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Construct Validation for Academic Application in Higher Education Institution (HEI) with Rasch Model

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ABSTRACT

The applications of Rasch measurement model has rapidly extended from educational fields to other technology and engineering field as well. Rasch Model has been used in evaluating construct validity of the web-based integrated student assessment application (WBISA) or commonly known as iCGPA application. WBISA is-administered on a sample of 65 academicians in higher education institutions using clustering sampling. A survey consists of multiple items for several respective main categories is used to collect data. However, there is a need to perform validation and reliability tests for the survey. Items were classified into several constructs, namely 1. Usability (consists of twelve items for example, “The application is easy to use”), 2. Reliability (consists of seven items such as “The information display shows the accurate information when referred or linked.”), 3. Efficiency consists of three items such as “The time taken to complete the tasks is reasonable.”), 4.Functionality (consists of six item such as “The functionality provided fits and needed by the users”.), 5. Supportability (consists of twelve items such as “There is a glossary for acronym used in the system.”), 6.Availability (consists of six items such as “The system is always up and available 24x7”.), 7.Security (consists of six items such as “There is a report if there is a security break-in while using the system.”), and 8 Integrity (consists of ten items such as “The data can only be accessed by authorized user.”). Analyses have been done to each of the items developed to obtained construct validity.

Key words: quality model, web-based application, Rasch analysis, construct validation

1. INTRODUCTION

According to [1],Public Institutions (PIs) have been nominated to be pilot for this iCGPA initiative. The five PIs are UKM, UMP, UiTM, UMK and UMT. Each of the PIs has individually developed an in-house integrated assessment system. Based on the Ministry of Higher Education (MOHE), twenty(20) public institutions implement their own assessment practices. These institutions are categorized based on three categories, namely Research University (RU), Comprehensive University (CU) and Focused University (FU). Each category has its own unique characteristics.

RU has the following characteristics:-

a) Fields of Study is on research Competitive entries
b) Quality lecturers
c) Ratio of undergraduates to postgraduates is 50:50

CU has the following characteristics:-

a) Various fields of study
b) Competitive entries
c) Quality lecturers
d) Ratio of undergraduate to postgraduates is 70:30

FU has the following characteristics:-

a) Fields of Study : Focus on research Competitive entries
b) Quality lecturers
c) Ratio of undergraduates to postgraduates is 50:50

There are 5 research universities, namely UKM, UM, UTM, UPM and USM, but only one university implements iCGPA at present. For comprehensive University (CU) category, the list includes UiTM, UIA, UNIMAS and UMS. For this category, UiTM is chosen to implement iCGPA. Lastly for (Focused University (FU), there are nine universities belongs to this category and three are selected to implement iCGPA which are UMP, UMK and UMT. A pilot study has been conducted and presented by [2]. This paper discusses results of a main study in accessing construct validation process using Rasch model.

2. METHODOLOGY

Web application served as vital medium for academician in accessing information and perform daily task in campus environment. Several programming languages could be used such as PHP and MySQL[3]. [4]stated that digital application or electronic application has been choosing as preferred application compared traditional or manual process among higher institution. WBISA administered on a sample of 65 academicians in public institutions in Malaysia. Items were quantitatively examined using WINSTEP[5]. The final survey is conducted on five public institutions which implement web-based integrated student assessment application (iCGPA). A survey has been developed to measure eight constructs, namely i) Usability ii) Reliability iii) Efficiency iv) Functionality v) Supportability vi) Availability vii) Security viii) Integrity.

2.1 Survey Development

Eight constructs were identified through preliminary study based on previous literature and interview with targeted respondent. [6] discussed the steps in determining the constructs. The constructs are identified by integrating web-based quality element and quality attribute in software engineering.

According to [7][8] there are several methodologies could be used, quantitative, qualitative or mix-method depends. Strategies of inquiry are associated with the research approach. Whether it is a quantitative, qualitative or mixed methods approach, it is a strategy that the researcher needs to be firm about.

Survey form used in the research consists of 62 items and divided in two sections. Section A consists of demographic questions and Section B consists of used likert scale 4 points (Strongly-Disagree, Disagree, Agree and Strongly-Agree). A likert scale as mentioned [9] is normally used to collect attitude data. Likert scales share a number of common features nevertheless of which attitudes they assess and with possible response and are expressed seldom in format such as SD (Strongly Agree), D(Disagree), N(Neutral), A(Agree) , and SA(Strongly Agree).

2.2 RASCH Model

Rasch model analysis has been widely used in the development and validation of research instrument. Rasch Model is used to analyse data. Application of the Rasch model through software such as Winstep [10] and other Rasch software be responsible for estimates of person and threshold locations on the latent variable scale. The software also yields indices of item and person fit to show that the requirement of unidimensionality is met. Rasch answer on by what method to have the right measurement with valid instrument. Instrument is extremely crucial if involve human life.

The normal solution is to apply the regression approach. It shows the best fit line that inline with the points as best as possible. Then, it can be used to make compulsory predictions by interpolation or extrapolation as necessary as shown in Figure 2.

$$y = \beta_0 + lm \quad (1)$$

In obtaining the best fit line, there exist differences between the actual point; y and the best line, the predicted point; ý. The difference is referred to as error; e.

$$yi - \acute{y}i = ei \quad (2)$$

According to [11], by accepting the fact that there is always error involved in the prediction model, the deterministic model of equation: 1) can be transformed into probabilistic model by including the prediction error into the equation; Equation 3) Rasch moves the concept of reliability from establishing "best fit line" of the data into producing reliable repeatable measurement instrument. Rasch focuses on creating the measurement instrument rather than fitting the data to suit the measurement model.

$$y = \beta_0 + \beta_1 m + e \quad (3)$$

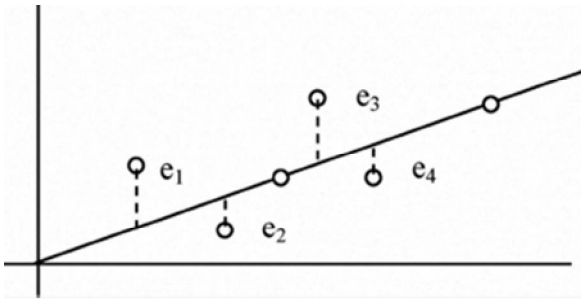

Figure 1: Best fit line: Linear Regression Model

3. RESULTS

3.1 Summary of Fit Statistics

This section will describe on how RASCH can be used to validate the construct validity. According to [12], applying Rasch model to perform validation process enable to measure item fit in the research conducted.

All sixty five respondents and sixty two items in the survey questionnaires were used in main study. The column labeled as "MEASURE" shows the difficulty estimates for the items.

"MODEL S. E.", shows the standard error of the item difficulty measures. Mean square "MNSQ" is provided for "OUTFIT" and "INFIT" columns. Outfit and infit mean-square values in the range of 0.60 to 1.40 [10], [13] are considered productive for measurement in rating scales.

A summary of the test data for fit statistics is presented in the Table 1. The general statistics in Table 1 shows that three thousand zero six data points were resulted and accumulated from thirty people and sixty two items. The value of Chi-Square X2 is 5849.46. In order to know if all the questionnaires were answered by the respondents, the reliability of Cronbach's Alpha(α) [14] was assessed. The value of Cronbach Alpha(α) is at 0.971 which was an excellent value.

The item reliability is (0.89) and person reliability is (0.97) as showed in Table 1. This indicates high reliability. If targeting < 1 error, then it is good targeting based on rating scale instrument quality criteria. So, the instrument is on target and showed a "Good" reliability[15] for both item and person reliability.

Table 1: Summary Fit Statistics

Persons	**65 Input**			**INFIT**		**OUTFIT**	
	Score	Count	Measure	MNSQ	Z-STD	MNSQ	Z-STD
Mean	176.7	62	**1.00**	**1.00**	**-0.3**	**0.99**	**-0.4**
S.D	24.2	0.0	1.74	**0.47**	2.5	**0.47**	2.5
Model Error : 0.25 (good)							
Separation : 5.78 (excellent)							
Person Reliability : 0.97 (excellent)							
Items	**62 Input**			**INFIT**		**OUTFIT**	
	Score	Count	Measure	MNSQ	ZSTD	MNSQ	ZSTD
Mean	179.5	63.0	**0.00**	**0.24**	**-0.1**	**0.99**	**-0.1**
S.D	13.5	0.0	0.77	**0.30**	1.5	**0.35**	15
Model Error : 0.24 (good)							
Separation : 2.87 (fair)							
Item Reliability : 0.89 (fair)							

UMEAN=.000 USCALE=1.000
Item RAW SCORE-TO-MEASURE CORRELATION = -1.00
3906 DATA POINTS. APPROXIMATE LOG-LIKELIHOOD
CHI-SQUARE: 5849.46

The 0.97 logit person reliability means that there are sufficient items to separate people with different abilities. The Rasch reliability coefficient might considered to be 'fair' to 'good' in terms of "yielding reliable distinctions"([16]). These people have excellent reliability and can be separated into six (5.78) groups or strata accordingly. The value of model error for Person fit statistic is 0.25 logits and for the item is 0.24 logits.

The misfit patterns to be considered focused on the five columns below:

i) Point Measure Correlation (PtMea Corr) :
0.4<PtMea Corr Value<0.85
ii) Infit mean square (MNSQ) : 0.5<MNSQ value <1.5
iii) Infit Z-standard(ZSTD) :-2<ZSTD value<+2
iv) Outfit mean square (MNSQ) : 0.5<MNSQ value<1.5
v) Outfit Z-standard (ZSTD):-2<ZSTDlue<+2

3.2 Point Measure Correlation

The column 'PTMEA Correlation' shown in Appendix A shows most of the items as having value between 0.3 and 0.7. All correlations should be positively and they should not be near zero [17]. Negatives values on the items indicate the item was measured in reverse pattern. The negative vales or reverse items can lead to a wrong interpretation of meaning by the respondent. Each items in construct A have an acceptable values for Infit MNSQ and Z-STD.

3.3 Category Statistics

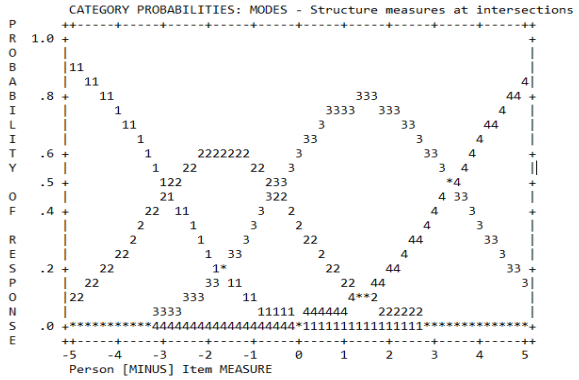

Figure 2: Category Probablities

The rating scale is an important element in measurement system and data validation. The purpose is to determine either the data collected is valid to analyzed and processed. The pattern of probabilities is consistent for each person and item which showed that the rating is good. Figure 1 above depicts the rating scale was collapsed into a scale ("1234") which shown a good response.

3.4 Principal Component Analysis

Figure 3 below shown raw variance explained by measures achieved by 65.1% compare to Rasch model which is 50.5%. This value can be considered accepted which is more than 40%. This situation occur because there is noise item in the questionnaire. The noise level calculate is 5.1% and can be accepted from maximum value which is 15%. Table 3 shown which item caused the noise occur.

STANDARDIZED RESIDUAL VARIANCE SCREE PLOT

Table of STANDARDIZED RESIDUAL variance (in Eigenvalue units)

		Empirical		Modeled
Total variance in observations =	177.9	100.0%		100.0%
Variance explained by measures =	115.9	**65.1%**		**64.9%**
Unexplained variance (total) =	62	34.9%	100.0%	35.1%
Unexplned variance in 1st contrast =	9	**5.1%**	14.5%	
Unexplned variance in 2nd contrast =	6.9	3.9%	11.2%	
Unexplned variance in 3rd contrast =	4.6	2.6%	7.4%	
Unexplned variance in 4th contrast =	4.3	2.4%	7.0%	
Unexplned variance in 5th contrast =	3.8	2.1%	6.1%	

Figure 3: **Contrast 1 - Component Principal Analysis**

Table 3 describes an item which caused the noise item. There is only one item which has residual correlation more than 0.7. This shown that the respondent see the two items which is Item Ib (Integrity – question (b)) and Item Ic (Integrity – question (c)) as same and confusing.

Table 3: Largest Standardized Residual Correlation Used to Identify Dependent

Correlation	Entry Number	Item	Entry Number	Item
0.93	**54**	**Ib**	**55**	**Ic**
0.70	53	Ia	54	Ib
0.69	13	Ra	14	Rb
0.68	49	Sec	60	Ih
0.66	56	Id	58	If
0.65	57	Ie	60	Ih
0.64	25	Fc	26	Fd
0.63	53	Ia	55	Ic
0.62	22	Ec	41	Aa
0.62	8	Uh	28	Ff

5. CONCLUSION

The research describes the result obtained from main study conducted to identify quality element of web-based application for academic domain. Future research will be conducted to develop a quality model using Partial Least Structural Equation Modeling (PLS-SEM).

APPENDIX

Refer Appendix A for item misfit and polarity.

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APPENDIX A

Item Misfit and Polarity

	Items	Infit		Outfit		PTMEA Correlation
		MNSQ	Z-STD	MNSQ	Z-STD	
Usability	Ua	0.83	-0.8	0.78	-0.9	0.66
	Ub	0.72	-1.5	0.67	-1.5	0.67
	Uc	0.8	-1.0	0.76	-1.0	0.66
	Ud	0.7	-1.7	0.62	-1.9	0.72
	Ue	0.96	-0.2	0.91	-0.4	0.68
	Uf	0.44	-3.3	0.36	-3.4	0.74
	Ug	0.97	-0.1	0.9	-0.5	0.70
	Uh	0.9	-0.5	1.53	2.2	0.43
	Ui	0.83	-0.7	0.82	-0.7	0.54
	Uj	1.16	0.9	1.57	2.4	0.39
	Uk	0.82	-1.1	0.89	-0.6	0.68
	Ul	0.55	-2.5	0.53	-2.3	0.71
Reliability	Ra	1.05	0.3	1.02	0.2	0.67
	Rb	1.11	0.7	1.06	0.4	0.65
	Rc	0.96	-0.1	0.95	-0.2	0.61
	Rd	1.29	1.5	1.29	1.4	0.58
	Re	0.91	-0.4	0.89	-0.5	0.69
	Rf	1.02	0.2	0.95	-0.1	0.54
	Rg	0.64	-1.8	0.62	-1.5	0.68
Efficiency	Ea	0.85	-0.8	0.84	-0.8	0.66
	Eb	1.2	1.1	1.19	1.0	0.63
	Ec	0.6	-2.6	0.56	-2.8	0.73
	Ea	0.85	-0.8	0.84	-0.8	0.66
Functionality	Fa	0.95	-0.2	0.93	-0.3	0.71
	Fb	0.62	-2.1	0.56	-2.2	0.74
	Fc	0.8	-1.0	0.74	-1.1	0.67
	Fd	0.65	-1.9	0.63	-1.8	0.69
	Fe	0.56	-2.4	0.53	-2.3	0.71
	Ff	1.33	1.5	2.13	3.7	0.29
Supportability	Sa	0.98	0	1.04	0.3	0.64
	Sb	1.64	2.9	1.73	3.0	0.46
	Sc	1.2	1.1	1.18	0.9	0.60
	Sd	1.24	1.4	1.17	1.0	0.62
	Se	0.91	-0.5	0.97	-0.1	0.69
	Sf	1.03	0.2	0.98	0.0	0.58
	Sg	0.86	-0.6	0.85	-0.5	0.53
	Sh	0.88	-0.5	0.83	-0.7	0.68
	Si	1.18	1.0	1.19	1.0	0.64
	Sj	0.85	-0.9	0.83	-1.0	0.72
	Sk	1.17	1.1	1.15	0.9	0.65
	Sl	1.44	2.4	1.45	2.4	0.59
	lg	1.92	3.9	1.85	3.4	0.41
	lh	0.73	-1.3	0.69	-1.1	0.64
	li	1.04	0.3	0.98	0.0	0.54
	lj	1.41	2.0	1.3	1.4	0.53

Availability	**Aa**	**0.98**	**0.0**	**0.91**	**-0.4**	**0.67**
	Ab	0.66	-2.2	0.66	-2.0	0.73
	Ac	0.73	-1.5	0.69	-1.6	0.72
Security	Sea	1.04	0.3	1.12	0.5	0.56
	Seb	0.75	-1.2	0.69	-1.4	0.66
	Sec	0.92	-0.3	0.88	-0.3	0.56
	Sed	0.90	-0.5	0.85	-0.7	0.69
	See	1.91	3.6	1.83	2.9	0.52
	Sef	1.08	0.5	1.07	0.5	0.72
Integrity	Ia	1.14	0.7	1.08	0.4	0.60
	Ib	0.91	-0.4	0.85	-0.5	0.64
	Ic	0.83	-0.8	0.77	-0.7	0.64
	Id	1.14	0.7	1.11	0.5	0.60
	Ie	0.7	-1.5	0.64	-1.2	0.59
	If	1.07	0.4	1.02	0.2	0.64