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Ascertaining the benefits of Life Long Education using Rasch Analysis on students pursuing Executive Programs in UTMSPACE

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Abstract

Lifelong learning has been the subject of interest in education for a very long time, not peculiar to Malaysia but worldwide. It has been acknowledged that education shall not be limited within the walls of institutions of higher learning but also the mass outreached. This is particularly of concern in our society when reading culture is still considerably low. Many stopped reading to expand their breadth and depth of knowledge upon leaving school and even undergraduates are not excepted. In the effort to develop a knowledged society, UTMSPACE has taken a bold move by going into the industries and offered several Executive Programs regarded as mature age entry students. This paper is an endeavour to establish a trouble-free and holistic method of measuring the participants' satisfaction by mean of Rasch Analysis. By capitalising on the predictive strength of Rasch Model to make measurement by inference, it can serve as a method to establish the instrument capability in attempting to measure what we are supposedly to measure more accurately, better and easier. Questions or *items* serves as the research instrument are duly verified as a reliable measuring device by Rasch Analysis. A case study on a pioneer group of students from the Executive Diploma in Manufacturing Management program implemented in UTMSPACE, students (N=22) was conducted to measure the students perception on how far the program meet their objective, inferred from their responses subsequent to four(4) series of courses attended whether it meets their expectation to their level satisfaction. The findings from Rasch Analysis support that the courses are beneficial and meet their expectation confirmed by the positive Person Mean ranging from; μ_{PERSON}=+0.68 to a very strong +4.02*logit* indicating that the program is of benefit to the participants.

Keywords*:* Executive Program, Life Long Learning, Learning Outcomes, performance measurement, engineering education, Rasch Model.

1. Introduction

Lifelong learning is critical today for all workers currently employed and for those seeking employment who require continually updated and expanded their job skills. Company restructure, separate out and recombine production units, refine their management hierarchy, outsource tasks, and use new communication technologies to access an international workforce. As a result, job descriptions, work arrangements, and work processes are constantly changing. Knowledge and skills must constantly be updated and expanded. Lifelong learning is a necessity. Adults must remain current through enrolment in continuing education programs to stay competitive in today's economy.

Lifelong learning is the process of keeping your mind and body engaged, at any age; by actively pursuing knowledge and experience. Lifelong learning is essential to their longevity. In order to respond to the growth of population of senior citizens, many countries have made efforts to improve the "quality of life" of senior citizens, medically, economically, and socially. One important trend in educational planning has been the increasing learning opportunities for this population before they reach their prime age [1].

Institution of Higher Learning has designed programs to empower learners so they become self-sufficient as they enhance their personal growth, increase their personal development, and develop self-actualization. This helps them evolve and become universally literate in body, mind, and spirit [2]. They can then able to pass their knowledge on to others, demonstrating the best ways to reach their full potential as productive citizens in today's world hence creating better financial worth.

2. Overview of Lifelong Learning

Lifelong learning has been the subject of interest in education for a very long time, not peculiar to Malaysia but worldwide. It has been acknowledged that education shall not be limited within the walls of institutions of higher learning but also the mass outreached. UTMSPACE has taken a bold move by going into the industries and offered several Executive Programs regarded as mature age entry students for this purpose.

UTMSPACE assures service offered is of value for money. Competition among Malaysian Institutions of Higher Learning in providing continuing education is getting more stiff by day. Quality is certainly no compromise; both the staff and also the content knowledge. Lifelong learning increases our wisdom. Lifelong learning enables us to put our lives in perspective. It increases our understanding of the whys and the whats of previous successes and failures, and it helps us understand ourselves better [3].

This is a unique opportunity of transforming and translating participants worthy experiences into real value for the betterment of society. The wisdom, insight – it's all of tangible benefit to the world. Academically, this is a data mining process conversion into structured knowledge. Lifelong learning enable the working group to be involved as active contributors to the society turning them as an incredible asset instead.

It becomes an integral part of lifelong learning to have a free exchange of ideas and viewpoints among elder learners. Lifelong learning opens the mind that brings about a whole new level of enlightenment thus leads to an enriching life of self-fulfillment. This structured academic learning is an educational adventure that expand participants awareness, embrace self-fulfillment, and truly create an exciting multi-dimensional life. Lifelong learning gives the benefit of real perspective of life and enables to explore the true meaning of the hills and valleys of our past. Lifelong learning helps us find the meaning in our lives.

Lifelong learning enables focus on the up keep with society's changes - especially the technological ones. A learning environment with the peers not only makes it possible to stay abreast of change but helps them adapt to such change. This offer them an avenue to make new friends and establish valuable relationships. It develops good interpersonal relationship, communication skills and build tolerance among participants. It nourishes the curious, hungry mind. All in all, lifelong learning helps to fully develop all the gaps a man has in life to the fullest.

Keeping that in mind, UTMSPACE has taken the concerted effort to assure that their program be delivered at level best. This paper is a preliminary effort towards such colossal effort in building the trust being a center of excellence of the highest degree. Eventually it is hoped that a more holistic program with a very comprehensive andragogy instructional method meeting the fundamentals of Knowles Theory [4].

In Knowles Theory, six (6) domain contribute to the motivation of adult learners; viz. the need to know, experiential learning activities, self-concept, subjects having immediate relevance to their work and problem-centered rather than content-oriented. This paper is an attempt to measure the satisfaction of the adult learners going through the 'goin back to school experience ' with the following questions;

1. What are the adult learners expectations of Teaching & Learning (T&L) to be provided by the IHL?
2. Do performance measurement system used to evaluate learning progress on adult learners in UTMSPACE valid?
3. How are performance measurement system linkages accomplished on the T&L in an IHL ?

A method of defining the required metrics in Engineering Education Performance Measurement is setforth modelled on Razimah (*2006*) Plan-Execute-Report-Monitor (P-E-R-M) assessment method to measure the Value for Money (VFM) Audit performance [5].

3. Measurement Method

Responses from the students survey is normally counted by the number of frequency and the product thereof is summed up to obtain the raw score. This raw score is used to determined the hierarchy of responses. This gives a series of order. Subsequently, it was divided by the expected total score to get their so called ' item mean' [6].

However, the raw score only give a ranking order which is deemed an ordinal scale that is continuum in nature [7]. It is not linear and do not have equal intervals which contradicts the nature of data fit for the due statistical analysis. It does not meet the fundamentals of sufficient statistics for evaluation [8].

Rasch focuses on constructing the measurement instrument with accuracy rather than fitting the data to suit a measurement model with of errors. In Rasch philosophy, the data have to comply with the principles, or in other words the data have to fit the model. In Rasch point of view, there is no need to describe the data. By focusing on the reproducibility of the latent trait measurement; instead of forcing the expected generation of the same raw score, i.e. the common expectation on repeatability of results being a reliable test, hence the concept of reliability takes its rightful place in supporting validity rather than being in contentions. Therefore; measuring customer satisfaction in an appropriate way is vital to ensure valid quality

information can be generated for meaningful use; by absorbing the error and representing a more accurate prediction based on Rasch probabilistic model [9].

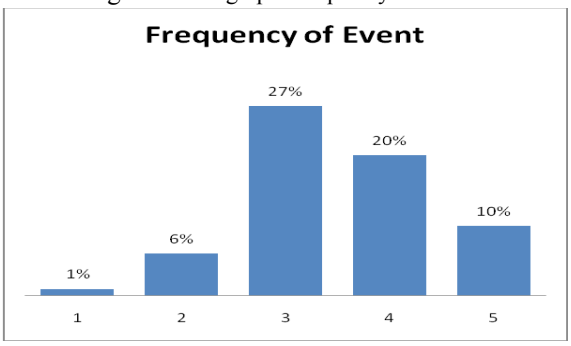
An attempt of a student to answer an item renders him some level of difficulty to choose a preferred response. Rather than summing up the frequency of response rating which is a complete disregard of allowable mathematical operation in ordinal data to obtain a so thought 'score' and subsequently the 'item mean'. Rasch sees it as a chance of a person selecting a given option hence in a rating of 1 to 5, from 'Dislike to Really Like', he has a 20-odd chance of selecting a choice of preference. So, if he chose 'Dislike' the odds will be 20:80, next slight dislike; 40:60 and so forth.

Let us see this exhibit to have a clearer picture. Given N=100 responses with the following frequency distribution; 1(5), 2(15), 3(45), 4(25) and 5(10) tabulated as in Table 1, then it will be transformed in the form of a bar graph as in Figure 1. Then, the scores (R*f) is summed up to obtain the so thought 'item mean'= 0.64, which yield a median of 3.20. This is completely a careless misrepresentation as 3.2 is totally meaningless and of no value which lies between 'Like'=3 and "Like Slightly'=4.

Table 1. Frequency Table and Score

Rating	**1**	**2**	**3**	**4**	**5**
F	5	15	45	25	10
Score (R*f)	5	30	135	100	50
%	1	6	27	20	5

Figure 1. Bar graph-Frequency of Event



Rasch see it as an odd of event as in Table 2 instead. We can put this on a probability scale as in Figure 2.

Table 2. Odds of Event Tabulation

Rating	**1**	**2**	**3**	**4**	**5**
$f\|_{=100}$	5	15	45	25	10
Odds	5:95	15:85	45:55	25:75	10:90

Now, for a given frequency of 5/100, Rasch see it as an odd of success being 5:95. There is need of a paradigm shift to read it as the odds of success hence a ratio data. A frequency of 15% shall now be seen as odd of success 15:85 and, so on. After all percentage is statistically recognized only a data summary; which is somehow largely confused as a unit of measurement.

This enable us to construct a log-odd ruler of probability an event taking place with the odd-of success as shown in Figure. 2 with unit termed as ***logit*** , derived from the term '**log-odd unit**'; as unit of measurement of ability akin to *meter* to measure length or *kilogram* to weight [10].

Figure 2. Probabilistic line diagram

In order to achieve an equal interval scale, we can introduce logarithm of the odd probabilistic value. Maintaining the same odd probabilistic ruler as in Figure 1, starting with 0.01 to 100, we can create an equal interval separation between the log odds units on the line, hence the measurement ruler with the *logit* unit. This can be verified by computing the value of $\log_{10}$ 0.01 (10^{-2}) equals to -2.0; value of $\log_{10}$ 0.1 equals to -1; value of $\log_{10}$ 1 equals to 0 and so forth. Figure 3 shows the newly established *logit* ruler as a linear scale with equal interval separation. It is just like looking at a thermometer with '0', as water being ice and 100 as boiling point whilst the negative extreme end as -273°C, the point where all atoms of any element come to a standstill.

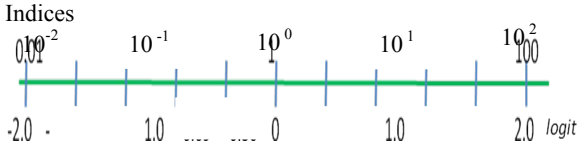


Figure 3. Logit ruler

Thus, we now have a valid construct of an instrument to measure the students satisfaction for each defined service domain.

4. Results and Discussion

The survey was conducted post-class, at the end of the two-days teaching session conducted on forthnightly basis. The classes are FMF1035 -Performance Measurement, FMF2034 -Preventive Maintenance, FMF3024 -Performance Appraisal and FMF2503 -Training Needs Analysis. The respondents are adult students (N=22) comprising primarily of Supervisors and Assistant Managers from Seiko Instrument International assembly plants in Johor Bahru. They have wide experience and a number of them possessed received tertiary

education up to Diploma level from various Institutions of Higher Learning in Malaysia. All the students profile were duly coded in the Person demography.

The result from the survey were processed using W*insteps v 3.6.8,* a Rasch analysis software; to obtain the *logit* values. Figure 4 shows the Person-Item Distribution Map (PIDM); i.e. the heart of Rasch analysis. The vertical dashed line represents the ideal less-to-best continuum of quality where the *persons*; i.e. the Students is on the left whilst the *items*; the domain of serviced rendered were plotted on the right side of the *logit* ruler. Since they share the same linear ruler, the correlation of the *person*, β_n and *item*, δ_i can now be established.

On the right hand side of the dashed line, the items are aligned from too easy to too hard, starting from the bottom. The distribution of student positions is on the left side of the vertical dashed line in increasing order of ability; the best naturally being at the top and the dissatisfied student is at the bottom most. Letter "M" denotes the student and item mean, "S" is one standard deviation away from the mean and "T" marks two standard deviations away from the mean. In Rasch Model, since we are interested in the person's ability for a given task, the scale is set to zero where the item is deemed 50:50 being the tipping point.

SUMMARY OF 20 MEASURED (NON-EXTREME) Persons

	RAW SCORE	COUNT	MEASURE	MODEL ERROR	INFIT MNSQ	INFIT ZSTD	OUTFIT MNSQ	OUTFIT ZSTD
MEAN	66.5	16.4	0.30	.69	.88	-.1	.86	-.2
S.D.	12.8	2.6	2.68	.17	.51	1.3	.64	1.1
MAX.	83.0	17.0	5.76	1.35	2.30	3.8	2.22	2.1
MIN.	20.0	5.0	-4.70	.54	.08	-1.6	.08	-1.8

REAL RMSE	.75	ADJ.SD	2.58	SEPARATION	3.44	Person	RELIABILITY	.92
MODEL RMSE	.71	ADJ.SD	2.59	SEPARATION	3.64	Person	RELIABILITY	.93
S.E. OF Person MEAN = .62								

MAXIMUM EXTREME SCORE: 1 Persons
VALID RESPONSES: 96.5%

SUMMARY OF 17 MEASURED (NON-EXTREME) Items

	RAW SCORE	COUNT	MEASURE	MODEL ERROR	INFIT MNSQ	INFIT ZSTD	OUTFIT MNSQ	OUTFIT ZSTD
MEAN	83.2	20.3	0.00	.60	.96	-.1	.89	-.3
S.D.	4.5	.5	1.34	.02	.43	1.2	.62	1.0
MAX.	90.0	21.0	3.70	.62	2.13	2.7	2.61	1.5
MIN.	71.0	20.0	-2.60	.56	.31	-2.3	.21	-1.9

REAL RMSE	.65	ADJ.SD	1.17	SEPARATION	1.81	Item	RELIABILITY	.77
MODEL RMSE	.60	ADJ.SD	1.19	SEPARATION	1.98	Item	RELIABILITY	.80
S.E. OF Item MEAN = .33								

UMEAN=.000 USCALE=1.000
Item RAW SCORE-TO-MEASURE CORRELATION = -.92 (approximate due to missing data)
328 DATA POINTS. LOG-LIKELIHOOD CHI-SQUARE: 303.38 with 291 d.f. p=.2968

Table 3. Sumary Statistics

Prior to proceeding any further, it is best to look at the Summary Statistics as in Table 3. In a survey, there are two(2) components that need to be validated; the Person and the instrument i.e. the item. Rasch has this unique feature to confirm both by mean of Person and Item Realiability which are 0.92 and 0.77 respectively. Since both reliability has the score above the minimum threshold of 0.6, this survey is truly measuring what is supposedly to be measured hence valid. The next information we are looking for in this table is the overall students' satisfaction level reflected by the Person Measure Mean; μ_{PERSON}= +0.30*logit* (P[Θ]=0.5744). This gives the indication that generally the students' satisfaction under scrutiny is just above expectation. SD_{PERSON}=2.68 shows that the students has a large spread with the most dissatisfied students being 09M04092 measured at -1.77*logit* being lowest whilst the happiest student 15M03125 is measured at maximum extreme measure of +8.30*logit*. Since the extreme measure is way up the scale and may distort other analysis, Rasch has discarded the person in other measurement. For this purpose, person 06F03064 measured at +5.76*logit* will be taken as maximum measure. Rasch also noted that the respondents to the survey has given a valid response of 96.50%. This is the major departure from the traditional statistics where in Rasch the data is tested against the model and how fit does it match the theoretical outcome hence how sincere the respondents are in giving their responses.

Figure 4 also shows the PIDM: *Students Location* where the students were separated by gender to evaluate the customer satisfaction trend. Rasch Analysis tabulates the students' location in a very clear graphical presentation which is easy to read and easier to understand [11]. Each student can be coded with attributes or factors that is deemed to affect their learning process.

There are 16 Males against 5 Females students in this study. Generally, the students separation, G=3.44 is good value that indicates that there is enough and differentiation among students satisfaction to separate them into distinct satisfaction level or strata. Strata can be calculated using the formula:

$$\text{Strata} = (4 \times \text{student separation} + 1)/3 \qquad \text{Equ. 1}$$

Thus, a student separation of 3.44 was computed into the strata formula which yielded 4.92; a good near five (5) separated groups (Very Unhappy to Very Satisfied). This profiling is clearly reflected by the PIDM in Figure 4. Generally, it shows the students four (4) separate satisfactory profiles [12];

Group 1: Very Unhappy students; (Male,N=2, 13.33%; Female,N=1, 16.67%) was not happy with the session. They complained the reference materials is in English which difficult to read and understand. This render the class not interesting. They also find the food provided not of quality.

Group 2: Dissatisfied students; (Male, N=3, 20.0%; Female, N=3,60.0%) who is somewhat happy with the program relevance and teaching technique but with reservations on the legibility of the materials thus affecting their interest.

Group 3: Satisfied students; (Male,N=7, 46.67%; Female,N=0,50%) They are happy lots with the program though they have little problem with

the legibility of their teaching materials and the food quality.

Group 4: Very Satisfied students; (Male, N=4, 26.67%; Female, N=1,16.67%) are completely happy with the program.

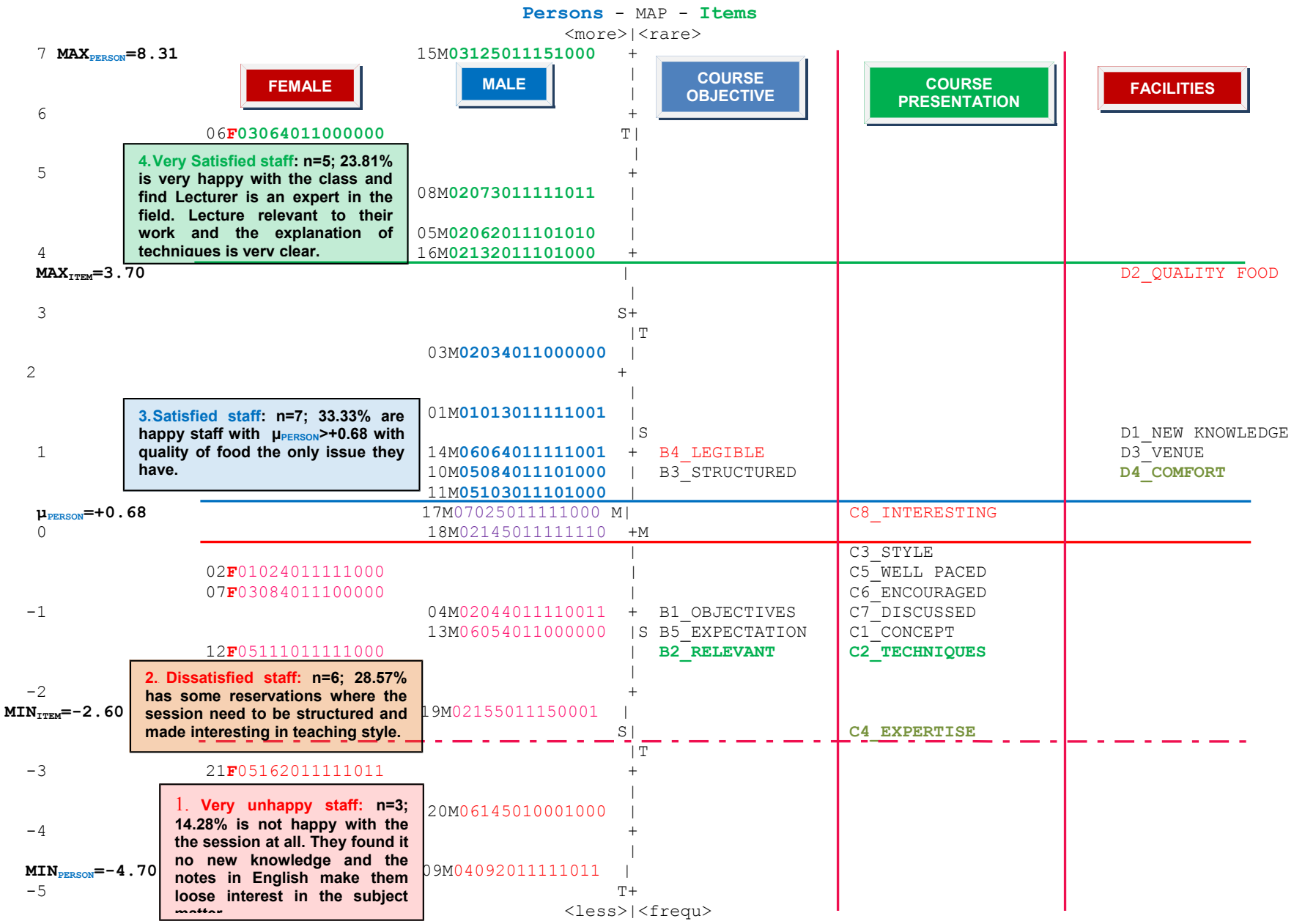


Figure 4. PIDM Students Location: Course Evaluation - Preventive Measurement 2009

Table 4. Person Measure

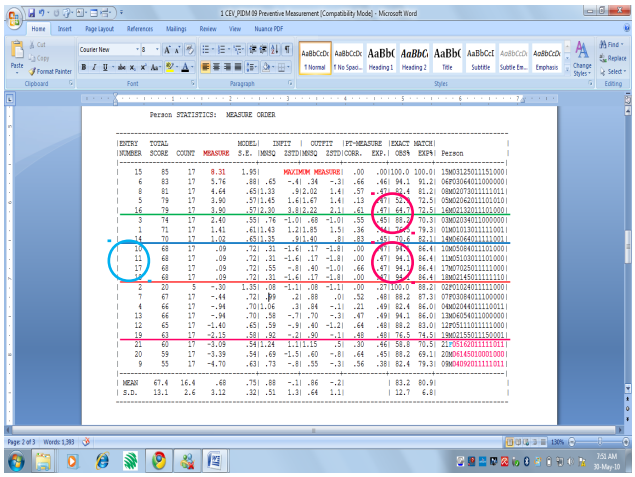


Table 4 shows the Person Measure indicating in details the of each individual *logit* measure. Rasch examine the item or person fit by looking at two types of fit values known as infit and outfit Rasch typically examine 'outfit' which is less threatening to measurement and easier to manage. Hence, we look at "outfit MNSQ" where the mean square (MNSQ) outfit for the item is expected to be near 1.0. Acceptable MNSQ outfit shall be near one but between 0.5 and 1.5 is bearable. It is noted that $MNSQ_{OUTFIT}$ of Person 16M02132 register the highest score, 2.22 and $MNSQ_{OUTFIT}$ of Person 02F01024 a low 0.08; both crossing the upper and lower limit. Next check is on the Z-STD where it should be within the range of +/-2 with ideal near zero. Again, Person 16M02132 score +2.1 exceed the upper bound. Rasch need the final check on Point Measure Correlation to be within the range of 0.4 to 0.8. Rasch need all the three(3) conditions to be breached before a data is discarded.

Rasch Point Measure Correlation is special where it detects the pattern of responses string. As it approaches zero, it gives an indication the responses is going in the opposite direction; the Person is saying 'No' to what normally others would say 'Yes' and vice-versa. A negative value makes a Person a suspect why it is behaving the reverse.

Table 5. Item Measure

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
15	71	20	3.70	.61	2.13	2.7	2.61	1.5	.59	.79	57.9	80.1	D2_QUALITY FOOD
14	79	20	1.12	.57	1.33	1.0	1.50	1.1	.68	.78	68.4	77.9	D1_NEW KNOWLEDGE
4	83	21	1.07	.56	1.14	.5	1.24	.6	.77	.77	70.0	78.2	B4_LEGIBLE
16	80	20	.78	.58	1.08	.4	.71	-.5	.74	.78	89.5	78.3	D3_VENUE
17	80	20	.78	.58	1.08	.4	.71	-.5	.74	.78	89.5	78.3	D4_COMFORT
3	84	21	.75	.57	.71	-.8	.50	-1.1	.85	.78	80.0	78.8	B3_STRUCTURED
13	81	20	.44	.59	1.26	.8	1.21	.6	.85	.78	73.7	79.8	C3_INTERESTING
8	83	20	-.30	.62	.67	-.8	.74	-.3	.82	.78	94.7	81.6	C3_STYLE
10	83	20	-.30	.62	.51	-1.4	.35	-1.4	.82	.78	94.7	81.6	C5_WELL PACED
11	83	20	-.30	.62	.79	-.4	.55	-.8	.77	.78	84.2	81.6	C6_ENCOURAGED
12	83	20	-.30	.62	.92	-.1	.66	-.5	.85	.78	73.7	81.6	C7_DISCUSSED
6	84	20	-.68	.62	.64	-.9	.43	-1.1	.86	.77	89.5	82.3	C1_CONCEPT
7	84	20	-.68	.62	.31	-2.3	.21	-1.9	.87	.77	100.0	82.3	C2_TECHNIQUES
1	89	21	-1.05	.61	.67	-.8	.46	-.9	.86	.76	90.0	83.0	B1_OBJECTIVES
5	89	21	-1.05	.61	1.02	.2	.82	-.1	.80	.76	80.0	83.0	B5_EXPECTATION
2	90	21	-1.42	.61	1.50	1.2	1.99	1.4	.60	.75	75.0	82.4	B2_RELEVANT
9	89	20	-2.60	.61	.56	-1.4	.38	-.5	.77	.70	94.7	80.2	C4_EXPERTISE
MEAN	83.2	20.3	.00	.60	.96	-.1	.89	-.3			82.7	80.6	
S.D.	4.5	.5	1.34	.02	.43	1.2	.62	1.0			11.2	1.7	

Table 5 shows the item measure in details. Rasch has a unique ability in recognizing the students development based on the students responses. From Table 3, note that Rasch has 'zero set ' the instrument to item mean; μ_{mean}=0.00*logit*. It shows a maximum item measure of +3.70*logit* for D2_Food Quality at the top hence the item participants most unhappy about whilst item C4_Expertise register -2.60*logit* being located at the bottom of the rung as the item they are most happy about. This gives quite large spread as depicted by the SD_{ITEM}=1.34 The critical most information a researcher is so jittery about would be the item reliability; i.e. whether the test is truly measuring what we are supposedly to measure [13]. $Reliability_{PERSON}$ is easier to be justified depending on how much demography input we have where else instrument reliability can be detrimental to the whole exercise as it could mean unreliable data hence a total re-do. This survey found the $Reliability_{ITEM}$ to be a sound -0.77 thus assure us a valid data for further analysis.

Generally, the item separation, G=1.81 is a fair value indicating two(2) simple group of difficulty level i.e. 'Easy and "Difficult". Strata can be calculated using the formula:

Strata = (4 X student separation +1)/3 Equ. 1

Thus, an item separation of 1.81 was computed into the strata formula which yielded 2.75; a near three(3) separate item groups (easy, mediocre, difficult).

Rasch allows vertical investigation by domain or dimension. Briefly, under Course Objective dimension the students find the course relevant (B2_Relevant= -1.42*logit*) but they find the reference materials in English somewhat stressful. For the course delivery, the students find the trainer has excellent expertise (C4_Expertise= -2.60*logit*) with sound teaching technique (-0.68*logit*) but the training is rather content heavy that makes it rather tense. Finally, the supporting facilities for the course is on the down side; even the least satisfactory item, D4_Comfort register a +0.78*logit* and the quality of food is simply not to their taste at +3.70*logit*.

Table 6. Summary Performance

Course	1053	3024	2043	2068
μ_{PERSON}	+0.68	+3.47	+3.05	+3.43
Separation	3.44	4.26	3.25	2.79
Strata	4.92	6.01	4.67	4.05

In summary, it can be seen in Table 6 that the students satisfactory level is positive, ranging from a mediocre satisfaction +0.68*logit* [P(Θ)=0.6637] to a consistent very satisfied +3.47*logit* [P(Θ)=0.9698]. It can be inferred that the students is finding the course value for money (VFM). The fine Separation of students is between 3 to 4 (mediocre to very satisfied) whilst strata between 4 to ideal 6 (very unsatisfied to very satisfied) supports this finding.

5. Conclusion

Rasch Model provides a sound platform of measurement equivalent to natural science which matches the SI Unit measurement criteria where it behaves as an instrument of measurement with a defined unit and therefore replicable. It is also quantifiable since it's linear.

The logit ruler has been developed with purpose to measure satisfaction; in this case students satisfaction. It can define the students profile based on their degree of satisfaction confirming the adult learners expectations of Teaching & Learning (T&L) to be provided by the IHL.

It is a noble innovation where the ability 'ruler' can transform ordinal data into measurable scale. It's graphical output is great which gives better clarity for quick and easy decision making [13]. Rasch enable the performance measurement system linkages accomplished on the T&L in an IHL.

The measurement conducted reveals the true degree of cognitive learning abilities of the Engineering undergraduates [14]. Now the performance measurement system used to evaluate learning progress on adult learners in UTMSPACE is deemed valid. Previously, lack of such measurement in Engineering Education has made the necessary reporting of corrective actions in the form of skills development, education and competency training difficult to formulate [15]. This major problem faced by Engineering Education Administrators in an IHL to design the necessary curriculum to mitigate the going concern is therefore resolved.

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