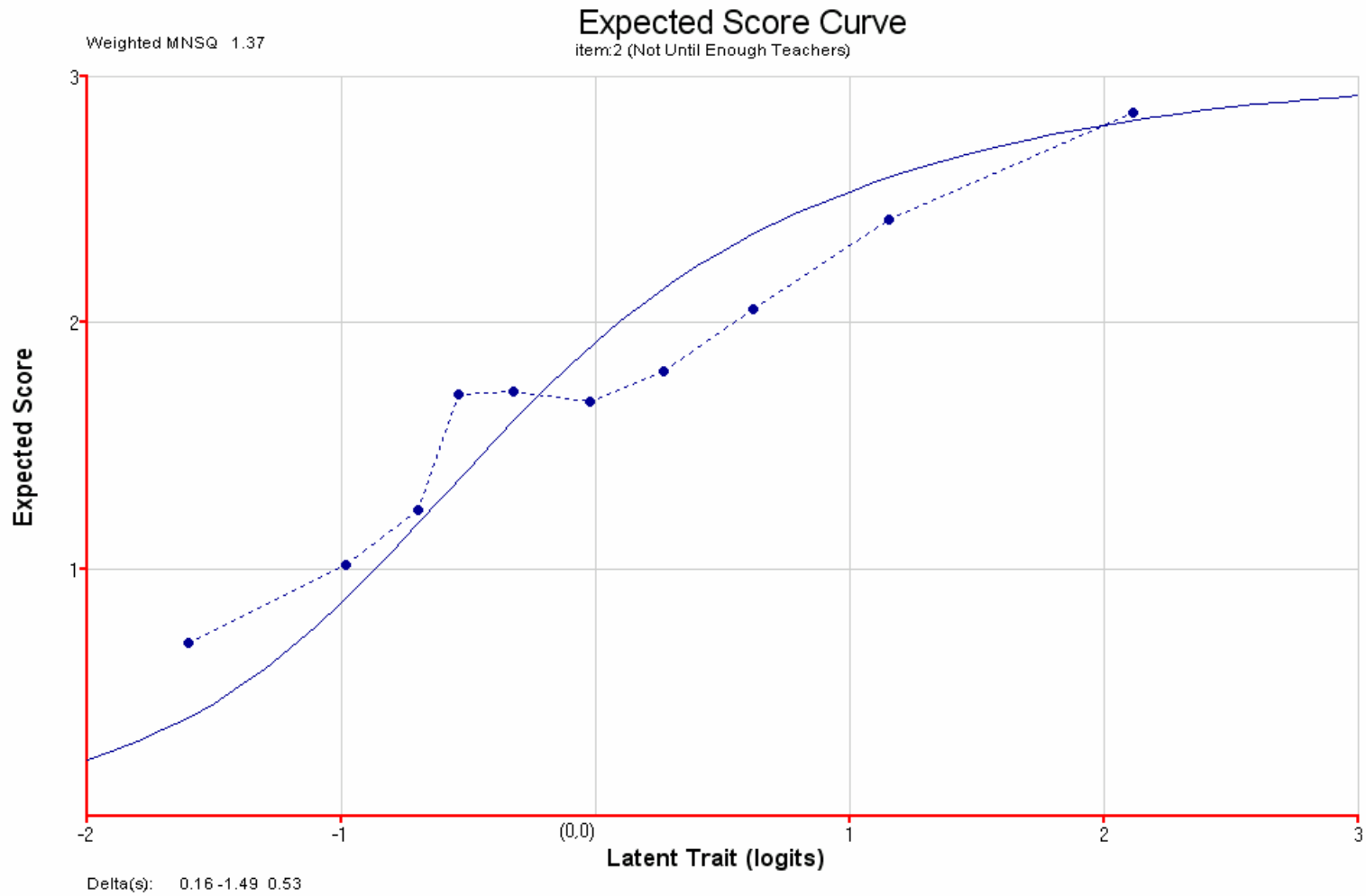
# Cumulative probability curves – 1 equal group size



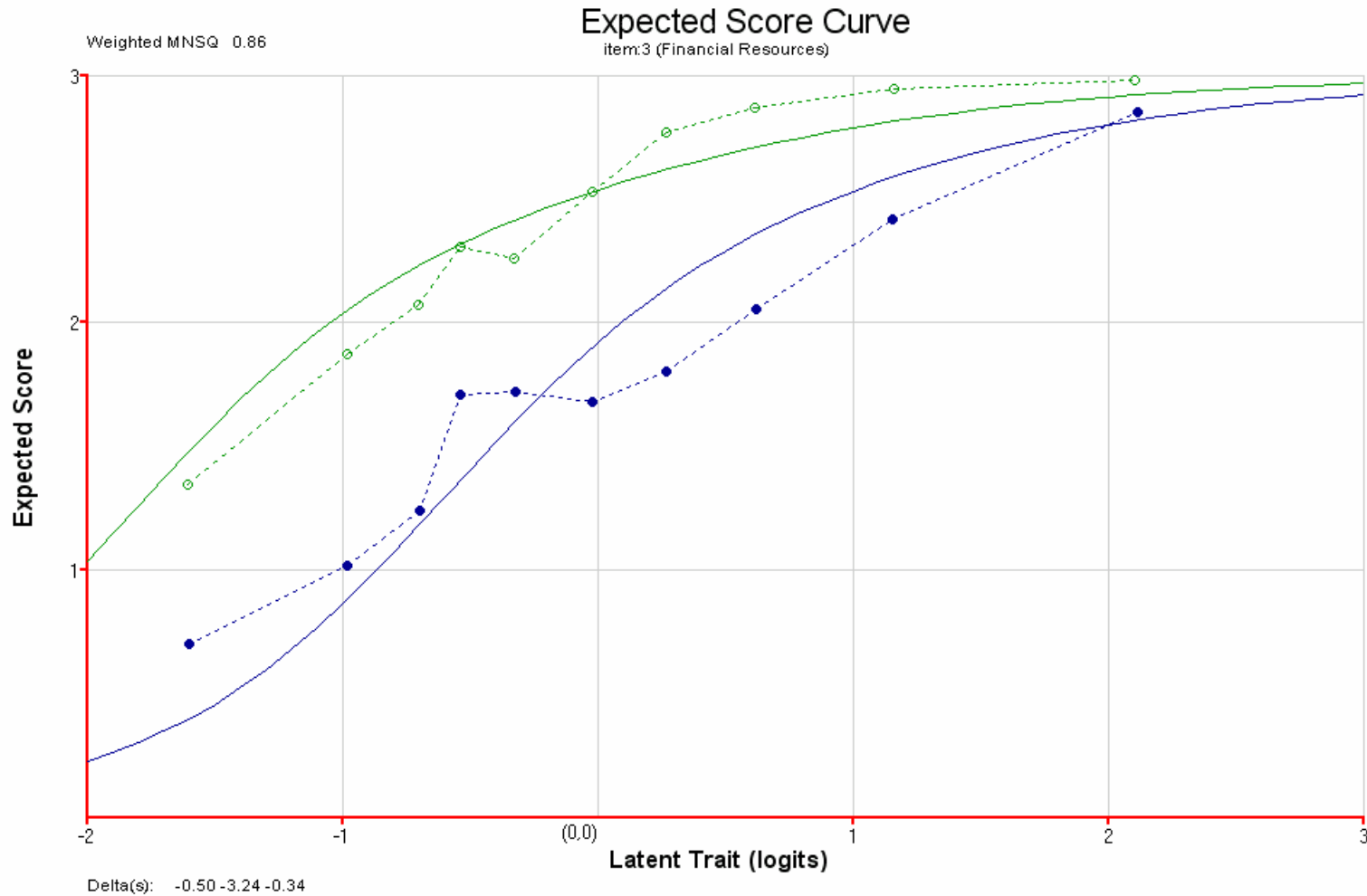
# Cumulative probability curves – 2 equal group width



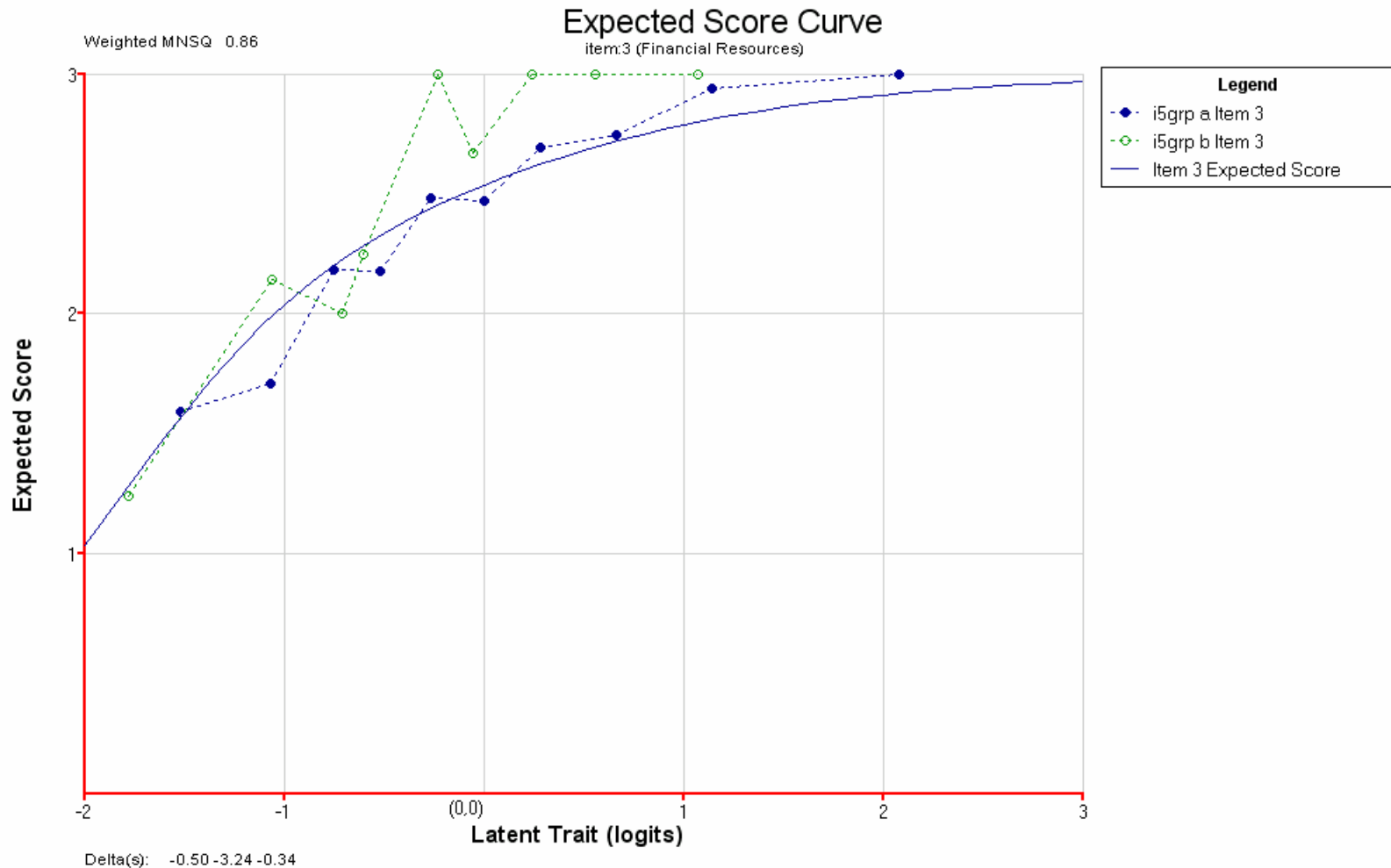
# expected score curve



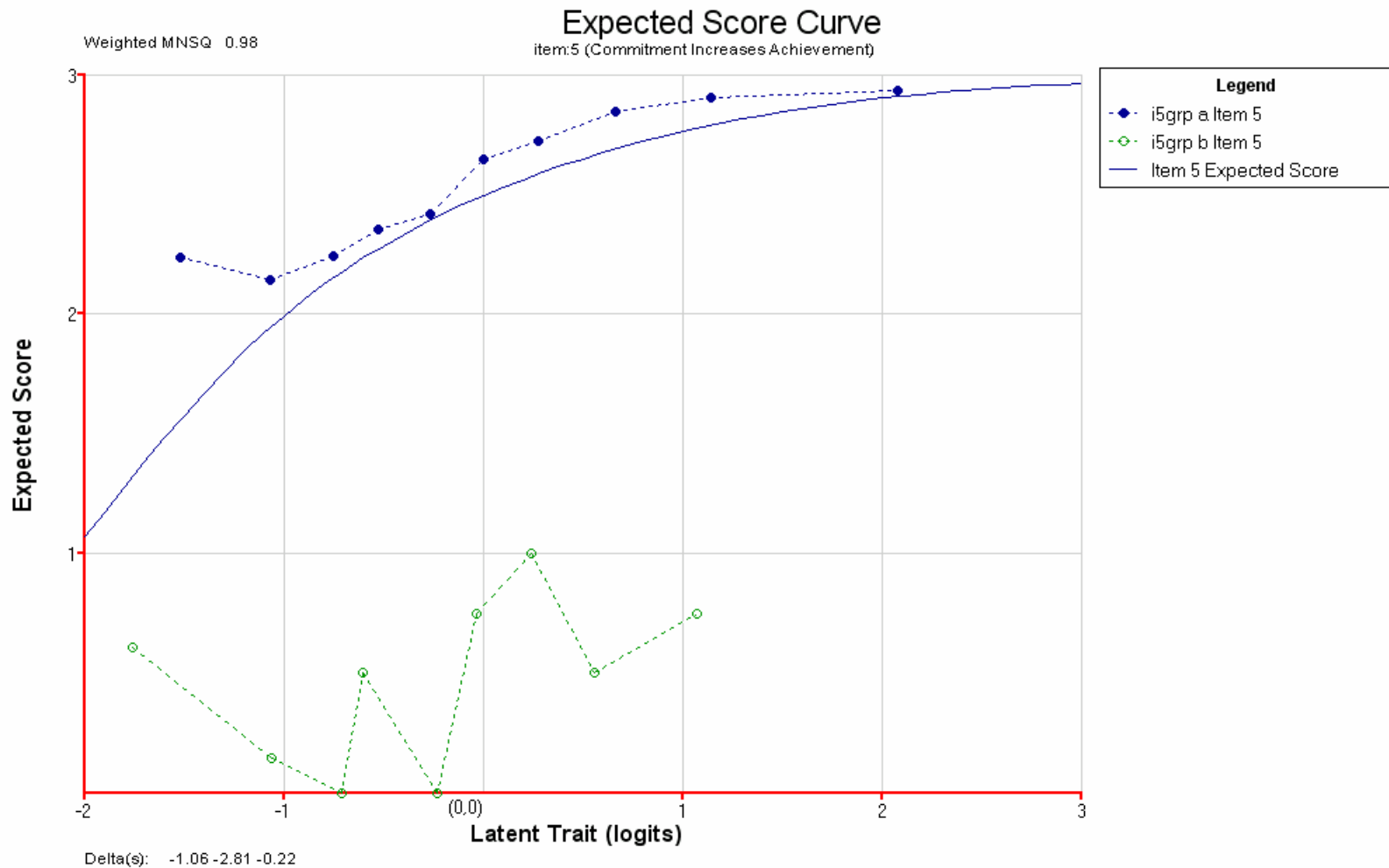
# expected score curves - 2 overlay graphs (general option)



# Multiple observed groups expected score curves

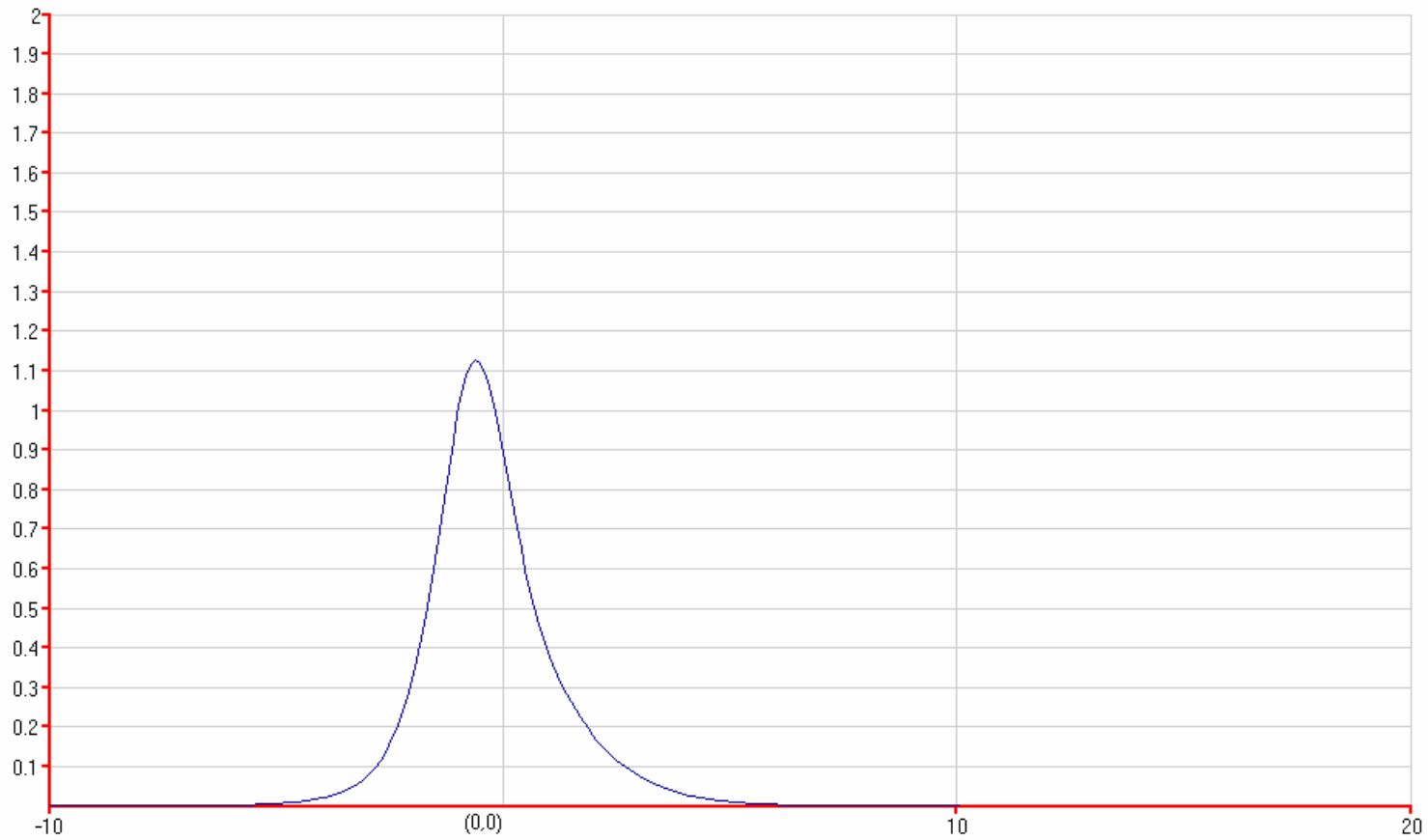


# Multiple observed groups - 2 expected score curves

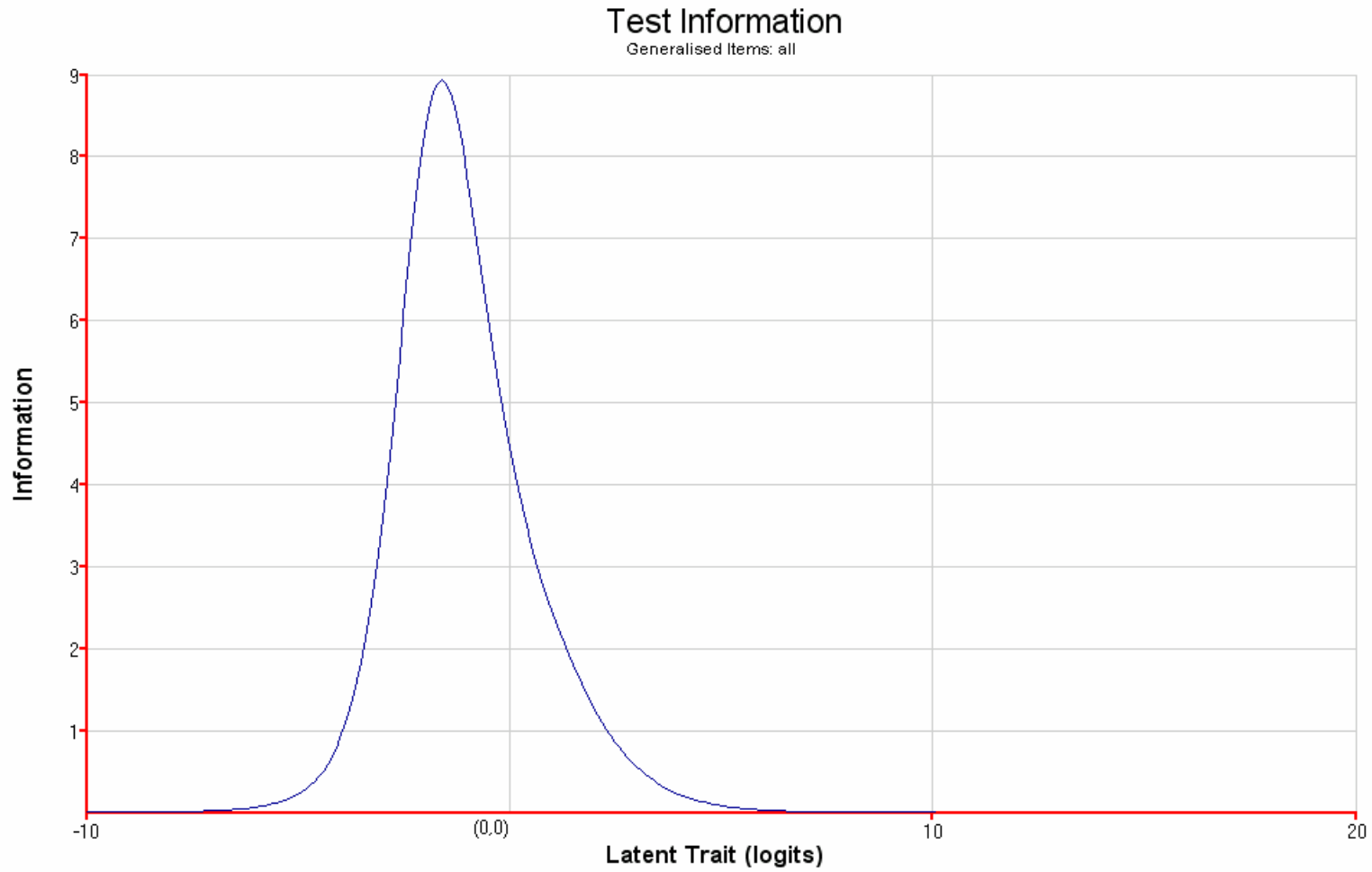


# Item information

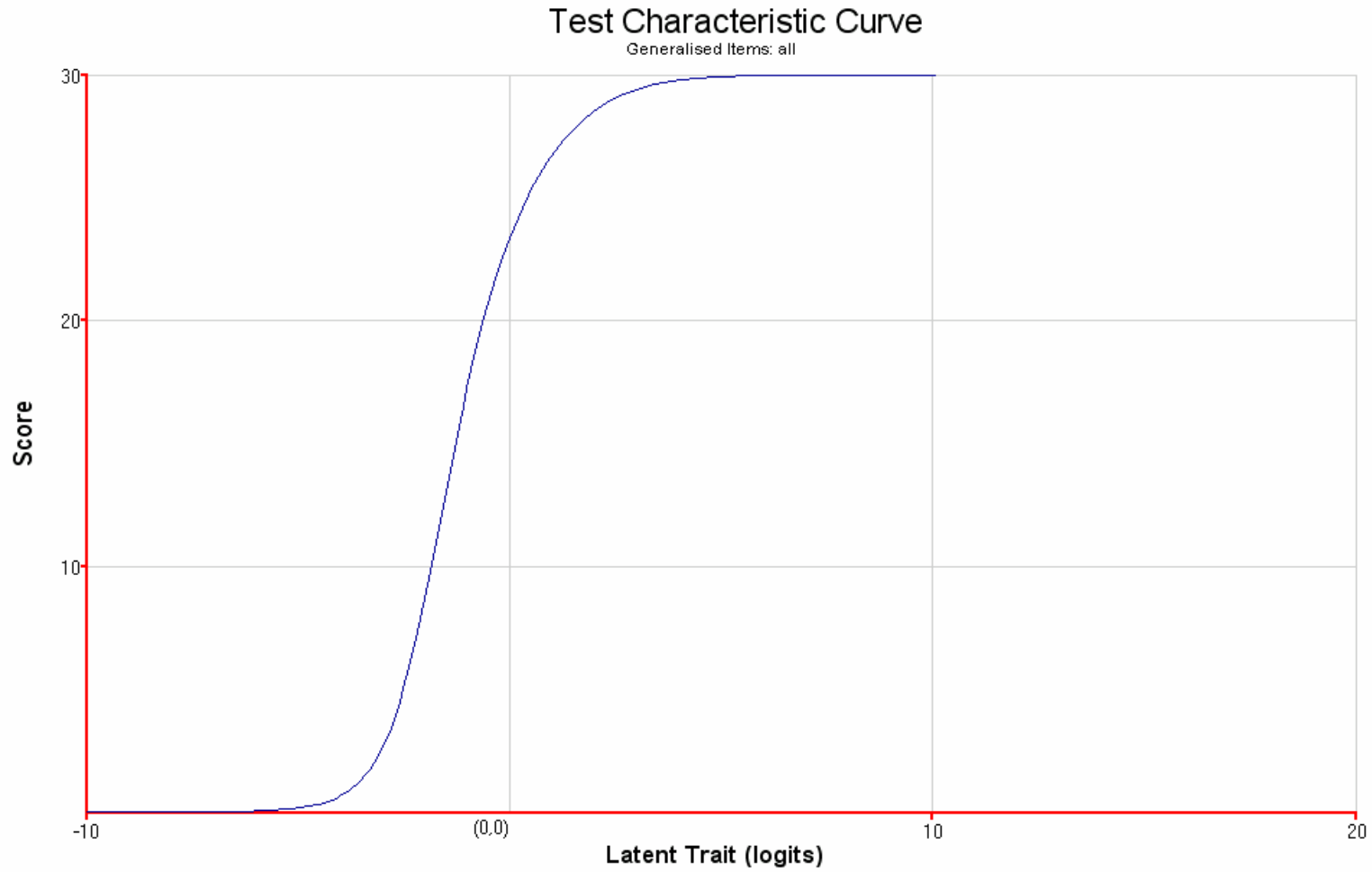
for item 2, example 2



# Test information



# Test characteristic curve



# Graph requests & options

options from **menu** and command language

- items, type of estimates, ability groups, scale
- overlay graphs, legend, layout & group variable

```
•plot icc! gins=2,bins=10,mincut=-5,maxcut=5,minscale=999,maxscale=-999,raw=yes,overlay=no,legend=no,estimates=latent,bintype=size;  
•plot tcc! gins=all,mincut=-10,maxcut=10,overlay=no,legend=no;
```

options from **menu** and command language

- series manager; plot layout colour & precision

# Facets Models

# Facets Models

```
Title Rater Effects Model One;
datafile ex3.dat;
format rater 17-18 rater 19-20
      responses 21-22 responses
25-26 ! criteria(2);
codes G,H,I,J,K,L;
score (G,H,I,J,K,L) (0,1,2,3,4,5);
labels 1 OP !criteria;
labels 2 TF !criteria;
model rater + criteria + step;
estimate;
show      !      estimates=latent      >>
ex3a.shw;
itanal >> ex3a.itn;
quit;
```

criterion	rater	response	parameters			
			$\delta_1$	$\rho_1$	$\tau_1$	$\tau_2$
1	1	0	0	0	0	0
1	1	1	1	1	1	0
1	1	2	2	2	1	1
1	1	3	3	3	0	0
1	2	0	0	0	0	0
1	2	1	1	-1	1	0
1	2	2	2	-2	1	1
1	2	3	3	-3	0	0
2	1	0	0	0	0	0
2	1	1	-1	1	1	0
2	1	2	-2	2	1	1
2	1	3	-3	3	0	0
2	2	0	0	0	0	0
2	2	1	-1	-1	1	0
2	2	2	-2	-2	1	1
2	2	3	-3	-3	0	0

$$\frac{\exp(1\theta - 1\delta_i - 1\rho_r - 1\tau_1)}{D}$$

$$\frac{\exp(2\theta - 2\delta_i - 2\rho_r - 1\tau_1 - 1\tau_2)}{D}$$

$$\frac{\exp(3\theta - 3\delta_i - 3\rho_r)}{D}$$

TERM 1: rater

VARIABLES

rater		ESTIMATE	ERROR <sup>^</sup>	MNSQ
1	14	0.975	0.029	1.14
2	17	0.133	0.029	1.34
3	18	-0.080	0.031	1.73
4	19	-1.289	0.028	1.34
5	24	0.650	0.029	1.56
6	38	-0.112	0.030	1.13
7	67	0.542	0.029	1.20
8	70	0.124	0.029	1.10
9	73	-0.003	0.028	1.16
10	74	-0.222	0.027	1.32
11	78	-0.608	0.029	1.17
12	79	-0.200	0.028	1.10
13	8	0.107	0.029	1.12
14	85	-0.010	0.028	1.41
15	89	0.420	0.031	1.13
16	93	-0.427*	0.112	1.18

TERM 2: criteria

-----				
VARIABLES				
-----				
	criteria	ESTIMATE	ERROR^	MNSQ
-----				
1	OP	0.089	0.010	0.97
2	TF	-0.089*	0.010	0.99
-----				

-----				
VARIABLES				
-----				
	step	ESTIMATE	ERROR^	MNSQ
-----				
	0			0.13
	1	-7.105	0.043	0.96
	2	-3.267	0.021	1.27
	3	0.608	0.015	1.16
	4	3.739	0.023	1.12
	5	6.026*		0.60
-----				

# More Facets

```
datafile ex4.dat;
format rater 1 topic 3 responses 5-9 /
       rater 1 topic 3 responses 5-9 /
       rater 1 topic 3 responses 5-9 /
       rater 1 topic 3 responses 5-9 !
criteria(5);
label << ex4.nam;
set update=yes,warning=no;
model    rater + topic + criteria +
         rater*topic + rater*criteria +
         topic*criteria +
         rater*topic*criteria*step;
export parameters >> ex4a.prm;
export reg >> ex4a.reg;
export cov >> ex4a.cov;
estimate ! nodes=10,stderr=full;
show parameters
!estimates=latent>>ex4a.shw;
```

TERM 1: rater

VARIABLES				
-----				
	rater	ESTIMATE	ERROR	MNSQ
-----				
1	Amy	-0.872	0.042	0.98
2	Beverly	-0.537	0.035	0.92
3	Colin	0.452	0.030	0.96
4	David	0.957*		1.08
-----				

TERM 2: topic

VARIABLES				
-----				
	topic	ESTIMATE	ERROR	MNSQ
-----				
1	Sport	-0.023	0.031	1.06
2	Family	0.016	0.033	0.96
3	Work	0.005	0.031	0.72
4	School	0.002*		1.06
-----				

TERM 3: criteria

VARIABLES				
-----				
	criteria	ESTIMATE	ERROR	MNSQ
-----				
1	spelling	-1.047	0.048	0.97
2	coherence	-0.569	0.037	1.04
3	structure	-0.051	0.035	0.94
4	grammar	0.551	0.029	1.02
5	content	1.116*		0.97
-----				

TERM 4: rater\*topic

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VARIABLES

-----

	rater		topic	ESTIMATE	ERROR	MNSQ
1	Amy	1	Sport	-0.012	0.057	0.95
2	Beverely	1	Sport	0.050	0.046	0.86
3	Colin	1	Sport	0.112	0.045	1.10
4	David	1	Sport	-0.149*		1.25
1	Amy	2	Family	-0.065	0.059	0.96
2	Beverely	2	Family	-0.039	0.049	0.73
3	Colin	2	Family	0.019	0.047	0.87
4	David	2	Family	0.085*		1.15
1	Amy	3	Work	0.038	0.054	0.73
2	Beverely	3	Work	0.020	0.048	0.93
3	Colin	3	Work	-0.039	0.044	0.94
4	David	3	Work	-0.019*		0.79
1	Amy	4	School	0.040*		1.31
2	Beverely	4	School	-0.031*		0.84
3	Colin	4	School	-0.092*		0.88
4	David	4	School	0.083*		1.10

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TERM 5: rater\*criteria

TERM 6: topic\*criteria

TERM 7: rater\*topic\*criteria\*step

VARIABLES

	rater		topic		criteria	step	ESTIMATE	ERROR	MNSQ
1	Amy	1	Sport	1	spelling	1			0.34
1	Amy	1	Sport	1	spelling	2	0.296	0.394	1.11
1	Amy	1	Sport	1	spelling	3	-0.296*		1.04
2	Beverly	1	Sport	1	spelling	0			0.24
2	Beverly	1	Sport	1	spelling	1	-0.184	0.484	3.87
2	Beverly	1	Sport	1	spelling	2	0.051	0.459	0.79
2	Beverly	1	Sport	1	spelling	3	0.133*		0.96
3	Colin	1	Sport	1	spelling	0			0.28
3	Colin	1	Sport	1	spelling	1	-0.671	0.347	0.77
3	Colin	1	Sport	1	spelling	2	-0.226	0.329	1.10
3	Colin	1	Sport	1	spelling	3	0.897*		1.16
4	David	1	Sport	1	spelling	0			0.51
4	David	1	Sport	1	spelling	1	-0.515	0.334	0.83
4	David	1	Sport	1	spelling	2	0.028	0.340	0.86
4	David	1	Sport	1	spelling	3	0.487*		1.04
1	Amy	2	Family	1	spelling	1			0.22
1	Amy	2	Family	1	spelling	2	-0.579	0.324	0.61
1	Amy	2	Family	1	spelling	3	0.579*		0.64
2	Beverly	2	Family	1	spelling	1			0.22
2	Beverly	2	Family	1	spelling	2	-0.533	0.276	0.89
2	Beverly	2	Family	1	spelling	3	0.533*		0.91
3	Colin	2	Family	1	spelling	0			0.17
3	Colin	2	Family	1	spelling	1	-0.301	0.397	0.86
3	Colin	2	Family	1	spelling	2	0.185	0.413	0.73
3	Colin	2	Family	1	spelling	3	0.116*		0.88

# A DIF Example

```
datafile ex5.dat;  
title TIMSS Mathematics - Gender Differences;  
format book 16 gender 17 level 18 gbyl 19  
       responses 20-25;  
labels << ex6.nam;  
key 134423 ! 1;  
model item - gender + item*gender;  
estimate !fit=no,stderr=full;  
show ! table=2 >> ex6a.shw;
```

=====  
TERM 1: item

-----  
VARIABLES

-----

	item	ESTIMATE	ERROR
1	BSMMA01	0.048	0.026
2	BSMMA02	-0.663	0.029
3	BSMMA03	-0.368	0.027
4	BSMMA04	0.562	0.026
5	BSMMA05	0.918	0.025
6	BSMMA06	-0.498*	

-----

TERM 2: gender

-----  
VARIABLES

-----

	gender	ESTIMATE	ERROR
1	0	-0.057	0.018
2	1	0.057*	

-----

TERM 3: item\*gender

VARIABLES

	item	gender	ESTIMATE	ERROR
1	BSMMA01	1 0	0.060	0.026
2	BSMMA02	1 0	0.029	0.029
3	BSMMA03	1 0	-0.100	0.027
4	BSMMA04	1 0	0.291	0.026
5	BSMMA05	1 0	-0.062	0.025
6	BSMMA06	1 0	-0.218*	
1	BSMMA01	2 1	-0.060*	
2	BSMMA02	2 1	-0.029*	
3	BSMMA03	2 1	0.100*	
4	BSMMA04	2 1	-0.291*	
5	BSMMA05	2 1	0.062*	
6	BSMMA06	2 1	0.218*	