DEVELOPMENT OF COMPETENCY ITEMS FOR VOCATIONAL TEACHERS USING RASCH MODEL ANALYSIS

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Abstract

Competent teachers are valuable assets in the Malaysian Public Skills Training Institutions (MPSTI) for Technical and Vocational Education and Training (TVET) programme. This study aimed to determine the summary statistics for items and persons, fit statistics, and item dimensionality test for the competency items on the vocational teachers at MPSTI using Rasch Model analysis. A total of 222 vocational teachers under the Ministry of Human Resources and Ministry of Youth and Sports participated in the pilot testing. This study collected data from purposive sampling of vocational teachers from seven public skills training institutions in Selangor, Negeri Sembilan, and Kuala Lumpur namely IKTBN Sepang, IKBN Kuala Langat, IKTBN Dusun Tua, IKTBN Chembong, ILP Kuala Lumpur, ILP Kuala Langat, and ADTEC Shah Alam specifically in mechanical, electrical, civil, and computer programme. This study had conducted a pilot test, which covered 180 competency items on technical competency, pedagogy competency and personal competency. The result reveals that the reliability of the item is 0.92, which is high spread with 3.94 separation items. The competency items are divided into four groups; namely difficult items, moderate items, easy items, and very easy items. The overall items are fit except for 40 items that have misfit criteria and they were discarded. The item dimensionality test reveals that the competency items are within the scope of measuring vocational teachers' competency. The modelled variance is 51.2%, which is considered fair and the unexplained variance in the first contrast is 4.2%, which is considered good. This study contributed to the development of competency items for the vocational teachers in MPTSI using Rasch measurement model. Findings of this study would be significant for TVET management as it provides a basis for a valid instrument in measuring competency of the vocational teachers.

Keywords: Competency item, Rasch measurement model, Vocational teachers.

1. Introduction

An educator is considered competent when he or she has three elements of competence namely knowledge, skills, and attitudes. Competent employees have the skills, capabilities, and competencies in carrying out their duties effectively [1] and teachers' competency can affect the achievements of student learning [2]. TVET educators' competency is an issue discussed at the national level as stated in the Eleventh Malaysia Plan (2016-2020). Therefore, the development of competency items for vocational teachers at Malaysian Public Skills Training Institutions (MPSTI) under the Ministry of Human Resources (MOHR) and Ministry of Youth and Sports (MOYS) based on National Occupational Skills Standard (NOSS) module is a crucial.

2. Literature Review

2.1. Competency

A worker should have cognitive skills (knowledge), interpersonal skills, and technical skills in achieving his or her work [3]. In this study, there are three domains namely technical competency, pedagogy competency, and personnel competency. Technical competence is the ability of a vocational teacher to apply knowledge and skills in the technical fields. Pedagogy competence is the ability of a teacher to teach and convey the theoretical and practical subjects. Personnel competence is the attitude that should be equipped by vocational teachers.

The underlying theory of technical competence is the work process knowledge theory [4]. Sulaiman [5] defined the theory of work process knowledge as a combination of knowledge and practical theories (skills). The exploration of work process knowledge theory is applied in the relationship between work, individual knowledge, collective knowledge, and work efficiency. Pedagogy competence refers to the pedagogical content knowledge (PCK) Shulman [6]. Shulman [7] emphasised that subject knowledge and pedagogy should be consistent. Teachers with knowledge in the field also need to master pedagogy to ensure that the teaching and learning process runs smoothly. Personnel competence is related to the personnel characteristics of a teacher [8]. Teachers' personalities are a part of competence and the personality of a worker can illustrate the achievement in his or her work [9]. In this study, personnel competence consists of efficacy, creative instructional strategies, verbal communication, work ethics, intrinsic motivation, and emotional intelligence.

Overall, there are 180 competency items in this study. Technical competency consists of specific knowledge and general knowledge [10] and skills [11] such as handling, maintenance, and inventory of machines and hand tools; handling students at the workshop; material and application; theoretical instructional strategies; practical instructional strategies; practical assessment; and work planning. Pedagogy competency consists of comprehension, transformation, instruction, evaluation and reflection [7].

There are six sub-domains of personnel competence consisting of efficacy (adapted from personel teaching efficacy (PTE) [12]); creative instructional strategies [13] namely student-centred learning, the use of multi-teaching aids assistance, connection between teaching contents and real life, open questions; verbal communication (adapted items from Effective Teacher Communication Skills And

Teacher Quality [14] namely listening, ability to get the message across, emotional management in the communication process, and assertive communication; work ethics (adapted instruments from Islamic Work Ethics [15]; intrinsic motivation - enjoyment and challenges (adapted from The Work Preference Inventory: Assessing Intrinsic [16]; and emotional intelligence [17] namely self-awareness, self-control, motivation, and empathy. The items consist of 61 technical competency items, 36 pedagogy competency items, and 83 personnel competency items, 36 pedagogy competency items, and 83 personnel competency items.

2.2. Rasch Measurement Model

The Rasch analysis provides a reliable and reputable measurement [18]. In this study, Rasch analysis provides more precise data on vocational teachers' competency items. Rasch [19] stated that the performance of a task is determined by the amount of latent trait possessed by the person and the amount demanded by the item [20]. The Rasch measurement model can be used to identify students' achievements [21] and suited measurement item analysis for the assessment of competence [22]. The concept of Rasch measurement model theorem is persons who are more able to answer have a greater likelihood of correctly answering all the items and easier items are more likely to be answered correctly by all persons [23]. This study concentrates on outlining the competency items for vocational teachers at the MPSTI under the MOHR and MOYS based on NOSS module. The Rasch measurement model was used to analyse the summary statistics for items, as well as fit items statistics and item dimensionality test for the competency items.

3. Methodology

This research aimed to identify the competency items for the vocational teachers at the MPSTI using quantitative survey approach. The competency items for the vocational teachers consist of 180 items, which were verified by 26 panels of experts as follows: local university lecturers (n=5), vocational teachers (n=11), and management officers (n=10) from the skills or vocational programme.

3.1. Population and sample

The purposive sampling of this study is the vocational teachers for technical programmes, which are based on the NOSS module at the MPSTI from Selangor, Kuala Lumpur, and Negeri Sembilan.

3.2. Procedures

The questionnaires were submitted to seven public skills training institutions after the researcher was granted the permission to conduct this study from the authority of MOHR and MOYS. The questionnaires are divided into two parts: 1) respondents information namely institutions and programme; and 2) 180 questions that need to be answered by the respondents. The researcher sent the questionnaires with accompanying letters.

3.3. Data analysis

The questionnaire used a 5 Likert scale. The results are compiled in SPSS format and transferred using Bond and Box Step, which is a customised WINSTEPS7. The response scales for the survey are Strongly disagree (1) to Strongly agree (5).

4. Results and Discussion

4.1. Respondents information

The target population of the pilot test comprised of IKTBN Sepang (*n*=55), ILP Kuala Lumpur (*n*=58), ADTEC Shah Alam (*n*=12), ILP Pedas (*n*=26), IKTBN Chembong (*n*=20), ILP Kuala Langat (*n*=20), IKBN Kuala Langat (*n*=20), and IKTBN Dusun Tua (*n*=11) with the amount of 222 vocational teachers. The purposely samples consist of vocational teachers in the technical programmes namely mechanical (*n*=110), electrical (*n*=60), computer (*n*=30), and civil (*n*=22).

4.2. Summary statistics for items

Table 1 shows the measurement of items for item separation and item reliability. The separation index is better when the value is more than 2.0. When the values of the separation index of the items are higher, the measurement instrument is better because the items are separated by different levels of difficulties [24]. For item reliability, a good Cronbach's alpha value is 0.65 to 0.95 and 0.7 to 0.9 and above [25]. In this study, the item reliability is 0.92, which indicates the item difficulty spreads highly with item separation at 3.38 logit. The values show that the instruments are in a very good condition and have a high level of consistency that can be used in the actual research [26]. It is noted that the item mean is 50, the maximum item or the highest location of the item on the logit ruler is 77.51 logit, and the lowest item on the ruler is located at 38.03 logit. The Item Model Fit Mean Square Range Extremes value of 0.47 is considered good [27]. In this study, the summary of overall competency factors with the Cronbach's α values of more than 0.7 is technical competency (0.91), pedagogy competency (0.93), efficacy (0.72), creative instructional strategies (0.81), verbal communication (0.82), work ethics (0.90), intrinsic motivation (0.93) and emotional intelligence (0.94).

Table 1. Summary statistics for items.

	Total score	Count	Measure	Model Error	Infit		Outfit	
					MNSQ	ZSTD	MNSQ	ZSTD
Mean	921.5	222.0	50.00	1.67	.98	-.5	.92	-.8
S.D.	23.4	.0	6.23	.05	.42	3.0	.52	3.1
Max.	964.0	222.0	77.51	1.70	3.00	9.9	3.54	9.9
Min	804.0	222.0	38.03	1.39	.52	-4.8	.41	-5.0
REAL RMSE	1.77	TRUE SD	5.97	SEPARATION	3.38	Person RELIAB ILITY	0.92	
MODEL RMSE	1.67	TRUE SD	6.00	SEPARATION	3.59	Person RELIAB ILITY	0.93	
S.E. OF Item MEAN = 0.47								

Figure 1 shows that the competency items in the pilot-test can be classified into four groups: difficult competency items, moderate competency items, easy competency items, and very easy competency items. It is assumed that the respondents can understand and agree with the competency items for the construct.
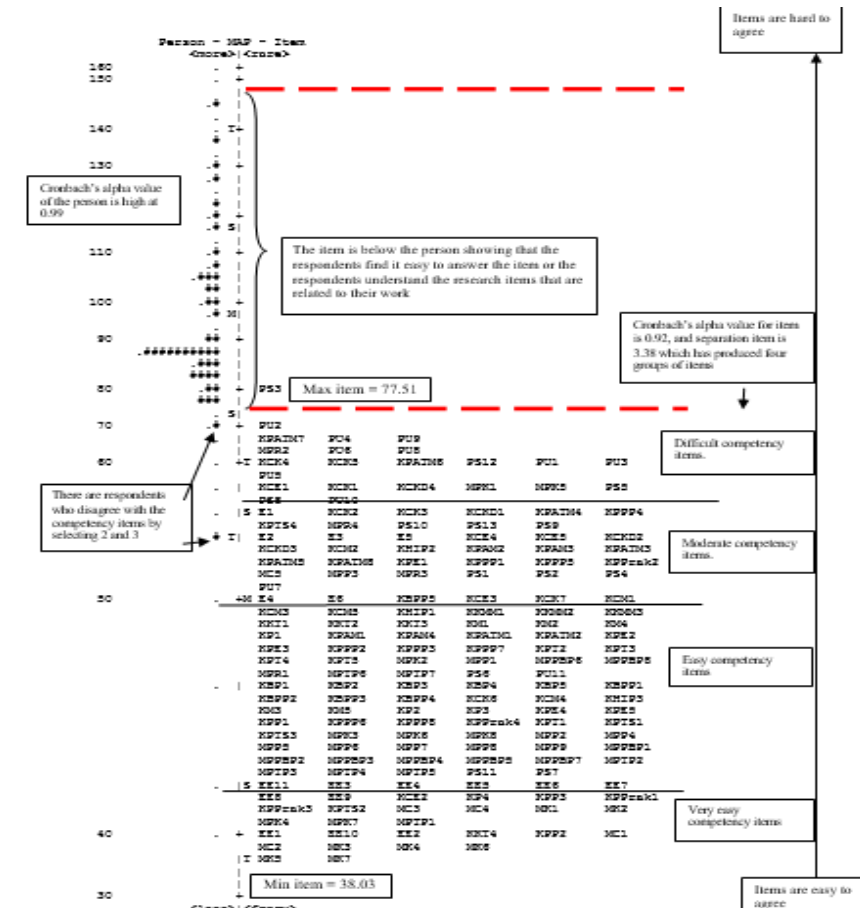
Fig. 1. Item person distribution map.

4.3. Item fit statistics

For the items in fit statistics, Azrilah [28] recommended criteria to check for any outliers or misfits data: 1) Point Measure Correlation: (Pt-Mea Corr); $0.4 <$ PT-Mea Corr value < 0.85; 2) Point Measure Correlation (PT-Mea Corr) is positive value (3) Outfit Mean Square (MNSQ): $0.5 <$ Outfit MNSQ value < 1.5; and (4) Outfit Z-Standard (Z-Std); $-2 <$ Outfit Z-Std value $<+2$. If the items do not meet the above criteria, they can be discarded due to poor quality fit. A misfit item is identified if all of the values are not within the acceptable region. This study used the range of $0.6<$ Outfit MNSQ value < 1.4 because the acceptable range of the item fit for the Likert scale (polytomous) is between 0.6 logits to 1.4 logits [29]. In this study, all the point measure correlation values have a positive value, indicating that all the items are behaving as expected. However, there are 141 items that are considered fit except 34 items that have misfit criteria and they are discarded. This study discarded the items that did not meet the three criteria of measurement (The values of PT-Measure Correlation, MNSQ Outfit, and Z-Std are not within the range as follows: 0.4 to 0.85 for PT-Mea Corr value; 0.6 to 1.4 for Outfit MNSQ; and +-2 for Outfit Z-Std value).

4.4. Item dimensionality test

The Rasch model measurement requires 40% as the indicator of uni-dimensionality and suggested the variance value explained by first contrast (size) <3% as excellent, 3 to 5% as very good, 5 to 10% as good, 10 to 15% as moderate, and 15% as poor [30]. Table 2 shows that the modelled variance is 51.2% and the unexplained variance is measured at 4.2%, which is very good as proposed by [30].

Table 2. Item dimensionality test.

			Empirical		Modelled
Total raw variance in observations	=	368.9	100.0%		100.0%
Raw variance explained by measures	=	188.9	51.2%		51.1%
Raw variance explained by persons	=	154.1	41.8%		41.7%
Raw variance explained by items	=	34.8	9.4%		9.4%
Raw unexplained variance (total)	=	180.0	48.8%	100.0%	48.9%
Unexplained variance in 1st contrast	=	15.5	4.2%	8.6%	
Unexplained variance in 2nd contrast	=	11.0	3.0%	6.1%	
Unexplained variance in 3rd contrast	=	8.9	2.4%	4.9%	

The next step is to examine the item redundancy through item pairs. This study has ten item pairs with high correlation through item pairs as shown in Table 3. Linacre [31] mentioned that the correlation value between two items should not be ≥ 0.7. In this study, six items are kept for the post-testing of competency items. Although the correlated items are in the same construct, the competency question is different from each other. The items need to be improved in regarding the text order for post-test purposes. This study discarded ten items.

Table 3. Possible multi-collinearity through item pairs.

Correlation	Entry Number	Item	Entry Number	Item
0.81	116	KPTS1	117	KPTS2
0.79	1	PS1	2	PS2
0.75	164	KCK1	166	KCK3
0.74	117	KPTS2	118	KPTS3
0.74	141	EE5	142	EE6
0.73	138	EE2	139	EE3
0.72	141	EE5	144	EE8
0.72	148	MK1	149	MK2
0.72	142	EE6	144	EE8
0.69	72	MPPBP3	73	MPPBP4

5. Conclusion

The Rasch measurement model identifies the misfit questions and tests the validity and reliability of the questions. The Winstep analysis revealed that the recorded item reliability index were quite high. It is considered that the instruments for the vocational teachers are reliable and valid for the actual study. A total of 40 items were dismissed and there were 140 valid items in the pilot test to determine the competency of vocational teachers. Therefore, the items for the competency model of vocational teachers are relevant with 140 items for technical domains, pedagogy domains, and attitude domains.

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