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Validating Mathematics Teachers Teaching Practices Questionnaire Using Rasch Measurement Model

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Abstract: This study aimed at testing and validating Teacher's Teaching Practices Questionnaire (TTPQ) of 24 items using Rasch measurement model. The instrument was used to identify teachers' teaching preference. The 263 Mathematics secondary school teachers were selected to be the sample of this study. They were required to respond to a 5 point Likert scale of 2 constructs that include teacher centred teaching and student centred teaching. The analysis has shown that the person reliability is given by 0.71 and the separation index is 1.56. While the item reliability is at good level of 0.99 and the separation index is 8.29, the Rasch Model has given the empirical evidence that TTPI is valid and reliable according to psychometric characteristics.

Key words: Teaching practices, Mathematics, teachers, Rasch Model, Malaysia

INTRODUCTION

Teaching Mathematics is rather unique in which it requires the best practices in classroom management. It requires knowledge and skill in order to deliver the subject matter effectively. To achieve the teaching objective, then teachers have to aware of good practices in delivering their instruction. The implementation in classroom is based on their teaching guidelines that will later reflect in their teaching practices. In addition, teachers have to improve their teaching practices in order to ensure that the students are able to grasp what has been delivered. The practices would enable them to cater the diversity of their students' learning. Indirectly, it motivates their students to do better in Mathematics as well as making classroom learning more enjoyable.

However, common issues in teaching practices are the types of teaching that suit the students' need and the common teaching style that are practised by Mathematics teachers. These are vital since producing effective teachers is the most significant factor in determining students' achievement (Kingsley and Romine, 2014). Although, teachers are bound to the teaching guidelines that have been set by the policy makers, they have the authority in using the appropriate teaching approaches in classroom. Students who benefit effective teaching practices would be part of the teachers' success. Some commonly teaching practices used include teacher centred teaching and student centred teaching (Garrett, 2008). In teacher centred teaching, teachers dominate the classroom process including taking control over the students. They are given teaching guidelines such as lecture notes and manuals that can be used in transmitting the knowledge to the students (Edwards, 2008). In contrast, student centred teaching focuses on the application of constructivist and socio-cultural learning theory which let the students develop themselves to become independent learners. Students have the authority in controlling their learning as well as creating learning community among them with the teachers' guidance. Despite being less controlled by the teachers, students are found to be more co-operative and the learning process is actively being practised.

Nevertheless, finding a good measurement for good teaching practices has been a provocative issue among researchers (Mullen and Farinas, 2004). Kingsley and Romine (2014) report the limitation in measuring the best teaching practices which has made them proposed Rasch Model to validate the psychometric characteristics of teaching practices. Some efforts have been done on the validation aspect of teaching practices among Mathematics teachers (Maat *et al*., 2011) and elementary teachers (Kingsley and Romine, 2014) as well as Chemistry teachers (Ezeudu *et al*., 2013). In addition Kingsley and Romine (2014) has listed several studies on the attempt in producing quantitative measures of teaching practices such as studies by Burnett and Meacham (2002) and Tschannen-Moran and Hoy (2001). These studies produce the reliability analysis of the developed instruments. For instance, Tschannen-Moran

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and Hoy (2001) developed teaching efficacy scale with two dimensions including personal teaching efficacy and teaching efficacy has produced an acceptable reliability value between 0.75 and 0.79. Though, the instrument has reported the reliability value, it can be considered as part of the validation technique.

Among the validation techniques are confirmatory factor analysis and the Rasch measurement model. The latter technique is widely used among researchers since Rasch Model has the advantages in producing reliability of item andperson using raw data. Furthermore, it provides information on item functioning yet detailed interpretation is required in presenting comprehensive report on items of the instrument (Tormakangas, 2011). This has become the justification of using Rasch Model in validating teachers' teaching practices in this study. Thus, the following research objectives are formed in order to produce the empirical evidence in terms of psychometric measurement using Rasch Measurement Model:

- To determine the reliability and separation index of person and item respectively
- To identify which items can be omitted from teachers teaching practices questionnaire based on infit and misfit cut-off point
- To identify any discrepancies among individuals and items in person-item distribution

MATERIALS AND METHODS

Using a survey methodology, 263 of Mathematics secondary school teachers were selected randomly to be the sample of this study. These teachers were requested to give response on 24 items of teachers teaching practices instrument. The instrument was adapted from Swan (2006) which has two constructs of student centred teaching and teacher centred teaching. The response of the item uses 5 point Likert scales ranging from "1" as strongly disagree to "5" strongly agree.

RESULTS AND DISCUSSION

Table 1 shows the analysis of person reliability and separation index of the TTPI. The reliability value of 0.71 indicates an acceptable (Bond and Fox, 2007). The value of 1.56 for the separation index shows that the respondents have been grouped into 2 strata based on their ability. However, Linarce (2005) states that any separation index value of >2 is considered good. Next, Table 2 shows the output for item reliability and the separation index value for the TPI. It can be shown that the item reliability is given by 0.99 which indicates high reliability. The separation index is given by 8.29 that it also fulfilled the recommended value as proposed by (Bond and Fox, 2007).

To answer the second research objective, the point measure correlation is used to fulfil the instrument validity as shown in Fig. 1. Since, all the point measure correlations show positive value, this indicates that the items have measured what they are supposed to measure. The acceptable value should be within 0. 4 and 0.8 which includes 9 out of 24 items. These items are 20, 22, 18.9, 14, 15, 10, 11 and 4. For further analysis, the Outfit Mean Square (MNSQ) sets the requirement that the value should be within 0.5 and 1.5 which include all items. The next criteria that should be considered is the outfit Z-standard value that should be in the range of -2 to 2. Based on the output, it can be shown that all items fulfilled the requirement.

Table 1: Summary statistic of person measured

					Infit		Outfit	
Test	Total score	Count	Measure	Model error	MNSQ	ZSTD	MNSQ	ZSTD
Mean	83.8	24.0	0.43	0.23	1.00	-0.21	0.00	-0.2
SD	8.8	0.0	0.48	0.02	0.60	1.90	0.61	1.8
Max.	112.0	24.0	2.68	0.40	3.59	5.60	4.10	5.9
Min.	54.0	24.0	-0.92	0.20	0.22	-3.80	0.24	-3.6

Real RMSE = 0.26, True SD = 0.40, Separation = 1.56, Person reliability = 0.71, Model RMSE = 0.23, True SD = 0.42, Separation = 1.80, Person reliability = 0.76, SE of person mean = 0.03

Table 2: Summary statistic of item measured

					Infit		Outfit	
Test	Total score	Count	Measure	Model error	MNSQ	ZSTD	MNSQ	ZSTD
Mean	918.4	263.0	0.00	0.07	0.99	0.01	0.00	0.1
SD	151.3	0.1	0.60	0.01	0.08	0.90	0.10	1.0
Max.	1161.0	263.0	1.15	0.09	1.15	1.90	1.20	2.4
Min.	647.0	263.0	-0.91	0.06	0.85	-1.60	0.76	-2.0

Real RMSE = 0.07, True SD = 0.59, Separation = 8.29, Item reliability = 0.99, Model RMSE = 0.07, True SD = 0.59 Separation = 8.39, Item reliability = 0.99, SE of item mean = 0.12

ITEM STATISTICS: MEASURE ORDER

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
21	672	263	1.15	.06	1.07	1.0	1.10	1.3	.35	.41	31.2	33.7	A21	0
12	647	263	1.05	.07	1.14	1.8	1.20	2.4	.24	.40	43.0	39.3	A12	0
17	668	263	.94	.06	1.15	1.9	1.18	2.2	.26	.41	38.0	37.0	A17	0
19	666	263	.93	.07	1.02	.3	1.04	.6	.36	.39	46.4	41.8	A19	0
20	741	263	.60	.06	1.05	.7	1.05	.8	.42	.45	38.0	31.2	A20	0
22	849	263	.37	.06	1.00	.0	.97	-.3	.40	.39	37.3	36.4	A22	0
2	817	263	.33	.07	1.02	.3	1.02	.3	.38	.39	42.2	38.8	A2	0
7	891	263	.11	.07	1.05	.6	1.03	.4	.32	.37	36.9	42.7	A7	0
5	907	263	.10	.06	1.05	.7	1.07	.8	.39	.43	26.6	32.4	A5	0
18	943	263	.08	.07	.94	-.6	.93	-.7	.45	.37	48.3	45.2	A18	0
3	921	263	.02	.07	1.03	.4	1.08	1.0	.34	.39	40.7	39.7	A3	0
9	943	263	-.03	.07	.99	.0	.99	-.1	.40	.38	42.2	42.9	A9	0
8	949	263	-.08	.06	1.05	.6	1.04	.5	.36	.40	37.3	38.5	A8	0
16	946	263	-.13	.08	.98	-.1	.98	-.2	.37	.35	47.9	48.1	A16	0
6	960	263	-.18	.07	1.04	.4	1.04	.4	.34	.38	43.3	42.0	A6	0
14	923	263	-.19	.07	.88	-1.6	.86	-1.7	.50	.37	43.3	41.7	A14	0
15	920	263	-.21	.07	.92	-1.0	.91	-1.1	.46	.35	46.4	44.2	A15	0
10	1030	263	-.37	.07	.91	-.9	.98	-.2	.41	.37	47.5	46.2	A10	0
11	1058	263	-.58	.08	.89	-1.0	.92	-.8	.45	.34	48.7	48.9	A11	0
13	1073	263	-.62	.08	1.00	.0	1.04	.4	.33	.34	49.4	47.5	A13	0
1	1130	263	-.73	.08	.90	-.8	.87	-1.0	.39	.31	52.5	52.0	A1	0
23	1141	263	-.74	.09	.96	-.3	.95	-.4	.34	.30	54.4	52.4	A23	0
4	1161	263	-.90	.08	.85	-1.2	.76	-2.0	.45	.30	51.7	51.5	A4	0
24	1085	263	-.91	.08	.96	-.4	.97	-.3	.37	.33	49.8	49.4	A24	0

Fig. 1: Infit and outfit MNSQ (item statistics: measurk order)

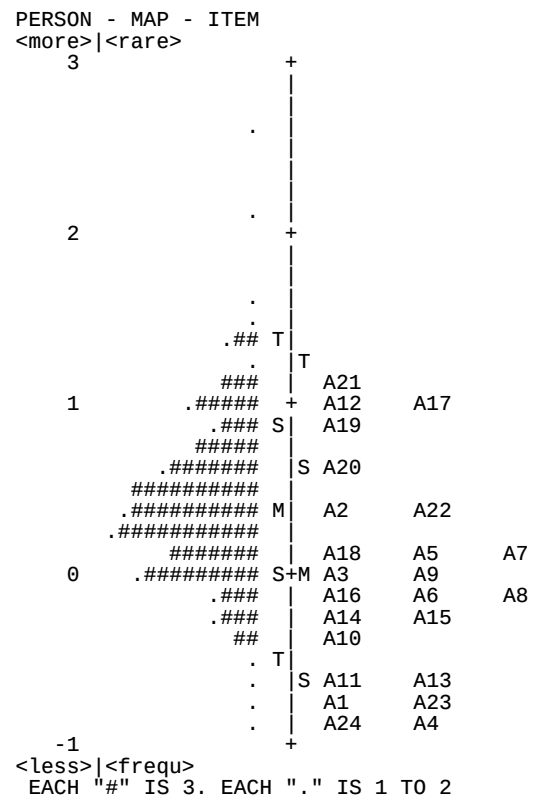

Fig. 2: Person map item

Another important analysis on instrument validity is based on person-item distribution mapas shown in Fig. 2. The items are ranked based on the difficulty level, from easy to difficult which is placed on the right side of the vertical line. Meanwhile, the respondents are ranked on the left side whichis based on their ability. It can be reported that four individuals are among the top in terms of ability which is shown by the dots at the upper part of the line. However, four indviduals are placed below the ability scale which is shown by the four dots at the bottom. While on the rightt scale, item A21 is considered to be the most difficult in terms of giving response for agreement based on the 5 point Likert scale. This is contrast to item A24 and item A4 which are placed at the lower part of the scale.This indicates easy items for the samples to agree on the statement of the item.

CONCLUSION

Producing items analysis for any questionnaire would benefit researchers in terms of quality aspect. It provides the substantial measurement criteria that indicate good items in measuring any constructs. It is vital to determine the validity and reliability which can be proven using psychometric properties of Rasch Model. Based on the reliability analysis, it can be concluded that the teaching practices instrument is reliable which would lead to the consistency of responses if being tested differently using the same group of samples.

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