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Assessing Engineering Technology Students' Attitude towards Problem Solving in Mathematics using Rasch Model

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Abstract: The students' attitude towards problem solving (SATPS) is designed to measure attitude based on three aspects that include patience, motivation and willingness. The purpose of the study is to conduct measurement and evaluation of (SATPS) instrument using Rasch Model to ensure the validity of the instrument. The instrument consists of 20 items was then analyzed using WINSTEP 3.69.1.11 with the intention to produce the evidence of validity on the instrument based on item response theory. The data is collected from 153 engineering technology students in a technical institute. The findings revealed that the instrument has reliability value of 0.95 and separation index is 4.42. The person reliability has value of 0.64 and separation index is 1.32. The fit statistics suggests some of the items were modified accordingly. The modification of the instrument would benefit to future study with regard to validation and reliability of SATPS.

Key words: Attitude, problem solving, Rasch model, mathematics

Introduction

Problem solving is considered vital in mathematics learning due to the impact which can be seen as the final process of finding solution to any given mathematics problems that is not known to the solver. However, the students' attitude towards problem solving plays as one of the main factors in determining the students' success in learning mathematics (Parmjit Singh & Lim Chap Sam, 2005). The feeling towards problem solving in mathematics can be viewed as positive or negative feeling in regards the process of solving any given mathematics problems. It can be considered as the emotional disposition (Mc Leod, 1994) as well as the conception about mathematics particularly in solving problems (Hart, 1989). The importance of problem solving among students is to boost their potential in order to enhance the mathematical development.

This will lead the students' ability to do reasoning and thinking mathematically which can create interest in learning mathematics (van de Walle, 2003). In addition to this, the examining and validating of the attitude towards problem solving is important in producing reliable measurement which can be done using the Rasch model. Validating using Rasch model has been widely used in various field of study not limited to statistical education research (Che Musa, Mahmud & Md Ghani, 2011). It is an important aspect in performing study using survey due to the validity and reliability of the instrument is questionable. Rasch model measurement has been used in validating the attitude towards science among 214 secondary students in Penang, Malaysia (Md Zain et ali., 2010) which draws conclusion that positive attitude towards science can be developed through school activities. A longitudinal study is proposed to determine the changes in the students' attitude. Another study on students' attitude towards learning elementary statistics has used Rasch model measurement in order to determine 139 secondary school students' competency (Che Musa et ali, 2011). The findings reveal that they had removed items with unusual patters in order to obtain a better value of item and person reliability. The ability of students is also shown based on the ranking of the difficulty level of the items.

The objectives of the study is 1) to identify the validity of SATPS using Rasch model; 2) to determine the person and item reliability of SATPS; 3) to identify the adequacy of the separation index of SATPS; 4) to identify the point measure correlation of the items of SATPS and 5) to identify the items that fulfilled the outfit and infit criteria.

Methodology:

The data was obtained from 153 engineering technology students from a local institute. The researcher self administered the instrument that was adapted from Effandi (2003). The SATPS instrument consists of 20 items with 4 point Likert scale (1=strongly disagree, 2=disagree, 3=agree and 4=strongly agree) which categorized into willingness (6 items), patience (6 items) and motivation (8 items). Using Winstep 3.69.1.11 was used to analyze the data according to item response theory (IRT). The first criteria that need to be considered is the person and item reliability as well as their separation index. The results are presented using person and item fit statistics the form of mean square values (MNSQ) and standardized z-scores for infit and outfit. The person-item- map is also computed to specify the ability of the respondents that match with the item difficulty level. The SATPS were measured by the Rasch Rating Scale Model since the item responses are in Likert scale which

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ranging from"1" as "Strongly Disagree" to "4" as "Strongly Agree".

Analysis and Results:

Using Rasch model analysis, it can be shown that there exist a relationship between person ability and the difficulty level of the item (Bond & Fox, 2007) which can be expressed by the following formula of probabilistic expression (Wright & Masters, 1982)

$$P_{ni}\left(x_{ni}=1 \mid \beta_n, \delta_i\right)=\frac{e^{(\beta_n-\delta_i)}}{1+e^{(\beta_n-\delta_i)}}$$

β_n is defined as the person ability.

δ_i is defined the item difficulty.

The statistical summary of the Rasch model output is one the procedures that need to be fulfilled. The reliability of person and item indicates how the person and item fit with the model. Bond and Fox (2007) stated that a good person and item reliability should be more than 0.8.While; the separation index shows the classification of the item and the person reliability with recommended value of more than 2.0.

PERSON	2335 INPUT	153 MEASURED		INFIT		OUTFIT	
	SCORE	COUNT	MEASURE	ERROR	IMNSQ	ZSTD	OMNSQ	ZSTD
MEAN	51.7	20.0	.12	.36	1.05	.0	1.02	-.2
S.D.	5.8	.0	.60	.06	.57	1.8	.58	1.8
REAL RMSE	.36	TRUE SD	.48	SEPARATION	1.32	PERSON RELIABILITY		.64
ITEM	20 INPUT	20 MEASURED		INFIT		OUTFIT	
MEAN	235.0	153.0	.00	.12	1.00	.0	1.02	.1
S.D.	40.8	.0	.56	.01	.21	1.9	.25	2.1
REAL RMSE	.12	TRUE SD	.54	SEPARATION	4.42	ITEM RELIABILITY		.95

Fig. 1: Summary Statistics for Person and Item of SATPS

Based on Figure 1, the person reliability shows an acceptable value of 0.64 with separation index of 1.32 for 153 respondents. The person reliability provides the information that the respondents are consistent if they are tested with other items that measure the same construct (Idris, 2010).The separation index indicates that there is two groups of respondents with different ability. However, a high value of 20 items reliability of 0.95 with separation index of 4.42. This shows that the items are also reliable if they are tested again using another set of respondents with similar characteristics. The person and item reliability can be increased if the value of Outfit/infit MNSQ is within 0.6 – 1.4 (Bond & Fox, 2007). In addition, any misfit items are also recommended to be separated in order to achieve the same objective.

ENTRY NUMBER	TOTAL SCORE	COUNT	MEASURE	MODEL S.E.	INFIT MNSQ	INFIT ZSTD	OUTFIT MNSQ	OUTFIT ZSTD	PT-MEASURE CORR.	PT-MEASURE EXP.	EXACT MATCH OBS%	EXACT MATCH EXP%	ITEM	G
3	343	153	.58	.11	1.62	5.0	1.70	5.5	-.26	.40	37.9	51.1	S3	0
13	347	153	.37	.08	1.50	4.8	1.69	5.3	.18	.51	24.8	30.8	Y13	0
7	348	153	.60	.12	1.07	.7	1.07	.7	.30	.38	56.9	53.4	Y7	0
2	436	153	-.48	.13	1.05	.5	1.08	.7	.30	.36	60.1	59.7	K2	0
17	388	153	.18	.12	1.03	.3	1.06	.6	.33	.37	45.8	52.9	K17	0
11	393	153	.12	.10	1.12	1.2	1.16	1.5	.34	.43	43.1	44.0	K11	0
20	399	153	.15	.12	1.02	.3	1.03	.3	.34	.37	57.5	56.0	Y20	0
9	388	153	-.03	.12	1.02	.2	1.02	.2	.35	.38	55.6	51.6	Y9	0
14	311	153	1.41	.13	.98	-.2	.98	-.2	.38	.35	60.8	58.8	Y14	0
16	399	153	-.21	.11	.99	-.1	1.01	.1	.40	.40	52.9	48.0	S16	0
4	442	153	-.70	.13	.95	-.4	.94	-.5	.42	.36	60.8	58.6	K4	0
15	395	153	-.01	.11	.96	-.3	.96	-.4	.45	.40	44.4	48.2	S15	0
6	425	153	-.42	.11	.95	-.4	.96	-.4	.45	.40	45.1	48.5	K6	0
5	446	153	-1.08	.13	.89	-1.0	.88	-1.1	.49	.34	61.4	60.0	S5	0
10	436	153	-.66	.13	.86	-1.3	.86	-1.3	.53	.36	62.1	57.6	K10	0
19	373	153	.33	.14	.82	-1.8	.81	-1.8	.57	.33	71.2	57.1	Y19	0
12	343	153	.62	.13	.81	-1.7	.81	-1.7	.59	.36	59.5	58.3	Y12	0
8	403	153	-.26	.13	.81	-1.9	.81	-1.8	.59	.36	56.2	53.6	Y8	0
1	429	153	-.48	.11	.81	-1.9	.82	-1.9	.60	.39	51.0	49.7	S1	0
18	468	153	-.04	.13	.78	-2.4	.78	-2.3	.63	.34	62.7	59.4	S18	0
MEAN	395.6	153.0	.00	.12	1.00	.0	1.02	.1			53.5	52.9		
S.D.	40.7	.0	.56	.01	.21	1.9	.25	2.1			10.4	6.8		

Fig. 1: Sample Item Measure Order

To identify the polarity of items that measure SATPS, point measure correlation (PTMEA CORR) value must be positive which indicating the items measure the required construct (Idris, 2010). However, item S3 has

shown a negative value of PTMEA CORR which indicates that the item response is in conflict with the variable (Linacre 2003). Items that have more than .38 of PTMEA CORR value contribute to the measurement of SATPS respondents which enable the researcher to distinguish the respondent accordingly. The next criteria that need to be evaluated is the analysis on infit and outfit of items. Infit and outfit mean square value respectively are shown to be within the acceptable range that is 0.6 to 1.4 (Bond & Fox, 2007). Based on table 2, two items of S3 and Y13 are found to be not included in the range which suggested that these items need to be removed. The modification can also be done if the two items are replaced by new items. The Z standard values report the t-test with infinite degree of freedom (Ariffin, 2008) which indicates the observation that can be predicted. If the z standard value is less than zero this applies the observation is easily predictable and if the value is more than 0 then the observation is rather difficult to be predicted. However the recommended all values of z score should be within -1.9 to 1.9 (Linacre, 2002) except for items S3, Y13 and S18.

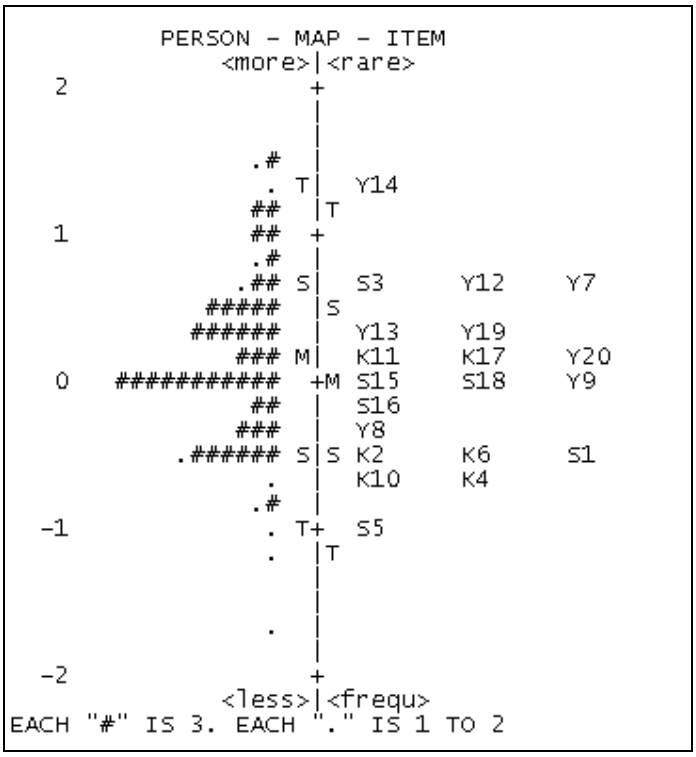

Fig. 2: Mapping of Difficulty Item-Respondent Ability for SATPS

Figure 2 shows a mapping of difficulty item to person ability of 153 respondents. Item Y14 is found to be the most difficult to be agreed by the respondents. While item S5 is considered to be the easiest item to be answered. Respondents with high ability in answering the items are positioned at the top scale. The respondents with low ability stay at the lower part of the scale. The symbol of "#" represents the number of respondents with three respondents are at the top of the scale that are much agreeable on the most difficult item of Y14 with 1.14 logits. The easiest item of S5 has -1.08. The logits values are calculated from the Figure 2. The distribution of the person ability is skewed to the upper scale. The constructs of SATPS are found to be easily answered based on all negative logits values in Figure 2. Overlaps items like K11, K17 & Y20 are also found to measure different constructs in SATPS.

Conclusion:

This study identifies that two items of S5 and Y14 are recommended to be dropped or modified with the purpose to increase the person and item reliability as well as the separation index. The importance of this analysis is to provide information that validation of any instrument is required in instrument developing process. This is to ensure that the instrument has an acceptable reliability value which should be consistent along the process. The quality of the results has been proven by the reliability and validity of SATPS using Rasch Model. This will produce quality findings which have minimum measurement error. The modification of the instrument can be enhanced through removing items with unusual responses. Using Rasch, it is possible to measure the attitude towards problem solving rather than qualitative study. This is due to the standardized ruler in measuring

the students' responses on their attitude towards problem solving as well as the difficulty of the item (Zakaria & Abdul Aziz, 2009). This study has set insights to the detail of the instrument of SATPS which could lead to the betterment of the said instrument in regards the items as well as the respondents.

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