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Transferring Raw Data for Rasch Model Analysis

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Abstract: Assessing students through final exam questions is a common assessment method at tertiary level. The overall grade will classify the students into categories. Yet, this overall grade does not show how the student answered the exam questions. The Rasch Model can show the ability of each student answering the exam questions. It also gives information on which is the most difficult and the easiest question in an examination. This study illustrates the steps of the exam marks that are processed in the Rasch Model. This begins by entering raw exam marks in the Excel worksheet. Then, the marks will be normalized and changed to the Likert scale. Then the data is saved as formatted text. Lastly, it will run in WINSTEPS. Summary statistics for person, summary statistics for item, fit statistics, item dimensionality and person-item distribution map are among of the Rasch Model output that can be obtain from WINSTEPS. These outputs show the performance of the students and the difficulty of the exam questions. The Rasch output can also identify a misfit examination question. This means the question is extremely hard for the students to answer. This study will be helpful to a new user to use Rasch Model because it will help him or her to analyze any data, especially, examination questions.

Key words: Data processing, Rasch Model, Excel, WINSTEPS, exam questions, assessment method

INTRODUCTION

Rasch Model gives a powerful analysis on determining the performance of students who sit for any examinations. It can give details on the level of difficulty of the exam questions. It can show how the students answered each question in an examination.

The Rasch analysis has been used widely to examine the reliability of exam questions and the impact on student's performance. Student's performance is not only dependent on the ability of answering the exam questions but also the relevance of the questions. Exam questions need to be arranged from the easiest to the most difficult in order for the students to have more time to answer the difficult questions (Nopiah *et al*., 2012).

Rasch Model has been used to measure student's performance in the examination and it is found that, if student's performance is higher than the mean item (question) it means that the student could answer the questions within the scope of the subject. Otherwise, a necessary action needs to be taken to improve student's understanding on the subject (Aziz *et al*., 2013).

Individual (person) reliability is determined by the summary statistics of individual whereby it shows the inconsistency of the individual answering the exam questions. The item which does not fit the whole exam questions can be determined by the analysis of Rasch Model.

MATERIALS AND METHODS

Method of research: Raw data which is the exam marks obtained from the test will be entered into Excel worksheet and then transferred to the notepad and lastly will be entered into WINSTEPS to get Rasch analysis.

Below are the steps needed to process the data. The data taken is from a pilot test conducted on 35 students from the Engineering Faculty of Universiti Kebangsaan Malaysia. About twelve students were from the Chemical

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Table 1: Distribution of marks for pilot test questions

Questions	Marks
1	6
2	6
3	6
4	9
5	9
6	12

Engineering Department, 10 students were from Civil Engineering Department while 13 students were from Electrical Engineering Department. Table 1 shows the distribution of marks for the pilot test questions.

RESULTS AND DISCUSSION

Step 1: Student's marks are entered into the Excel sheet as shown in Fig. 1 and 2. CH01 represents the first student from the chemical engineering list, CV01 represents the first civil engineering student and EE01 represents the first electrical engineering student from their respective list. Data '1' (yellow) shows that the chemical engineering students obtained 1 mark for question 3.

Step 2: This step is to normalize all the marks 'over 100' using the given equation:

$$\frac{\text{Student's mark}}{\text{Total marks of the question}} \times 100$$

For example, data '1' (yellow) is normalized to 17 using the following method:

$$\frac{1}{6} \times 100 = 17$$

Step 3: Normalized data is changed to the Likert scale using the following mathematical equation:

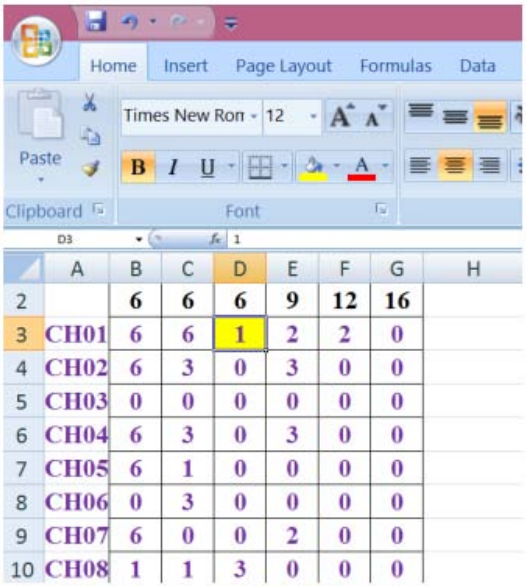
$$= \text{IF}(K3 = "","", \text{IF}(K3 = "xx", "x",$$
$$\text{IF}(K3 \geq 70,5,\text{IF}(K3 \geq 60,4,\text{IF}(K3 \geq 50,3,$$
$$\text{IF}(K3 \geq 40,2,\text{IF}(K3 < 39,1)))))))$$

Table 2 shows the range of marks for the Likert scale. For example, data '17' (yellow) was given Likert scale 1. Figure 3 shows the changing of data transformed into Likert scale.

Step 4: Delete the data from column B to column O. Delete row 1 and 2. Next at column A, right click and choose 'column width' and type '4'. For the data from column B to G, right click and choose 'column width' and type 1. Figure 4 shows the adjustment of the column width.

Table 2: Range of data for Likert scale

Likert scales	Range of marks
1	0-39
2	40-49
3	50-59
4	60-69
5	70-100



	A	B	C	D	E	F	G	H
2		6	6	6	9	12	16	
3	CH01	6	6	1	2	2	0	
4	CH02	6	3	0	3	0	0	
5	CH03	0	0	0	0	0	0	
6	CH04	6	3	0	3	0	0	
7	CH05	6	1	0	0	0	0	
8	CH06	0	3	0	0	0	0	
9	CH07	6	0	0	2	0	0	
10	CH08	1	1	3	0	0	0	

Fig. 1: Entering data in Excel

Step 5: 'Save as' the file as formatted text (Space delimited) as shown in Fig. 5.

Step 6

Algorithm 1; Open the file. Add the following information:

```
&INST
 TITLE = "Pilot Test"
 PERSON = Person; persons are ...
  ITEM = Item; items are ...
 ITEM1 = 5; column of response to first item in data record
   NI = 6; number of items
 NAME1 = 1; column of first character of person label
NAMELEN = 4; length of person identifying label
 XWIDE = 1; number of columns per item response
 CODES = 12345; valid codes in data file
 UIMEAN = 0; item mean for local origin
 USCALE = 1; user scaling for logits
 UDECIM = 2; reported decimal places for user scaling
MISSCORE = -1
LINELENGTH = 50
&END
1
2
3
4
5
6
END LABELS
```

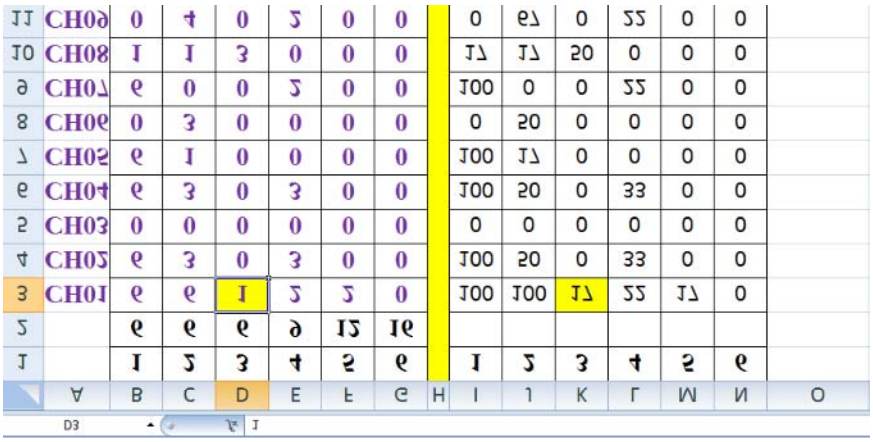
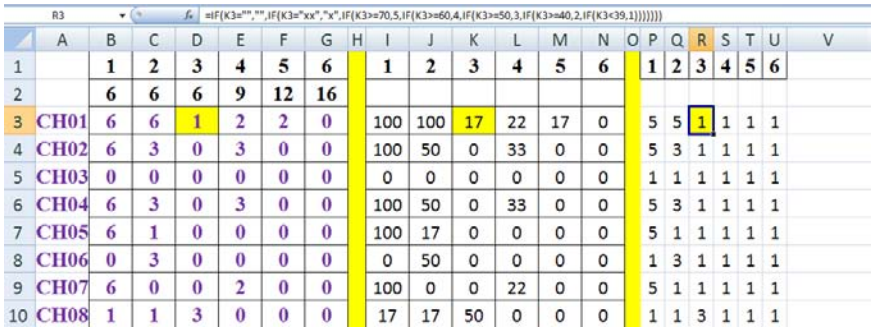


Fig. 2: Normalizind data



	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V
1		1	2	3	4	5	6		1	2	3	4	5	6		1	2	3	4	5	6	
2		6	6	6	9	12	16															
3	CH01	6	6	1	2	2	0		100	100	17	22	17	0		5	5	1	1	1	1	
4	CH02	6	3	0	3	0	0		100	50	0	33	0	0		5	3	1	1	1	1	
5	CH03	0	0	0	0	0	0		0	0	0	0	0	0		1	1	1	1	1	1	
6	CH04	6	3	0	3	0	0		100	50	0	33	0	0		5	3	1	1	1	1	
7	CH05	6	1	0	0	0	0		100	17	0	0	0	0		5	1	1	1	1	1	
8	CH06	0	3	0	0	0	0		0	50	0	0	0	0		1	3	1	1	1	1	
9	CH07	6	0	0	2	0	0		100	0	0	22	0	0		5	1	1	1	1	1	
10	CH08	1	1	3	0	0	0		17	17	50	0	0	0		1	1	3	1	1	1	

Fig. 3: Changing of data to Likert scale

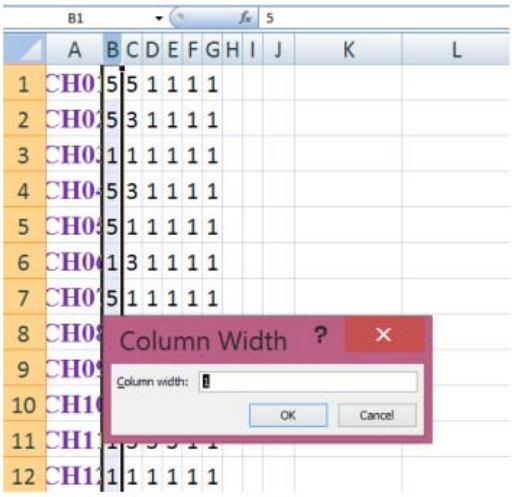


Fig. 4: Adjustment of the column width

Title is the name of the file. ITEM1 = 5 means the first item (data) placed at column 5. NI = 6 means number of item (questions). NAME 1 = 4 means the length of CV01

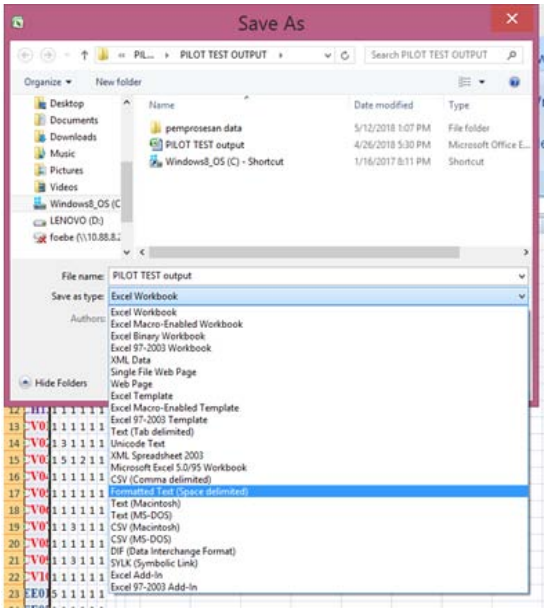


Fig. 5: 'Save as' the formatted text

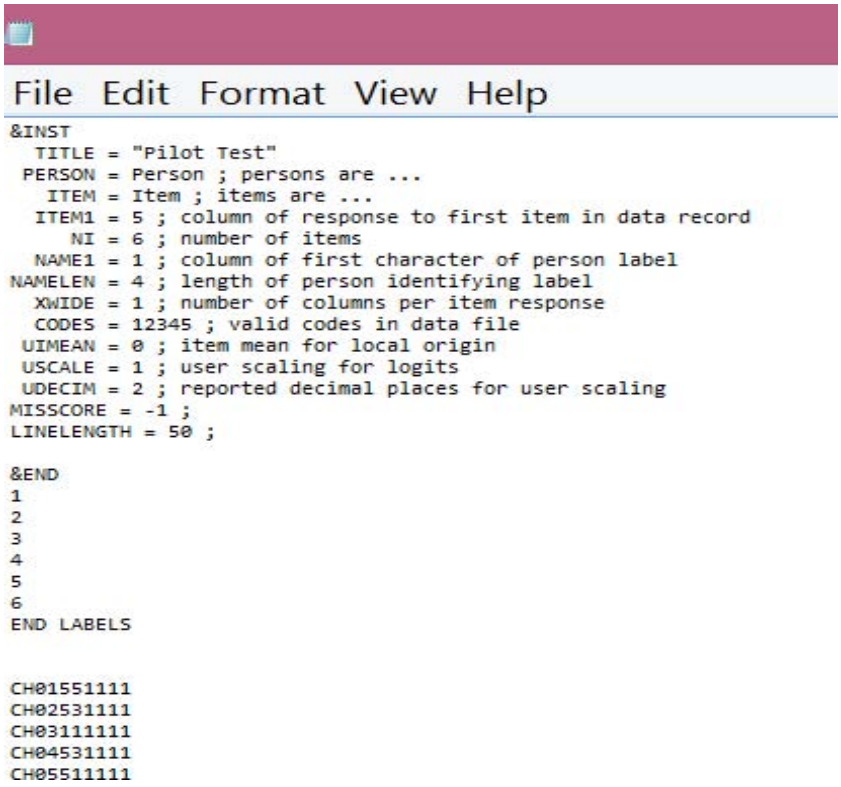


Fig. 6: Save as the file formatted text

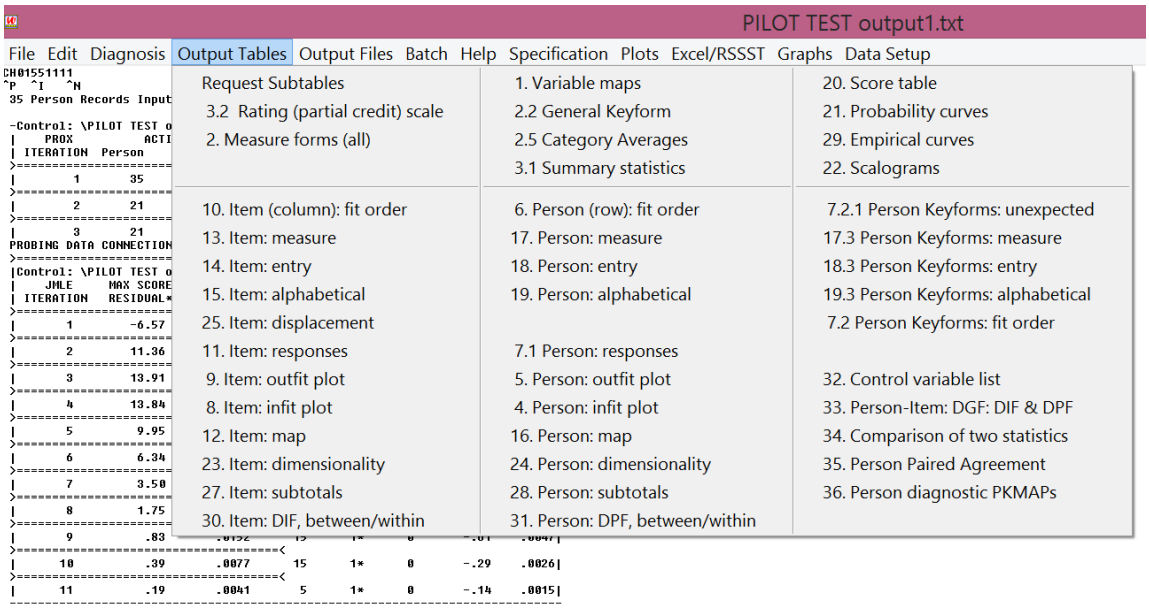


Fig. 7: Output files

is 4. XWIDE = 1 means the number of column for one piece of data. CODES = 12345 means that the Likert scale has been used. Then, we save the file as shown in Fig. 6.

Step 7: Close the file run the file in WINSTEPS. Figure 7 shows the output files from WINSTEPS. Below are some of the outputs from the Rasch Model. Figure 8 shows

SUMMARY OF 35 MEASURED (EXTREME AND NON-EXTREME) Person

	TOTAL SCORE	COUNT	MEASURE	MODEL ERROR	INFIT MNSQ	INFIT ZSTD	OUTFIT MNSQ	OUTFIT ZSTD
MEAN	8.6	6.0	-1.33	.77				
S.D.	2.5	.0	.65	.45				
MAX.	14.0	6.0	-.30	1.31				
MIN.	6.0	6.0	-2.09	.37	.31	-1.0	.19	-.4
REAL RMSE	.89	TRUE SD	.00	SEPARATION	.00	Person RELIABILITY		.00
MODEL RMSE	.89	TRUE SD	.00	SEPARATION	.00	Person RELIABILITY		.00
S.E. OF Person MEAN = .11								

Fig. 8: Summary statistics for person

SUMMARY OF 5 MEASURED (NON-EXTREME) Item

	TOTAL SCORE	COUNT	MEASURE	MODEL ERROR	INFIT MNSQ	INFIT ZSTD	OUTFIT MNSQ	OUTFIT ZSTD
MEAN	53.2	35.0	.00	.32	.80	-.1	.94	.0
S.D.	17.2	.0	.71	.23	.23	.6	.56	.8
MAX.	77.0	35.0	1.08	.75	1.16	.8	1.97	1.3
MIN.	36.0	35.0	-.82	.14	.53	-1.1	.44	-1.3
REAL RMSE	.39	TRUE SD	.59	SEPARATION	1.49	Item RELIABILITY		.69
MODEL RMSE	.39	TRUE SD	.59	SEPARATION	1.50	Item RELIABILITY		.69
S.E. OF Item MEAN = .35								

Fig. 9: Summary statistics for item

Item STATISTICS: MEASURE ORDER

ENTRY NUMBER	TOTAL SCORE	TOTAL COUNT	MEASURE	MODEL S.E.	INFIT MNSQ	INFIT ZSTD	(2) OUTFIT MNSQ	(3) OUTFIT ZSTD	(1) PT-MEASURE CORR.	PT-MEASURE EXP.	EXACT MATCH OBS%	EXACT MATCH EXP%	Item
6	35	35	1.81	1.49	MAXIMUM MEASURE				.00	.00	100.0	100.0	6
5	36	35	1.08	.75	.53	.1	.49	.0	.16	.12	95.2	97.0	5
4	39	35	.38	.34	.59	-.2	.44	-.4	.30	.22	81.0	87.0	4
3	43	35	.07	.24	.91	.0	1.97	1.3	.16	.30	57.1	63.7	3
1	71	35	-.71	.14	1.16	.8	1.06	.4	.61	.61	.0	14.1	1
2	77	35	-.82	.14	.78	-1.1	.73	-1.3	.71	.66	4.8	11.4	2
MEAN	50.2	35.0	.30	.51	.80	-.1	.94	.0			47.6	54.6	
S.D.	17.1	.0	.93	.48	.23	.6	.56	.8			38.9	35.9	

Fig. 10: Fit statistics

the summary statistics for person. Person represents the students who sit for an examination. Summary statistics for person gives the mean person, person separation and person reliability (Lohgheswary *et al*., 2016).

Figure 9 shows the summary statistics for item. Item means the questions in an examination. Summary statistics for item gives the mean item, item separation and item reliability value (Lohgheswary *et al*., 2017a).

Figure 10 shows the fit statistics. Fit statistics is also known as item statistics. It is able to identify the item (question) which does not fit the examination. This is done by inspecting the point correlation (1), outfit MNSQ (2) and outfit ZSTD (3) (Lohgheswary *et al*., 2017b). Figure 11 shows the item dimensionality. Unidimensionality means that the instrument is measuring in one dimension. Raw variance explained by measures and unexplained variance in 1st contrast determines whether or not the instrument is unidimensional (Lohgheswary *et al*., 2017c). Figure 12 shows the person-item distribution map. This map is also known as Wright MP. One side on the map shows the ability of students in answering the exam questions while the other side of the map shows the difficulty of the exam questions (Lohgheswary *et al*., 2018).

Table of STANDARDIZED RESIDUAL variance (in Eigenvalue units)

		-- Empirical --		Modeled
Total raw variance in observations	=	9.1	100.0%	100.0%
Raw variance explained by measures	=	4.1	**45.0%**	40.8%
Raw variance explained by persons	=	.3	2.8%	2.5%
Raw Variance explained by items	=	3.8	42.2%	38.2%
Raw unexplained variance (total)	=	5.0	55.0% 100.0%	59.2%
Unexplned variance in 1st contrast	=	2.0	**22.2%** 40.5%	
Unexplned variance in 2nd contrast	=	1.4	15.1% 27.5%	
Unexplned variance in 3rd contrast	=	1.0	10.8% 19.7%	
Unexplned variance in 4th contrast	=	.6	6.6% 12.0%	
Unexplned variance in 5th contrast	=	.0	.1% .3%	

Fig. 11: Item dimensionality

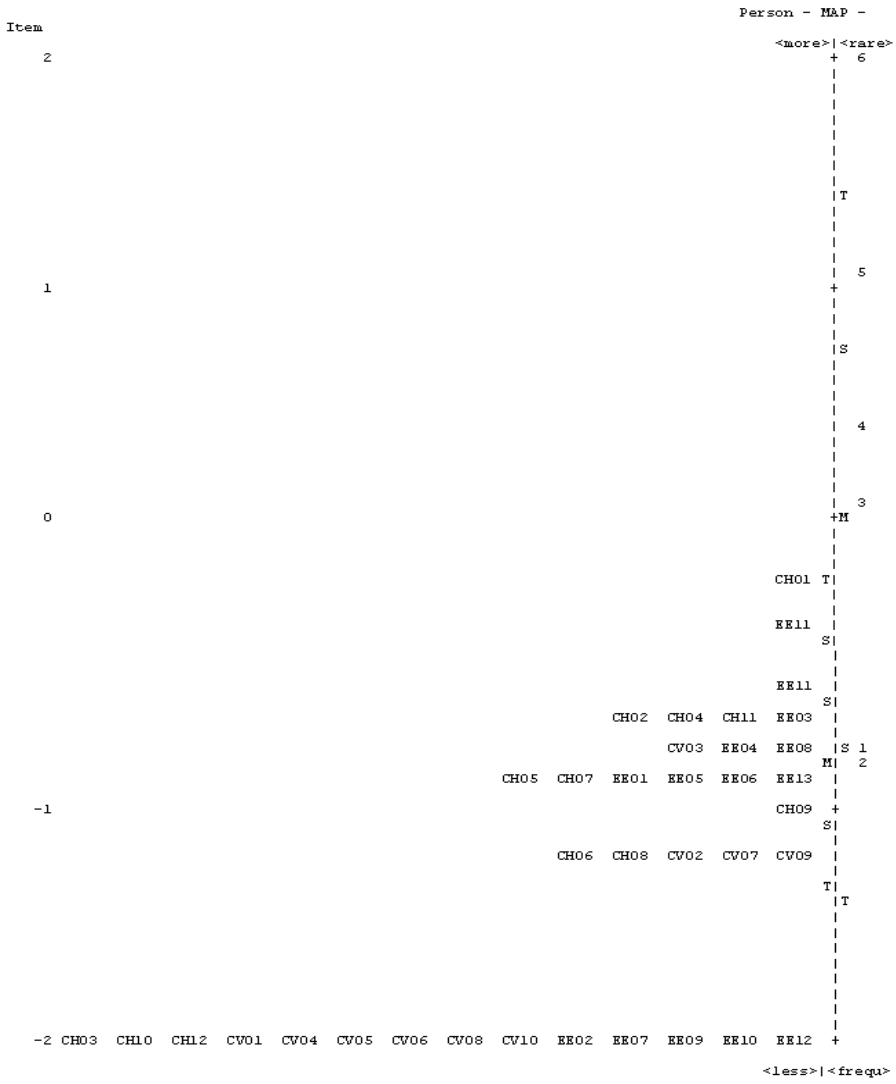


Fig. 12: Person-item distribution map

CONCLUSION

Rasch Model is a powerful tool that examines the performance of students in the examination by providing the details on how each student attempts to answer the exam questions. This study provides the detailed steps on how to process the raw data of the exam questions. The data was transferred to Excel and then normalized.

Furthermore, the Likert scale is given to the normalized data. Then, the data is saved as formatted text. Next some information is added and then the file in formatted text is run into WINSTEPS to obtain the Rasch Model analysis. Summary statistics for person, summary statistics for item, fit statistics, item dimensionality and person-item distribution map are some of Rasch Model output which is also shown in this study. The details of the steps will ensure that one will get clear picture on how to analyze the data via. the Rasch Model. This procedure will be very helpful for a beginner who is starting to use the Rasch Model to analyze the data.

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REFERENCES

Aziz, A.A., A. Zaharim, N.F.A. Fuaad and Z.M. Nopiah, 2013. Students performance on engineering mathematics: Applying rasch measurement model. Proceedings of the 12th International Conference on Information Technology Based Higher Education and Training (ITHET),October 10-12, 2013, IEEE, Antalya, Turkey, pp: 1-4.

Lohgheswary, N., Z.M. Nopiah and E. Zakaria, 2016. Evaluating the reliability of pre-test differential equations questions using Rasch measurement model. J. Eng. Sci. Technol., 11: 31-39.

Lohgheswary, N., Z.M. Nopiah, A.A. Aziz and E. Zakaria, 2017c. Achievement of course outcome in vector calculus pre-test questions. J. Fundam. Appl. Sci., 9: 394-403.

Lohgheswary, N., Z.M. Nopiah, A.A. Aziz and E. Zakaria, 2017b. Evaluation of pre-assessment model on improving students performance in Linear Algebra course. Global Stochastic Anal. Spec. Issue, 1: 56-63.

Lohgheswary, N., Z.M. Nopiah, A.A. Aziz and E. Zakaria, 2017a. Using rasch analysis to identify difficult course outcomes in linear algebra. Indian J. Sci. Technol., 10: 1-5.

Lohgheswary, N., Z.M. Nopiah, A.A. Aziz and E. Zakaria, 2018. Filtering the course outcomes for engineering mathematics lab via Rasch model. Intl. J. Adv. Appl. Sci., 5: 1-5.

Nopiah, Z.M., M.H. Jamalluddin, N.A. Ismail, H. Othman and I. Asshaari *et al*., 2012. Reliability analysis on examination course using Rasch measurement model. Sains Malaysiana, 41: 1171-1176.