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Introduction

This document contains step-by-step instructions on how to calculate the basic item analysis measures in excel. These include item Facility Values (FV), Discrimination Indices (DI), Distractor Analysis (DA). Please note that the measures are based on the Classical Test Theory and the results are meaningful in the context of your current test population and may not be generalisable to a wider target test population.

The document also contains links to Professor Glenn Fulcher’s website on how to use Excel spreadsheets for Classical Test Analysis. The focus of the document is on the technicalities of calculating these measures in excel. See the reference list on the session slides for some background reading recommendations.

Preparing your data file

1. In an excel spreadsheet, enter candidate numbers or case IDs to the first column
2. Use the first row, starting with cell B1 to record Item numbers
3. Enter your answer key into the second row
4. Enter your data for closed-ended items as A-D or 1,0, starting with the third row:
 - a. For multiple-choice items, enter answers A-D, as selected by students. This will enable you to do distractor analysis.

	A	B	C	D	E	F	G	H	I	J	K
1	Candidate	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10
2	key	B	C	B	C	A	D	A	B	A	D
3	001	B	C	A	C	A	B	A	B	B	C
4	002	B	C	C	C	A	D	B	B	A	D
5	003	B	D	D	D	A	B	A	C	D	D

- b. For dichotomous items, enter 1 for correct answers and 0 for incorrect ones.
- c. For open-ended items, marked manually, record 1 for correct answers and 0 for incorrect answers.
- d. If a candidate has not attempted an item, leave the cells blank to be able to distinguish between missing data and incorrect answers.
- e. If a candidate was absent, exclude them from the calculations.

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q
1	CandidateNo	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Q11	Q12	Q13	Q14	Q15	Totals
2	001	1	1	0	1	1	0	1	1	0	0	1	1	1	1	0	10
3	002	1	1	0	1	1	1	0	1	1	1	1	1	1	1	1	13
4	003	1	0	0	0	1	0	1	0	0	1	1	1	1	1	0	8

5. Insert a column for the total scores and use the =SUM (first cell: last cell) formula to calculate the total score for each row.

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q
1	CandidateNo	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Q11	Q12	Q13	Q14	Q15	Totals
2	001	1	1	0	1	1	0	1	1	0	0	1	1	1	1	0	=SUM(B2:P2)

6. For a multiple-choice test, create a separate tab and convert the A-D values into 1s and 0s. This will enable you to calculate the facility values and the discrimination indices for the items.
 - a. The easiest way to do this is to use the Score Converter excel template on this website: <http://language-testing.info/statistics/excel.html>
 - b. You can also do it manually by highlighting a column and using the “Find + Replace” function to replace all correct answers with a 1 and all incorrect answers with a 0.

	A	B	C	D	E	F	G	H	I	J
1	Candidate	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9
2	key	B	C	D	C	A	D	A	B	A
3	001	B	C							
4	002	B	C							
5	003	B	D							
6	004	B	C							
7	005	C	D							
8	006	B	D							
9	007	C	D							
10	008	C	D							
11	009	B	C							
12	010	B	D							

Find and Replace

Find what: B

Replace with: 1

Options >>

Replace All Replace Find All Find Next Close

Calculating overall test reliability in Excel

It is worth calculating an estimate of the overall test reliability before zooming in onto individual items. Use the “Cronbach's Alpha” excel template on this website:

<http://language-testing.info/statistics/excel.html>

1. Input your data in the “1, 0” format into the first tab.
2. Check the Cronbach's Alpha value in the second tab. It is measured on a scale from 0 to 1, with 0.7 being an acceptable level of internal test consistency and reliability.

Calculating Item Facility Values in Excel

1. Use the '=Average (first cell: last cell)' formula, press enter

	A	B	C	D	E
1	CandidateNo	Q1	Q2	Q3	Q4
36	035	0	1	1	1
37	036	1	1	1	1
38	037	1	1	1	1
39	038	1	1	1	1
40	039	1	0	0	1
41	040	1	0	1	1
42	FV	=AVERAGE(B2:B41)			

2. Click on the cell with the formula and drag it across the FV row. This will generate facility values for the rest of your items.

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P
1	CandidateNo	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Q11	Q12	Q13	Q14	Q15
39	038	1	1	1	1	1	0	0	1	1	1	1	1	1	1	1
40	039	1	0	0	1	1	0	0	1	1	1	1	1	1	1	0
41	040	1	0	1	1	1	1	0	1	1	1	1	1	1	1	1
42	FV	0.60	0.43	0.68	0.80	1.00	0.55	0.15	0.65	0.70	0.90	0.93	0.65	0.88	0.70	0.40

3. Decide which items might be potentially 'too hard' (FV < 0.3) or 'too easy' (FV > 0.7).

Tip: apply conditional formatting to highlight values < 0.3 in red, and values > 0.7 in green to flag up potentially problematic items. Withhold the judgement until you have calculated the discrimination indices, though.

Calculating Item Discriminability Indices in Excel

1. sort in order of total scores
2. decide on proportion of 'high scorers' and 'low scorers' (should be about 27% each)
3. calculate discriminability index 'DI' for each item (use the difference between the high scorer average and the low scorer average)
4. Decide which items are apparently 'discriminating well' / 'not discriminating well':
 - 1 = an item is working perfectly
 - 0.3 and above = an item is working well enough
 - 0 = no discrimination
 - - value = negative discrimination (i.e. weaker students are performing better than stronger ones on this item)
5. Try to interpret the results, in conjunction with other item analysis measurements (item facility values, their impact on the scale variance and overall test reliability). Possible reasons for low discriminability indices include:
 - errors in the item
 - mistakes in the key
 - contract-irrelevant variances (e.g. guessing or using background knowledge)

Distractor analysis

Distractor analysis is based on counting the frequency of occurrences of the distractors in the responses provided by the cohort. If a distractor is not selected by many candidates, it means it is not attractive enough and might need to be reviewed or replaced. In excel you can use the =COUNTIF formula to calculate distractor frequency:

1. Go the excel tab where you have the data recorded as A-D.
2. Scroll down to the bottom of your data set and add labels A-D to the 4 rows below it.
3. Go to the bottom of the column for your first item, for example column B. Add a formula =COUNTIF (ColumnFistCellNumber: ColumnFistCellNumber: last cell, "A"), for example: =COUNTIF (B3:B42, "A"). This will count all the occurrences of distractor A in responses provided for item 1.
4. Drag the formula down to rows labelled B, C and D and amend the letter in the formulae from A to B, C, and D respectively. For example: =COUNTIF (B3:B42, "B") to count the frequency for distractor B.

	A	B	C	D
1	Candidate	Q1	Q2	Q3
2	key	B	C	B
36	034	C	C	B
37	035	C	C	B
38	036	B	C	B
39	037	B	C	B
40	038	B	C	B
41	039	B	D	C
42	040	B	D	B
43	A	=COUNTIF(B3:B42, "A")		
44	B	=COUNTIF(B3:B42, "B")		
45	C	15	15	4
46	D	1	13	3

You may wish to use conditional formatting to highlight distractors that were not frequently chosen by candidates. There is no specific rule about how many times an effective distractor is selected. For a small pilot data set, it might be worth reviewing distractors with frequencies lower than 3.

5. Select all data in the distractor frequency rows of your data set
6. Go to the Conditional Formatting menu at the top of your excel sheet
7. Select "highlight cell rules > less than" option, enter 3 > click ok. The distractors that are underperforming will be automatically flagged up in red.

The screenshot shows the Excel interface with the Conditional Formatting menu open. The 'Less Than' dialog box is displayed, showing the criteria '3' and the format 'Light Red Fill with Dark Red Text'. The background spreadsheet shows the same data as the previous table, with the distractor frequency rows (43-46) highlighted in red.

Interpreting item analysis results

It is important to exercise caution when interpreting item analysis results and to consider several item characteristics such as its facility, discrimination index and distractor performance together. If you have calculated these measures in separate excel tabs, it might be a good idea to copy and paste them into the same one, in order to get a fuller picture of the item performance.

	A	B	C	D
1	CandidateNo	Q1	Q2	Q3
42	FV	0.60	0.43	0.68
43	DI	0.62	0.54	0.31
47	A	0	0	4
48	B	23	9	27
49	C	15	15	4
50	D	1	13	3