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Utilization of Rasch Measurement Model in Evaluating Reliability, Validity and Quality of Examination Questions: A Case Study of Information Technology Fundamentals Course

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ABSTRACT

In most of the higher universities and institutions in the Kingdom of Saudi Arabia, final examination been used as an assessment tool to measure students' academic performance. A good reliability, validity and quality of a set of constructed on final exam's questions would be able to measure both students' academic performance and their cognitive skills. Rasch Measurement Model been used to evaluate the reliability, validity and quality of the final exam questions for the Information Technology Fundamentals (IT280) course. The analysis indicated that the quality and reliability, validity and quality of the final exam questions constructed were relatively good.

Keywords: Final exam, Item Analysis, Item Difficulty, Person Fit, Quality, Rasch Measurement Model, Reliability

1. INTRODUCTION

Information Technology Fundamentals (IT280) course is intended to be at the introductory level and to provide foundation skills for subsequent courses. It provides an overview of the discipline of IT, describes how it relates to other computing disciplines, and begins to install an IT mindset. The goal is to help students understand the diverse contexts in which IT is used and the challenges inherent in the diffusion of innovative technology [1].

College of Computer and Information Sciences (CCIS) at Al Imam Mohammad Ibn Saud Islamic University (IMSIU) is towards complying with the American Accreditation Board of Engineering and Technology, 2000 (ABET) requirements, which promote OBE learning process. One of the ABET criteria is to measure the quality of student performance. In CCIS, student performance measurement has been dependent on the students' overall performance in sporting out obligations inclusive of final examinations, mid examinations, quizzes, class assignments, lab contributions and class projects.

Validity is considered by many to be one of the utmost importance for any effective assessment. There have been many definitions of what validation of a test entails. For some, a valid test is simply one which measures what it was designed to measure [2]. This is perhaps the most well known definition and since its introduction in the early twentieth century, various alternatives have been presented. Examination item is an important instrument to reflect students' achievement and differentiate proficient students from the amateur. The scarcity of guideline on testing the reliability and validity of examination item needs to be addressed to ensure a systematic method in assessing students' ability [3].

More recently, in a revolutionary article, argued for the concept of construct validity. He described construct validity as the evaluation of the appropriateness of interpretations and usage of the results of the assessment, based on the support from empirical evidence and theory [4]. There are six facets in [4] definition of construct validity: content,

substantive, structural, generalizability, external and consequential.

Rasch Measurement Model is a mathematical analysis of data categories such as a question response [5, 6]. In this study, Rasch is used to measure the reliability, validity and the quality of the IT280 final exam questions, IT280 final exam is consists of 35 sub-questions in order to cover the Course Learning Outcomes (CLOs) of this course. Reliability, validity and quality of assessment tools in learning and teaching is essential in order to measure the students' ability and understanding. Therefore, the final examination question of IT280 course was taken in consideration in the assessment tool. The questions were constructed based on students' ability and understanding, level of questions' difficulty and Bloom's cognitive thinking skills. The quality of the questions is a part of the reliability and validity in which in measuring the level of degree of whether the questions covers the course content and its CLOs [7]. In CCIS, there no role of measuring reliability, validity and quality of any of exams' questions and only the course's instructors have measure its reliability and validity by using a four ways: (a) Difficulty value of each question (the students are able to understand the question or not). (b) Discriminative Value of each question (the question is relevant to the course or not), (c) Format (types of answers required) and (d) Spelling. Rasch Measurement Model has been utilized to measure the reliability, validity and quality of some courses [8-12]. Since different researches applied but it has not been applying in IT courses.

The main goal of this study is to evaluate the reliability, validity and quality of final examination questions for IT280 course by utilizing Rasch Measurement Model. The evaluation process is check whether the constructed questions calibrate with students' learning abilities and the course contents or not. It is part of the study to enrich and improve students' cognitive thinking skills and ability in developing IT application.

2. METHODOLOGY

The data that was obtained from the final examination of IT280 course, which was conducted for the second year Information Technology students at CCIS, IMSIU in the second semester 2015/-2016. This study was conducted for all 69 students who have registered for the course. The final examination consists of 35 questions which was divided into seven questions: (Q01, Q02...Q07). Students are required to answers all questions. The course became chosen due to the fact it's miles a obligatory and main course for all second year students within the department. besides, the students' knowhow toward the direction may be very important given that most of the students may be involved within the training program at the end of their third year studies. therefore, students need to pass this course in prior to the training. The Course Learning Outcomes (CLOs) for IT280 course is tabulated in Table 1.

Table 1: IT280 CLOs

No	CLOs
CLO1	Understands the IT terminologies such as hardware, software, networks, database, computer ethics and security
CLO2	Developing the IT systems and applications
CLO3	Integrating the IT terminologies with each other
CLO4	IT products and services judgment
CLO5	Explore the IT jobs opportunities
CLO6	Techniques if utilization and explore the Internet and web services
CLO7	Examines the ethical issues that arise as a result of increasing use of computers, and responsibilities of those who work with computers, either as information technology professionals
CLO8	Describes operational issues, policies and procedures, attacks and defence mechanisms, risk analyses, recovery, and information security

The questions are entered as entry number as tabulated in Table 2. The item is labeled as Question No., and Taxonomy Bloom Level of Learning, which the students expected to develop three Level of Bloom's Taxonomy, namely Remembering/ Understanding (1), Applying/Analyzing (2), Evaluating/ Creating (3). Thus for entry item number 1, the item is coded as Q1.1 (as shown in Table 2).

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Table 2: Entry Number Coded for each Question

Question No	Sub-question No	Entry No	CLO	Type of question
Q01	1	Q1.1	CLO1	Multiple Choice Questions
	2	Q1.2	CLO3	
	3	Q1.3	CLO1	
	4	Q1.4	CLO6	
	5	Q1.5	CLO2	
	6	Q1.6	CLO8	
	7	Q1.7	CLO1	
	8	Q1.8	CLO6	
	9	Q1.9	CLO3	
	10	Q1.10	CLO7	
	11	Q1.11	CLO4	
	12	Q1.12	CLO8	
	13	Q1.13	CLO6	
	14	Q1.14	CLO2	
	15	Q1.15	CLO5	
Q02	1	Q2.1	CLO5	Fill in the blank with the right IT career
	2	Q2.2	CLO5	
	3	Q2.3	CLO5	
	4	Q2.4	CLO5	
	5	Q2.5	CLO5	
Q03	1	Q3.1	CLO4	True or False
	2	Q3.2	CLO7	
	3	Q3.3	CLO6	
	4	Q3.4	CLO1	
	5	Q3.5	CLO1	
Q04	1	Q4.1	CLO4	Open Question (IT products and services)
	2	Q4.2	CLO4	
Q05	1	Q5.1	CLO7	Case Study (Ethic and security)
	2	Q5.2	CLO7	
	3	Q5.3	CLO8	
Q06	1	Q6.1	CLO6	Open Question (Web services)
	2	Q6.2	CLO6	
Q07	1	Q7.1	CLO8	Classify (Science or Technology)
	2	Q7.2	CLO8	
	3	Q7.3	CLO8	

Rating from final exam results have been amassed and compiled. As those row rating have specific total marks for every query, a standardization method is used. The formula for the standardization is given under [10]:

$$zij = \frac{Xij \quad min}{xjmaxxj} \qquad (1)$$

Where i = the ith students (i = 1, 2, ..., 69), j = the jth questions (j = 1, 2, ..., 35), zij = standardized marks for ith student and jth question, xij = marks for ith student and jth question, min xj = minimum marks for jth question, and max xj = maximum marks for jth question.

Responses from the students' exam results were analyzed using rating scale in which the students were rated according to their achievement. From (1),

$$zij*10=A \qquad (2)$$

Then, A is classified correspond to the rating scale in Table 3.

Table 3: Rating Scale [10]

Marks (A)	0-1.49	1.50-3.49	3.50-6.49	6.50-8.49	8.50-10.00
Rating scale	1	2	3	4	5

The grade rating is tabulated and analyzed using Bond&Fox Steps, the Rasch Measurement Model software.

3. RESULTS AND DISCUSSIONS

The statistic summary for 35 IT280 final examination questions answered by 69 students on 35 items/questions scale are shown in Figure 1. The person's mean of +.72 (SE .17) is the first indicator that the students find this set of final

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exam questions comparatively easy. This means that they tend to answer all the questions correctly. The mean square fit (IMNSQ and OMNSQ) and the z statistic (INFIT ZSTD and OUTFIT ZSTD) are closer to their expected values, +1 and 0 respectively for items and persons. This shows satisfactory fit to the model. Moreover, the item reliability (Rasch equivalence to Cronbach's alpha) is .90 while person reliability is good at .89. The values of item and person reliability (> 2.34) do confirm that the instrument used for measuring the student learning ability for IT280 is reliable, reproducible, and valid for measurement.

	TOTAL SCORE	COUNT	MEASURE	MODEL S.E.	INFIT MNSQ	INFIT ZSTD	OUTFIT MNSQ	OUTFIT ZSTD
MEAN	378.9	63.0	-.01	.26	1.39	-.1	1.68	.1
P.SD	53.1	.0	1.97	.10	.94	1.2	1.29	.7
S.SD	53.1	.0	2.00	.10	.95	1.2	1.30	.7
MAX.	301.0	66.0	3.73	1.11	4.12	2.5	6.07	2.2
MIN.	93.0	18.0	-4.32	.82	.18	-1.5	.08	-.7
REAL RMSE	1.18 TRUE SD		1.58 SEPARATION	2.34 Item	RELIABILITY .89			
MODEL RMSE	1.01 TRUE SD		1.69 SEPARATION	3.67 Item	RELIABILITY .90			
S.E. OF Item MEAN = .08								

Figure 1 Statistic Summary

Figure 2 shows the items/questions statistics in Measure order. The Rasch fit statistics disclose that four items, Q1.4, Q3.1, and Q6.2 behaved more erratically than expected with an Outfit MNSQ value > 2.1. However, after confirming that the Infit MNSQ is within the range, it is accepted in this analysis. Other items fit sufficiently to the model, with their Infit and Outfit Mean-square values and Infit and Outfit Z-std values all lying within the acceptable range.

ENTRY NUMBER	DATA CODE	SCORE VALUE	DATA COUNT	%	ABILITY MEAN	P.SD	INFT MNSQ	OUTF MNSQ	PTMA CORR.	ITEM
1	4	3	69		.79	1.41	.8	1.56	.08	Q1.1
2	1	1	69		-1.85	.99	.8	1.0	.11	Q1.2
3	3	3	69		1.07	.80	.6	.4	.10	Q1.3
4	5	5	69		2.63	3.06	1.7	1.5	.56	Q1.4
5	6	6	69		3.25	.87	1.2	1.2	.44	Q1.5
6	7	7	69		4.63	.48	.7	.6	.23	Q1.6
7	3	3	69		1.07	.80	.6	.4	.10	Q1.7
8	5	5	69		2.63	3.06	1.7	1.5	.56	Q1.8
9	6	6	69		3.25	.89	1.2	1.2	.44	Q1.9
10	7	7	69		4.63	.70	.7	.6	.23	Q1.10
11	3	3	69		1.07	.80	.6	.4	.10	Q1.11
12	5	5	69		.63	1.06	1.7	1.5	.56	Q1.12
13	6	6	69		.25	.81	1.2	1.2	.44	Q1.13
14	7	7	69		4.63	.77	.7	.6	.23	Q1.14
15	3	3	69		1.07	.80	.6	.4	.28	Q1.15
16	5	5	69		2.63	1.06	1.7	1.5	.56	Q2.1
17	6	6	69		3.25	.81	1.2	1.2	.32	Q2.2
18	7	7	69		4.63	.00	.7	.6	.23	Q2.3
19	6	6	69		3.25	.81	1.2	1.2	.44	Q2.4
20	7	7	69		4.63	.00	.7	.6	.23	Q2.5
21	6	6	69		3.25	2.81	1.2	1.2	.44	Q3.1
22	7	7	69		4.63	.00	.7	.6	.23	Q3.2
23	6	6	69		3.25	.81	1.2	1.2	.43	Q3.3
24	7	7	69		4.63	.63	.7	.6	.23	Q3.4
25	6	6	69		3.25	.81	1.2	1.2	.46	Q3.5
26	7	7	69		4.63	.87	.7	.6	.23	Q4.1
27	6	6	69		3.25	.85	1.2	1.2	.44	Q4.2
28	7	7	69		4.63	1.45	.7	.6	.23	Q5.1
29	6	6	69		3.25	.81	1.2	1.2	.43	Q5.2
30	7	7	69		4.63	.00	.7	.6	.27	Q5.3
31	6	6	69		3.25	.80	1.2	1.2	.44	Q6.1
32	7	7	69		4.63	3.54	.7	.6	.25	Q6.2
33	6	6	69		3.25	.89	1.2	1.2	.44	Q7.1
34	7	7	69		4.63	.70	.7	.6	.23	Q7.2
35	6	6	69		3.25	.73	1.2	1.2	.44	Q7.3

Figure 2 Items/Questions Measure

Figure 3 illustrated the Wright Map in which establishes the distribution of persons/students on the left, represented

by S01-S69, and the distribution of items/questions on the right, represented by the entry number (refer Table 2). The easiest questions are Q1.4, Q1.14 and Q2.3, which are located at -4.32 logits (SE .82), while the questions that is most difficult to answer are Q5.1 and Q5.2 (Which are related to ethics and security topics) located at the top of the item/question distribution at +3.73 logits (SE 1.11). Three students (S65, S58 and S43) found that the exam questions are difficult which are located at the top of the item/question distribution at +3.73 logits (SE 1.11). While the student S66 found that, the exam questions are very easy to be answered which is located at -4.32 logits (SE .82).

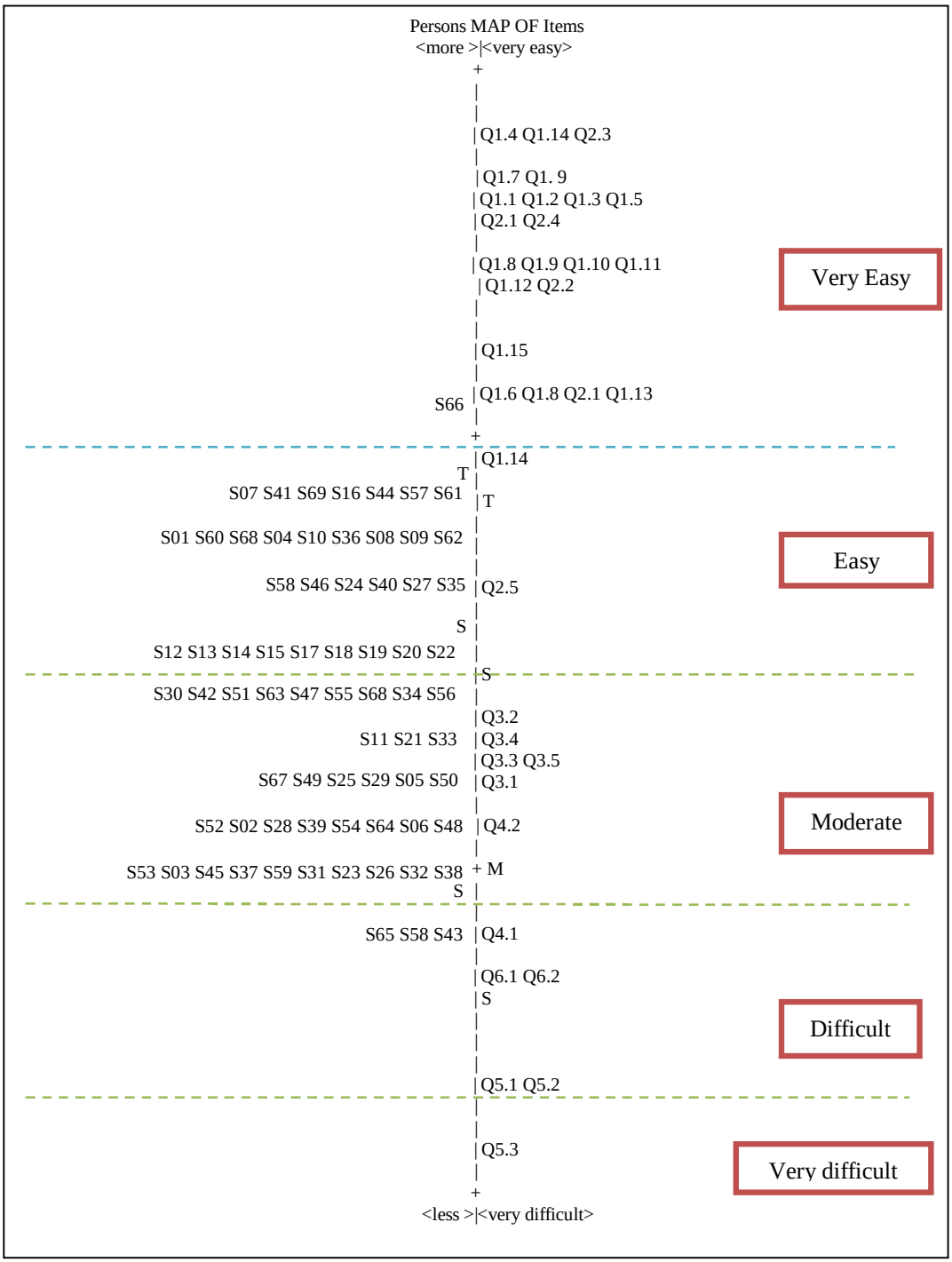

Figure 3 Wright Map

The principal contrast analysis of the Rasch residual variance is shown in Figure 4. The variance explained by measures is good (61.7%). The unidimensionality of the IT280 final examination instrument is strongly confirmed by

having a good unexplained variance in the first contrast (6.2%). Thus, it proved that the questions are only related with the content of this subject.

	Eigenvalue	Observed	Expected
Total raw variance in observations =	50.9521	100.0%	100.0%
Raw variance explained by measures =	25.9521	61.7%	50.7%
Raw variance explained by persons =	10.3167	20.2%	20.2%
Raw Variance explained by items =	15.6354	30.7%	30.6%
Raw unexplained variance (total) =	25.0000	49.1% 100.0%	49.3%
Unexplned variance in 1st contrast =	4.6287	6.2% 18.5%	
Unexplned variance in 2nd contrast =	2.9434	5.8% 11.8%	
Unexplned variance in 3rd contrast =	2.2957	4.5% 9.2%	
Unexplned variance in 4th contrast =	1.7322	3.4% 6.9%	
Unexplned variance in 5th contrast =	1.6327	3.2% 6.5%	

Figure 4 Principle Contrast Analysis

4. Conclusion and Future Research

This study explained the evaluation of reliability, validity and quality of final examination paper for Information Technology Fundamentals (IT280) course for IT students at College of Computer and Information Sciences (CCIS) at Al-Imam Mohammad Ibn Saud Islamic University (IMSIU) by using Rasch Measurement Model. This study discovered that the questions of the final examination paper for IT280 is reliable and in a good quality to measure students' academic performance. However, any negative questions should be omitted in any exams in the future. These findings can be future references for questions construction of other IT courses.

In conclusions, this study confirms the reliability, validity and quality of the 35 items/questions of the final examination paper for IT280 via a reliable and valid analysis. This study also found that, although the small sample size is used, Rasch Measurement Model is an effective tool in assessing the reliability and quality of final examination paper accurately and fast by classifying the questions according to students' learning ability and their cognitive thinking skills.

In the future, we will continue our efforts to evaluate the reliability, validity and quality for other assessment tools for other IT courses in order to prepare the evidences for the quality of student performance measurement. This will be a great asset for the IT department in CCIS, IMSIU in complying with the American Accreditation Board of Engineering and Technology, 2000 (ABET) accreditation requirement.

References

[1] L. Snyder, Fluency with information technology: Wiley Online Library, 2008.
[2] W. J. Boone, J. R. Staver, and M. S. Yale, Rasch analysis in the human sciences: Springer, 2013.
[3] A. M. Talib, F. O. Alomary, and H. F. Alwadi, "Assessment of Student Performance for Course Examination Using Rasch Measurement Model: A Case Study of Information Technology Fundamentals Course," Education Research International, vol. 2018, 2018.
[4] T. D. Reeves and G. Marbach-Ad, "Contemporary test validity in theory and practice: a primer for discipline-based education researchers," CBE-Life Sciences Education, vol. 15, p. rm1, 2016.
[5] A. A. Aziz, A. Mohamed, N. Arshad, S. Zakaria, and M. S. Masodi, "Appraisal of course learning outcomes using Rasch measurement: A case study in Information Technology education," International Journal of Systems Applications, Engineering & Development, vol. 4, pp. 164-172, 2007.
[6] A. M. Talib, R. Atan, R. Abdullah, and M. A. A. Murad, "Security framework of cloud data storage based on Multi Agent system architecture-A pilot study," in Information Retrieval & Knowledge Management (CAMP), 2012 International Conference on, 2012, pp. 54-59.
[7] A. Mohamed, A. Aziz, S. Zakaria, and M. S. Masodi, "Appraisal of course learning outcomes using rasch measurement: a case study in information technology education," in Conference Proceeding 7th WSEAS International Conference on Artificial Intelligent, Knowledge Engineering and Databases (AIKED â€˜08), 2008, pp. 20-22.
[8] A. A. Aziz, A. Zaharim, N. F. A. Fuaad, and Z. M. Nopiah, "Students' performance on engineering mathematics: Applying rasch measurement model," in Information Technology Based Higher Education and Training (ITHET), 2013 International Conference on, 2013, pp. 1-4.

[9] S. A. Osman, M. A. Khoiry, W. H. W. Badaruzzaman, and A. Mutalib, "Measurement of students' understanding in final examination of Statics and Dynamics Course using Rasch Measurement Model," in Teaching, Assessment and Learning for Engineering (TALE), 2013 IEEE International Conference on, 2013, pp. 805-810.
[10] H. Othman, I. Asshaari, H. Bahaludin, Z. M. Nopiah, and N. A. Ismail, "Application of Rasch measurement model in reliability and quality evaluation of examination paper for Engineering Mathematics courses," Procedia-Social and Behavioral Sciences, vol. 60, pp. 163-171, 2012.
[11] H. Othman, N. A. Ismail, I. Asshaari, F. M. Hamzah, and Z. M. Nopiah, "Application of Rasch measurement model for reliability measurement instrument in vector calculus course," Journal of Engineering Science and Technology, vol. 10, pp. 77-83, 2015.
[12] R. F. M. Said, "Application of Rasch Measurement Model in Evaluating Student Performance for Foundation of Computing II," in 7th International Conference on University Learning and Teaching (InCULT 2014) Proceedings, 2016, pp. 251-259.

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