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The Rasch Model Analysis for Statistical Anxiety Rating Scale (STARS)

Siti Mistima Maat, Mira Khalisa Rosli

Faculty of Education, The National University of Malaysia, Bangi, Selangor, Malaysia
Email: sitimistima@ukm.edu.my, mirakhalisarosli@gmail.com

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Abstract

The importance of statistics plays a growing role in research including students. The purpose of this study is to produce psychometric measurement using Rasch Model Analysis. 173 postgraduate students were chosen randomly to give response to 51 items of Statistical Anxiety Rating Scale (STARS). The collected data were analysed using SPSS and Winstep software. Based on the analysis, the person item and item reliability indicate 0.94 and 0.92 respectively. Item separation index for both person and item was more than the cut-off point of 2.00 which is considered good. The Rasch Model analysis has shown key aspects in learning statistics to be improvised.

Keywords

Statistical Anxiety, Rasch Model, Students, Postgraduates

1. Introduction

Statistics has been introduced to universities students since the 20th century (Arumugam, 2014) as the world nowadays needs Statistics to decipher information. The intention is to let the students understand the statistical concepts and be able to apply in real life situation. However, learning Statistics has become the greatest challenge among students at all levels of study. It has been recorded that the educators received students' feedback that shows their anxiety towards the Statistics course and decreasing students' performance in the course (Shah, Hamid, & Sulaiman, 2014). Also, in Ashaari, Judi, and Mohamed (2011), the deterioration of students' attendance in class is really disturbing as it may affect their performance towards statistics. The difficulties in understanding statistics create barriers which give negative impact regardless of their field of study.

This relates to the existence of negative feelings towards statistics that can be defined

as statistical anxiety which can occur when the students have to learn statistics (Schneider, 2011). Due to this negative perception, the students are not aware of the importance of Statistics (Keeley, Zayac, & Correia, 2008). They even start to put off or avoid any task or assignments that relate to Statistics (Onwuegbuzie, 2004). This situation will dent the students' ability to learn and foster all the necessary skills in order to apply it to find data (Mcgrath, Greiner, Brown, Ferns, & Wanamaker, 2015). Since statistics is related to mathematics, the students with weak mathematical background tend to struggle more in learning statistics (Shah et al., 2014).

There are a lot of ways to measure statistical anxiety, and Statistical Anxiety Rating Scale (STARS) is used widely in terms of observing the students' anxiety towards Statistics and helping the educator to find ways to curb this problem (Liu, Onwuegbuzie, & Berks, 2011; Mcgrath et al., 2015). There are six major constructs in which four of the constructs focus on the context itself and the other two constructs are related to social issues (Williams, 2014). The constructs contained in STARS are interpretation anxiety, test and class anxiety, worth of statistics, computational self-concept, fear of asking for help and fear of statistics teachers. Interpretation anxiety is used to measure the students' anxiety regarding how they interpret the data given in journals; test and class anxiety will reflect their feelings when enrolling any Statistics classes including test and examination. Meanwhile the worth of statistics construct is used to see how the students valued the usefulness of statistics and computational self-concept reflects their own mathematical concept and applies the right analysis to interpret the result (Williams, 2014). Furthermore, fear of asking for help will access the student asking for help on understanding any statistical output, and fear of statistics teachers is how the students affect the statistics instructor.

Koh and Zawi (2014) found that there is no anxiety effect shown but the students experienced the highest score of anxiety in class activities while Shah et al. (2014) recorded a high level of anxiety and the highest score is found in fear of statistics teachers. Mcgrath et al. (2015) found that there is a non-significant negative correlation between anxiety and performance while a significant negative relationship between anxiety and self-efficacy which is consistent with Perepiczka, Becerra, and Chandler (2011) outcomes. However, there is a nonlinear correlation found in anxiety and performance (Keeley et al., 2008). Meanwhile, Sesé, Jiménez, Montaño, and Palmer's (2015) finding indicates that the test anxiety is positively related to statistical anxiety through Structural Equation Modelling (SEM) method. Teman (2013) has done similar study on examining STARS using Rasch Model to 423 undergraduates and graduates. Somehow, a right dose of anxiety helps to elevate one's motivation by making them work smarter in learning and understanding statistics and eventually excel in the statistics course. Besides that, it seems that anxiety is affected by the students' achievement goal and motivation as found in Lavasani[a] and Weisani (2013).

The study of statistical anxiety in students is crucial for the educators to program the curriculum that is accessible for the students without any hindrance through it. Substantial past studies have been done on statistical anxiety yet the focus on psychometric analysis is still limited.

Therefore, the objective of this study is to determine the psychometric analysis of Statistical Anxiety Rating Scale (STARS) using the Rasch Model which include the following:

1) To determine the person and item reliability respectively;
2) To determine item separation index of person and item;
3) To identify the person and item measure respectively.

2. Methodology

This research used a survey research design for data collection purposes. Initially, 180 postgraduate students were chosen randomly to be the research's samples. However, based on SPSS analysis, 7 data were considered outliers and have to be removed from the original data. There were postgraduate students who enrolled in various fields of study such as Mathematics Education, Pre School programme, Malay Studies, Teaching English as Second Language (TESL) and so forth. The remaining data of 173 students was further analysed using Winstep in order to obtain the Rasch Model output. Majority of the respondents were female students which comprised of 135 (78%) and the remaining were 38 (22%) male students (**Table 1**).

Initially, STARS was developed by Cruise et al. with 89 items and after several analysis and varimax rotation, 51 items are interpretable (Baloğlu, 2002). The STARS used in this study was adapted from a previous study (Schneider, 2011) and the translation was done according to local research setting. Five point Likert scale was used which ranged from "1" as "Strongly disagree" to "5" as "Strongly agree". The consistency of the translation was done by language and content experts. Thirty minutes were given to the respondents in order to complete the questionnaire. Prior to Rasch model analysis, the STAR has gone through all the related assumptions that need to be fulfilled.

3. Findings

In this study, statistical anxiety is defined as latent trait which can be measured based on logit scores (Fisher, 1995). Based on the analysis using Rasch Model, **Table 2** shows the output for person reliability and item separation index for 173 postgraduate students. The person reliability and item reliability were found to be rather high (Saidfudin et al., 2010) at 0.94 and 0.92 respectively. Any reliability value which is closed to 1 is considered consistent internally (Oon et al., 2016). This indicates that the items are supposedly measuring the statistical anxiety as required. While the separation index of 4.12 has exceeded the cut-off point of 2.0 as suggested by Fisher (2007). The person's separation index refers to the spread of all the respondents along a continuum

Table 1. Demographic profile.

Gender	Frequency	%
Male	38	22.0
Female	135	78.0
Total	173	100.0

Table 2. Person reliability and item separation index.

SUMMARY OF 173 MEASURED PERSON

	TOTAL SCORE	COUNT	MEASURE	MODEL ERROR	INFIT		OUTFIT	
					MNSQ	ZSTD	MNSQ	ZSTD
MEAN	170.0	51.0	0.44	0.18	1.03	−0.9	1.02	−0.9
S.D.	27.7	0.0	0.95	0.04	0.85	4.1	0.85	4.0
MAX.	253.0	51.0	5.15	0.71	4.54	9.9	4.43	9.9
MIN.	107.0	51.0	−1.37	0.16	0.08	−7.7	0.08	−7.6

REAL RMSE 0.22 TRUE SD 0.92 SEPARATION 4.12 PERSON RELIABILITY 0.94
MODEL RMSE 0.19 TRUE SD 0.93 SEPARATION 4.95 PERSON RELIABILITY 0.96
S.E. OF PERSON MEAN = 0.07

Table 3. Item reliability and item separation index.

SUMMARY OF 51 MEASURED ITEM

	TOTAL SCORE	COUNT	MEASURE	MODEL ERROR	INFIT		OUTFIT	
					MNSQ	ZSTD	MNSQ	ZSTD
MEAN	576.8	173.0	0.00	0.10	1.00	−0.1	1.02	0.1
S.D.	42.1	0.0	0.35	0.01	0.18	1.6	0.24	1.9
MAX.	696.0	173.0	0.81	0.12	1.60	5.3	1.85	6.8
MIN.	474.0	173.0	−0.83	0.08	0.74	−2.6	0.72	−2.6

REAL RMSE 0.10 TRUE SD 0.33 SEPARATION 3.29 ITEM RELIABILITY 0.92
MODEL RMSE 0.10 TRUE SD 0.33 SEPARATION 3.41 ITEM RELIABILITY 0.92
S.E. OF ITEM MEAN = 0.05

line based on an agreeable aspect. There were four distinguished group of respondents based on their anxiety level towards statistics.

Next, **Table 3** shows the summary of 51 measured items for STARS. The item reliability was found at a good rate of 0.92 with separation index of 3.41. The item separation spread the items along the interval scale. Any low value for item separation indicates poor item division which is low reliability value. To overcome this issue, more respondents are required so that the reliability value could be increased. Both values were fit with the requirement for good measurement. The high item reliability value indicates high consistency in estimating the construct. It has a high probability value in the statistical anxiety measure which is due to the number of samples. As the sample increases, the reliability value increases which indicates that the instrument is stable (Arasinah, Bakar, Ramlah, Soaib, & Zaliza, 2015). Oon et al. (2016) suggested to add more items in order to have good measure in the dimension for the item separation index.

Positive point measure correlation of all STARS items is shown in **Table 3** which indicates to attend content validity. The values are ranging from 0.34 to 0.68 which meets the cut of point of more than 0.30 as suggested by Smith (2003) which is illustrated by the values in the red box.

Next, the item fit statistics for person is also shown in **Table 4**. Both person and

items fit are considered the same which applies the equivalent fit criteria (Bond & Fox, 2015). The INFIT describes the performance which is based on the samples' responses (Oon et al., 2016). In addition, the OUTFIT represents the unweighted score for the unexpected item behaviour which is beyond the samples' responses. The suggested Infit mean square (INFIT MNSQ) and Outfit mean square (OUTFIT MNSQ) values should be between 0.72 to 1.30 logits which implies t values in the range of −2 to +2 (Bond & Fox, 2015). As such, the Infit values 0.79 to 1.60 with their t values ranging from −2.3 to 5.3. The outlier person was shown by the 32nd respondent which indicates Infit value of 1.60 of t value 5.3. While the Outfit value which ranging from 0.72 to 1.85 and t value is between −2.6 to 6.8. The outlier is shown by 25th and 32nd respondents. Items #32, #17, #46, #18 & #15 are highlighted in yellow which are categorized as misfitting items. Further investigation on the respondents of those items is needed to be done in order to identify some anticipated problems. However, the values conclude that the items were measured in the same direction.

Based on Person-Map Item figure as shown in **Figure 1**, the vertical dash separates the person and the items. The symbol of # represents the frequency of the respondents. Each symbol represents two respondents. The respondents are also ranked based on

Table 4. Item measure for STARS.

ENTRY NUMBER	TOTAL SCORE	COUNT	MEASURE	MODEL S.E.	INFIT		OUTFIT		PT-MEASURE		EXACT MATCH		ITEM	G
					MNSQ	ZSTD	MNSQ	ZSTD	CORR.	EXP.	OBS%	EXP%		
32	474	173	0.81	0.08	1.60	5.3	1.85	6.8	0.34	0.61	36.4	38.6	C32_1	0
17	526	173	0.52	0.09	1.34	2.9	1.47	3.7	0.40	0.57	53.2	49.1	C17_1	0
30	524	173	0.52	0.09	1.15	1.4	1.28	2.5	0.50	0.58	50.9	46.1	C30_1	0
35	527	173	0.48	0.10	0.89	−1.0	0.89	−0.9	0.62	0.57	59.0	51.1	C35_1	0
43	534	173	0.37	0.09	0.90	−0.9	0.91	−0.7	0.62	0.58	59.0	50.4	C43_1	0
34	533	173	0.36	0.09	0.84	−1.5	0.85	−1.3	0.66	0.58	61.3	52.3	C34_1	0
47	534	173	0.36	0.10	0.89	−1.0	0.87	−1.1	0.63	0.57	59.0	54.3	C47_1	0
33	535	173	0.32	0.09	0.96	−0.3	0.96	−0.3	0.61	0.59	59.5	50.6	C33_1	0
9	549	173	0.31	0.10	1.17	1.4	1.17	1.4	0.46	0.55	54.9	53.0	C9_1	0
31	546	173	0.29	0.09	0.83	−1.6	0.85	−1.4	0.66	0.58	57.8	46.5	C31_1	0
46	542	173	0.29	0.09	0.94	−0.5	1.70	4.6	0.59	0.59	59.5	54.1	C46_1	0
50	538	173	0.26	0.09	0.86	−1.2	0.83	−1.4	0.66	0.59	60.7	53.1	C50_1	0
37	545	173	0.25	0.10	0.80	−1.8	0.78	−1.9	0.68	0.58	61.8	52.0	C37_1	0
29	539	173	0.23	0.09	0.96	−0.3	1.05	0.4	0.61	0.59	59.0	50.1	C29_1	0
39	562	173	0.17	0.10	0.81	−1.7	0.80	−1.8	0.66	0.55	60.7	53.8	C39_1	0
19	555	173	0.17	0.10	1.05	0.5	1.03	0.3	0.53	0.56	59.0	54.7	C19_1	0
45	562	173	0.17	0.09	0.79	−1.9	0.82	−1.6	0.66	0.57	60.1	50.5	C45_1	0

Continued

49	564	173	0.16	0.10	0.78	−1.9	0.74	−2.1	0.68	0.56	63.0	56.4	C49_1	0
24	569	173	0.15	0.09	1.04	0.4	1.10	0.8	0.54	0.56	57.2	51.4	C24_1	0
18	560	173	0.13	0.10	1.24	2.1	1.38	3.1	0.43	0.56	54.9	49.7	C18_1	0
3	575	173	0.11	0.10	1.22	1.8	1.28	2.2	0.42	0.54	53.8	51.9	C3_1	0
41	563	173	0.11	0.10	0.84	−1.4	0.81	−1.6	0.66	0.57	59.5	53.6	C41_1	0
16	563	173	0.11	0.10	1.28	2.3	1.26	2.1	0.42	0.57	49.1	51.6	C16_1	0
48	573	173	0.11	0.10	0.93	−.6	0.91	−0.7	0.60	0.56	63.6	57.7	C48_1	0
42	555	173	0.10	0.09	0.85	−1.4	0.85	−1.2	0.66	0.58	61.3	51.5	C42_1	0
14	580	173	0.10	0.09	1.14	1.2	1.22	1.8	0.48	0.55	58.4	48.4	C14_1	0
40	576	173	0.07	0.09	0.86	−1.3	0.87	−1.1	0.63	0.57	57.2	47.5	C40_1	0
51	570	173	0.05	0.09	1.02	0.2	1.08	0.7	0.57	0.58	54.9	52.3	C51_1	0
38	565	173	0.03	0.10	0.78	−2.2	0.76	−2.3	0.69	0.57	57.2	49.8	C38_1	0
36	573	173	0.03	0.09	0.89	−1.0	0.97	−0.2	0.62	0.57	59.0	48.0	C36_1	0
44	569	173	0.02	0.10	0.94	−0.5	0.91	−0.7	0.60	0.57	60.1	52.8	C44_1	0
27	581	173	0.00	0.09	0.76	−2.3	0.73	−2.5	0.69	0.57	60.1	48.1	C27_1	0
12	576	173	−0.01	0.11	1.04	0.4	1.04	0.3	0.52	0.54	56.6	53.3	C12_1	0
6	586	173	−0.07	0.11	1.24	1.9	1.25	2.0	0.39	0.54	56.1	54.0	C6_1	0
26	596	173	−0.19	0.10	0.81	−1.8	0.79	−1.9	0.66	0.56	58.4	49.3	C26_1	0
11	597	173	−0.23	0.11	0.91	−0.8	0.88	−0.9	0.59	0.54	61.3	55.5	C11_1	0
5	588	173	−0.24	0.10	0.99	−0.1	0.96	−0.3	0.56	0.55	60.7	52.3	C5_1	0
13	612	173	−0.30	0.10	1.23	2.0	1.30	2.6	0.39	0.53	48.6	48.5	C13_1	0
25	623	173	−0.32	0.09	0.74	−2.6	0.72	−2.6	0.68	0.54	53.8	46.6	C25_1	0
20	591	173	−0.32	0.11	1.13	1.1	1.12	1.0	0.47	0.54	60.7	53.3	C20_1	0
4	617	173	−0.34	0.10	1.09	0.8	1.11	0.9	0.47	0.53	50.9	50.3	C4_1	0
21	599	173	−0.34	0.10	1.02	0.3	0.99	−0.1	0.55	0.56	60.1	50.8	C21_1	0
22	619	173	−0.36	0.09	0.96	−0.3	0.91	−0.7	0.58	0.55	52.0	46.0	C22_1	0
10	612	173	−0.37	0.11	1.01	0.1	1.02	0.2	0.52	0.52	54.9	50.9	C10_1	0
15	663	173	−0.39	0.08	1.33	2.7	1.41	2.7	0.41	0.52	53.2	43.0	C15_1	0
7	619	173	−0.47	0.12	1.18	1.5	1.18	1.5	0.37	0.49	54.9	54.4	C7_1	0
23	588	173	−0.49	0.11	0.91	−0.8	0.89	−0.9	0.60	0.55	65.9	57.0	C23_1	0
8	696	173	−0.56	0.11	1.13	1.3	1.06	0.6	0.42	0.48	45.7	51.3	C8_1	0
2	658	173	−0.65	0.10	0.98	−0.1	0.94	−0.5	0.52	0.50	46.2	50.6	C2_1	0
28	627	173	−0.71	0.10	0.82	−1.8	0.80	−2.0	0.64	0.53	60.1	47.8	C28_1	0
1	690	173	−0.83	0.10	0.97	−0.2	0.87	−1.0	0.53	0.49	48.0	48.8	C1_1	0
MEAN	576.8	173.0	0.00	0.10	1.00	−0.1	1.02	0.1			56.6	50.9		
S.D.	42.1	0.0	0.35	0.01	0.18	1.6	0.24	1.9			5.3	3.4		

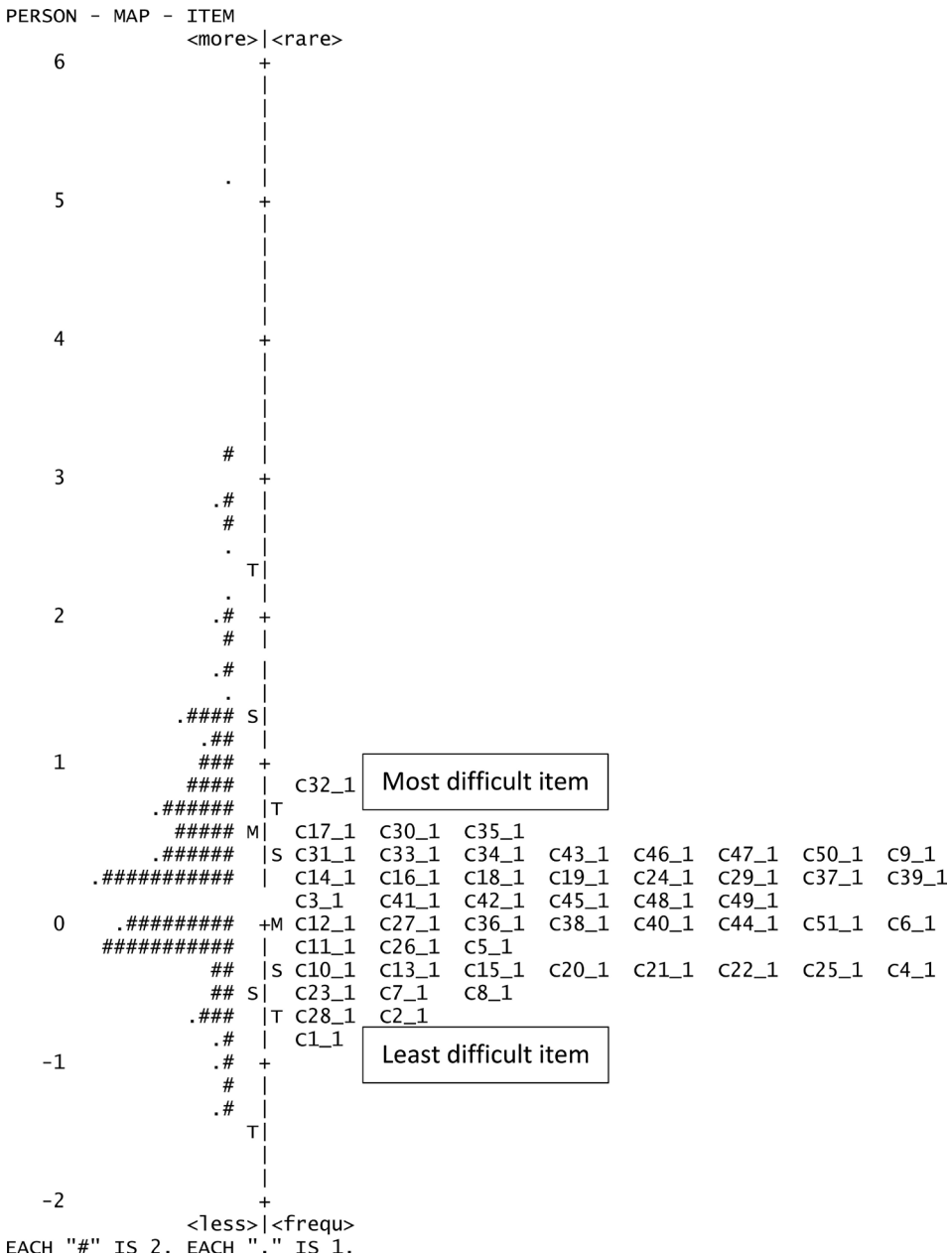

Figure 1. Person map item.

their ability. The lower part is for respondents with low ability and the top is for those respondents with high ability. The items of STARS are placed on the right side of the line and are sorted accordingly. The easiest items are placed at the bottom and gradually the most difficult items are on the top. Item C32 refers to statement of "Most statistics teachers are not human" which is considered the most difficult item among all the STARS items. While item C1 of "Studying for an examination in a statistics course" is easy to be agreed by all the respondents.

The distribution of persons in this study does not match with the item distribution. Most items are overlapping with the others which are measuring the same underlying

constructs. For instance, C28 of "Statistics takes more time than it's worth." and C2 of "Interpreting the meaning of a table in a journal article" are considered as a single construct. Both items are categorized as easy items. Indirectly, this figure provides the information on discrimination for item difficulty and person ability respectively.

4. Conclusion

The lack of statistical evidence of STARS has prompted this study. This research presents psychometric characteristics for STARS which aims at profiling postgraduate students based on their statistical anxiety responses. Based on the Rasch model analysis, it provides the evidence that the STARS is acceptable to be used in determining the anxiety level among students and beneficial to the educators in accessing student's anxiety. Teman (2013) suggested that altering the words and rebuilding the items can help increase the efficiency of this instrument. The STARS has been evaluated psychometrically that can be used in future works particularly in replicating the study. Other aspects in Rasch Model analysis can be taken into consideration including differential item functioning for future research.

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