Innovation Using Rasch Model Approach in Measuring Multiple Intelligences

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Abstract - Multiple Intelligences are important for public university students in Malaysia to know their level of intelligent. To know their level of the intelligent the students need to assess them by using self assessment. They need an instrument that is valid and reliable to use in the context of Malaysian higher education institution. The aim of this paper is to develop a self assessment instrument that is valid and reliable by using Rasch Model analysis. The instrument consists of nine domains verbal linguistic (VL), spiritual (KR), interpersonal (IE), music (MZ), logic mathematic (LM), intrapersonal (IA), visual spatial (VR), naturalistic (NA) and body kinesthetic (KB). The first version had 81 items and after the WINSTEP analysis, the final version consisted of 70 items. The first version was tested using online electronic Multiple Intelligences instruments (e-MI) on 1036 university students from various faculties from one of the university in Malaysia. Every sub construct has 9 items. Since the number of items has been reduced from 81 to 70 items, the time taken to answer the instrument has been decreased. The 70 items of the instrument is considered as the second version of the self assessment instrument of Multiple Intelligences.

Keywords - Multiple intelligences; construct validity; online; psychometric testing; Rasch; validity; reliability

1 Introduction

There are various interpretations of intelligence that have been studied such as the ability to learn or understand from experiences, the ability to receive and store knowledge, mental ability to respond quickly and successfully in new situations and the mental capacity to analyze a given situation [6][14] [23].

There are various theories about intelligence that are along the lines of the theory of multiple intelligences. The theory was first proposed by Gardner [6] in his book Frames of Mind: The Theory of Multiple Intelligences. He found seven types of intelligences that sometimes work simultaneously. They are the verbal-linguistic intelligence, logical-mathematical intelligence, visual-spatial intelligence, kinesthetic intelligence, musical intelligence, interpersonal intelligence, and intrapersonal intelligence; to which naturalistic intelligence and spiritual intelligence were subsequently added. In his recent work Gardner [7] also considered intelligence as "raw, biological potentials, which can be seen in its pure form only in individuals who are, in the technical sense, freaks."

1.1 Multiple intelligences measurement

Academic achievement is related to multiple intelligences [23]. It is a bio-psychological potential to process certain types of information in a specific way to produce something meaningful in a community [6]. However, different individuals have different and distinctive multiple intelligences. Many researchers have begun to explore the relationship between multiple intelligences and the academic performance of students. Gardner's multiple intelligences theory [6] emphasized the diversity of students. Hence, various instruments have been developed to identify and measure intelligences. Multiple intelligences measurement models have long been developed by researchers in other

countries to evaluate the relationship between intelligence and achievement of students [11] .

IQ tests have always been regarded as the best benchmark to categorize and place students into various fields. Studies have shown that IQ is one's intelligence in language, logical thinking, and calculations. Gardner [6] removed the definition of the traditional intelligence and intelligence test from the public and education which have consisted of the language and mathematical intelligences only. He made society recognize the abilities of musicians, fashion designers, farmers, athletes, weavers and also religious leaders as intelligence. The reason being is that they meet the definition of intelligence as the ability to solve problems and produce valuable products in their socio-cultural context. Moreover, their intelligences become the source of income that meet the needs and demands of their lives.

Klein [9] suggested that teachers should increase their knowledge and strategies to identify students' intelligences in problem-solving and other tasks. This would enhance the effectiveness and appropriateness of implementing the multiple intelligences theory in the classroom. Therefore, schools would need a valid and reliable tool or instrument for assessing students' multiple intelligences and to consolidate their preferences in choosing the appropriate tools [19] .

Previous studies have shown that very few multiple intelligences measurement instruments were tested for validity. The constructs that make up this multiple intelligence measurement model need to be ensured that they contain items of high validity and reliability [20] . Construct validity includes content relevance, representativeness, and criterion-relatedness. Therefore, this study is necessary to develop a multiple intelligences measurement as an online instrument that would thoroughly measure the multiple intelligences constructs and to help individuals identify their multiple intelligences ability.

The instrument used in this study is the first online culture-fair instrument built to suit the local context in assessing the perception and the preferences of respondents in Malaysia against their own multiple intelligences [19]. Data and findings of this study will provide a predictive representation of students' multiple intelligences in general and particularly by their gender and field of study.

2 Problem Formulation

The online version of the electronic Multiple Intelligences Instrument (e-MI) contains 81 perception items of five-point Likert scale that represent nine different intelligence domains. It applies a quantitative approach which involves the collection of data using an electronic questionnaire that is run online. Advantages of computer-based assessment include automated and rater-free scoring, immediate feedback, and is easily accessible. Benefits associated with educational assessment include the ability to process detailed data and the potential to build tasks that assess skills that cannot be easily done by other means of assessment [25] . The remarkable advantage of internet is the effortless access to information that has led to a new, fast and handy range of tools and capabilities for innumerable fields of activity [4].

The study was conducted using a quantitative survey approach. The population of the study is from one of the university in Malaysia undergraduate students. The sample was clustered according to the faculty. It consisted of 1036 students, 291 males and 745 female. The respondents' age ranged from 18 to 20 years old. The data was analyzed using Winsteps version 3.68.2, a Rasch-based item analysis program. Mapping method of difficulty item to respondent ability is used to clearly demonstrate arrangement of difficulty level for those matched items with personal distribution of capabilities on a logits scale.

3 Results

Table 1 shows the responses from each faculty: gender, race, and stream. The number of female respondents are 745 (72%) where as males are 291 (28%). The total of Malay students are 747 (72.2%), Chinese 223 (21.5%), Indian 50 (4.8%) and others 16 (1.5%). Science and non-science students are the respondents in this study. The number of

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non Science students are 399 (33.2%) where as science students are 637 (66.8%).

Table 1. Profile of Respondents

Demography Factor	N	Factor	Frequency	Percentage
Gender	1036	Male	291	28.0
		Female	745	72.0
Race	1036	Malay	747	72.2
		Chinese	223	21.5
		Indian	50	4.8
		Others	16	1.5
Streams	1036	Science	637	33.2
		Non Science	399	66.8

The data was analyzed using Winsteps version 3.68.2 to determine the validity and reliability of the e-MI. Rasch Model analysis provided item reliability and construct validity.

Table 2 shows reliability index personals which is 0.95. Person reliability interpretation is equivalent with Alpha Cronbach or KR20 [22] . Person reliability index of 0.95 is an acceptable value [16] to expect consistency level of person arrangement on the log scale if this sample is to answer different set of items but measures the same construct [21]. Person Separation index value of 4.19 means there are 4 levels of respondent ability identified in this study. This value shows high reliability of sample, which is 0.95 [21].

Table 2 . Person Reliability : Multiple Intelligences

Summary of 1036 Measured Persons

	RAW			MODEL		INFIT		OUTFIT
	SCORE	COUNT	MEASURE	ERROR	MNSQ	ZSTD	MNSQ	ZSTD
MEAN	306.9	81.0	.94	.15	1.03	-.2	1.02	-.3
S.D.	29.8	.0	.77	.05	.52	2.8	.54	2.7
MAX.	404.0	81.0	6.69	1.00	3.37	8.8	7.18	8.2
MIN.	185.0	81.0	-1.15	.12	.21	-6.9	.23	-6.7

REAL RMSE .18 ADJ.SD .74 SEPARATION 4.19 PERSON RELIABILITY .95
MODEL RMSE .16 ADJ.SD .75 SEPARATION 4.65 PERSON RELIABILITY .96
S.E. OF PERSON MEAN = .02

Table 3 shows item reliability index which is 0.99. Reliability value 0.99 is high because it is approaching 1.0 [21]. This means recurrence expectation position of e-MI skills item will be high if this set item was answered by other sample group with similar ability [21]. Separation value of item is 14.09, which means multiple intelligences items in this scale can be statistically differentiated to 14 levels of difficulty.

Table 3.Item Reliability : Multiple Intelligence

SUMMARY OF 81 MEASURED (NON-EXTREME) ITEMS

	RAW		MODEL		INFIT		OUTFIT	
	SCORE	COUNT	MEASURE	ERROR	MNSQ	ZSTD	MNSQ	ZSTD
MEAN	3929.4	1036.0	.00	.04	1.00	-.1	1.02	.3
S.D.	458.4	.0	.63	.01	.10	2.1	.14	2.6
MAX.	4737.0	1036.0	1.25	.06	1.35	8.2	1.58	9.9
MIN.	2898.0	1036.0	-1.18	.03	.85	-3.2	.83	-3.4

REAL RMSE .04 ADJ.SD .63 SEPARATION 14.09 ITEM RELIABILITY .99
MODEL RMSE .04 ADJ.SD .63 SEPARATION 14.29 ITEM RELIABILITY 1.00
S.E. OF ITEM MEAN = .07

Figure 1 shows a hierarchy of person ability and item difficulty in a straight line. It is found that all items are scattered and heading towards various level sample ability. Person position with high ability (very much agreeable) stays at the top scale while person with low ability (less agreeable) stays in the lower part of the scale. The most difficult item (NA item no 3) stays at the top scale while simplest item (KR item no 8) stays in the lower part of the scale. Difficult items were able to be answered by only highly capable persons. Easy items were also able to be answered by persons with high and low ability. Items overlap exist (example IA item no 8,IE item no 2, KB item no 6, LM item no 5, LM item no 6, MZ item no 4,NA item no 7 and NA item no 8) which show items stated at several difficulty levels, which are almost identical [5] .Items that are over lapped also found to measure themes that are different in Multiple Intelligences.

The most difficult item endorsed by respondent is NA item no 3 measuring 1.25 followed by KB item no 8, NA item no 1, NA item no 2, VR item no 3, KB item no 3, NA item no 6, . Item KR item no 8 is the easiest item endorsed by respondents because it has the lowest difficulty level [5]. It is found that each item in the Multiple Intelligences instrument has different difficulty level in order to differentiate Multiple Intelligences level among students.

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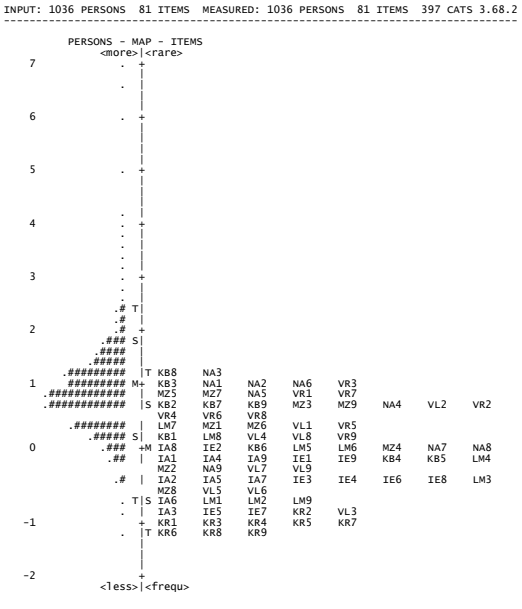

Fig.1 . Mapping Difficulty Item - Respondent Ability In Multiple Intelligences

Table 4 displays clearly difficulty level of each item in the Multiple Intelligences instrument . The most difficult item endorsed by respondent is NA item no 3 measuring 1.25 followed by KB item no 8, NA item no 1, NA item no 2, VR item no 3, KB item no 3, NA item no 6 . Item KR item no 8 is the easiest item endorsed by respondents because it has the lowest difficulty level [5]. It is found that each item in the Multiple Intelligences instrument has different difficulty level in order to differentiate Multiple Intelligences level among students.

Table 4: Item Distribution According to Level of Difficulty in Multiple Intelligences

ENTRY NUMBER	TOTAL SCORE	COUNT	MEASURE	MODEL| S.E.	INFIT |MNSQ	ZSTD	OUTFIT |MNSQ	ZSTD	PT-MEASURE |CORR.	EXP	ITEM
66	2898	1036	1.25	.04	1.03	.7	1.03	.8	.49	.51	NA3
80	3039	1036	1.11	.03	1.08	2.0	1.14	3.2	.46	.51	KB8
64	3137	1036	1.07	.03	1.12	2.8	1.15	3.5	.42	.49	NA1
65	3163	1036	1.02	.04	.98	-.5	.99	-.3	.50	.48	NA2
57	3125	1036	1.01	.04	1.01	.2	1.03	.8	.48	.49	VR3
75	3090	1036	1.00	.03	1.23	5.6	1.32	7.0	.39	.51	KB3
69	3280	1036	.91	.04	.95	-1.2	.95	-1.0	.51	.47	NA6
68	3273	1036	.88	.04	.97	-.6	.98	-.4	.49	.48	NA5
55	3382	1036	.80	.04	.98	-.5	1.00	-.1	.46	.45	VR1
34	3298	1036	.80	.03	1.35	8.2	1.58	9.9	.33	.50	MZ7
61	3350	1036	.78	.04	.91	-1.9	.91	-1.9	.51	.47	VR7
32	3346	1036	.77	.04	1.04	.9	1.06	1.3	.45	.48	MZ5
2	3401	1036	.69	.03	1.10	2.4	1.15	3.3	.43	.49	VL2
30	3495	1036	.67	.03	1.07	1.7	1.14	2.9	.42	.47	MZ3
79	3403	1036	.66	.03	.97	-.8	.97	-.7	.49	.48	KB7
67	3564	1036	.62	.04	.93	-1.6	.95	-1.1	.49	.44	NA4
56	3457	1036	.60	.04	1.09	2.1	1.15	3.2	.41	.47	VR2
36	3501	1036	.59	.03	.98	-.4	.99	-.2	.48	.47	MZ9
62	3568	1036	.57	.04	.95	-1.2	.95	-1.0	.47	.45	VR8
60	3537	1036	.56	.04	.86	-3.2	.86	-3.1	.54	.45	VR6
58	3538	1036	.53	.04	.96	-.8	.97	-.6	.47	.45	VR4
81	3587	1036	.51	.04	.87	-3.1	.88	-2.7	.53	.46	KB9
Showed just upper and lower data											
6	4185	1036	-.33	.05	1.02	.3	1.08	1.4	.36	.37	VL6
35	4351	1036	-.38	.04	1.06	1.0	1.07	1.2	.32	.36	MZ8
24	4317	1036	-.42	.05	.92	-1.6	.90	-1.9	.42	.35	IE6
39	4327	1036	-.43	.05	1.17	3.0	1.22	3.6	.23	.36	LM3
50	4128	1036	-.45	.05	.90	-2.1	.89	-2.1	.47	.38	IA5
47	4310	1036	-.46	.05	.95	-1.0	.95	-1.0	.40	.35	IA2
26	4118	1036	-.46	.05	.90	-2.2	.92	-1.6	.46	.38	IE8
21	4069	1036	-.47	.05	.88	-2.4	.88	-2.5	.48	.38	IE3
38	4480	1036	-.57	.05	1.14	2.2	1.18	2.9	.23	.34	LM2
45	4520	1036	-.59	.05	1.08	1.2	1.17	2.6	.26	.33	LM9
51	4304	1036	-.63	.06	.91	-2.0	.90	-2.0	.44	.35	IA6
37	4569	1036	-.63	.05	1.16	2.4	1.29	4.1	.20	.33	LM1
3	4168	1036	-.73	.05	.99	-.2	.99	-.2	.37	.37	VL3
25	4216	1036	-.79	.05	.91	-1.8	.91	-1.7	.45	.36	IE7
48	4322	1036	-.87	.05	.95	-.8	.96	-.7	.39	.35	IA3
23	4314	1036	-.88	.05	.95	-.9	.96	-.8	.39	.36	IE5
11	4556	1036	-.89	.05	.98	-.4	.96	-.6	.34	.32	KR2
12	4566	1036	-.90	.05	.95	-.9	.94	-1.1	.36	.32	KR3
10	4662	1036	-.97	.05	1.00	.0	1.00	.0	.31	.31	KR1
16	4687	1036	-.99	.05	1.00	.0	.99	-.1	.30	.30	KR7
13	4737	1036	-1.02	.05	1.03	.5	1.04	.7	.26	.29	KR4
14	4553	1036	-1.06	.05	.97	-.6	.94	-1.0	.35	.32	KR5
15	4672	1036	-1.15	.06	.97	-.5	.92	-1.3	.33	.30	KR6
18	4675	1036	-1.15	.05	.96	-.7	.92	-1.2	.34	.30	KR9
17	4718	1036	-1.18	.05	1.00	.0	1.55	7.4	.28	.29	KR8
MEAN	3929.4	1036.0	.00	.04	1.00	-.1	1.02	.3			
S.D.	458.4	.0	.63	.01	.10	2.1	.14	2.6			

4. Discussion

Rasch's result of the analysis on e-MI construct discovered person reliability index value is 0.95. This finding showed that all e-MI constructs: The instrument consists of nine domains verbal linguistik , spiritual, interpersonal, music, logik matematik, intrapersonal, visual spatial, naturalistic, kinaesthetic body were having acceptable person reliability [21] scale if this sample answers different set of items but measure the same constructs [21] . Results of the analysis on item reliability also showed reliability value item to all nine constructs were high that is 0.99. This values show recurrence expectation in each order of e-MI construct items was high if the set item was answered by other sample group with same matching ability [21] [24].

Analysis of person strata number for e-MI revealed that there are 4 ability levels of respondents in this study. This finding proved that high person reliability, agrees with Smith [16] which states that separation index person of 2 and above shows higher reliability that is 0.80 and above. Based on item difficulty map, person ability can be clearly seen that the items are scattered nicely at the linear line heading towards targeted respondent. This finding is consistent with Bond & Fox [5] proposition of the criteria of higher reliability of an item.

5. Conclusions and Further works

This study identifies that some items could be dropped, refined and modified in order to increase construct's validity and reliability of the e-MI(electronic Multiple Intelligences Instrument). Statistical analysis that is in use in this study is Rasch Model. This study is important, especially in providing exposure to

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researchers, instrument builders and question developers in terms of validity and credibility and analytical method that were chosen. Researchers should ensure each items are unidimensional in nature, having different difficulty level and fair to every person who are taking these tests. Reliability of items and person should also be viewed seriously to ensure the instrument that is built and the sampling which has high consistency. Therefore, the instrument can produce meaningful measurement. From this study, the reliability and validity check on the instrument construct, 11 items from 81 should be dropped because they are not unidimensional and having different levels of difficulty. The study will extend into Differential Item Functioning analysis to drop item bias base on gender, race and stream.

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