Teaching Methodology Evaluation Using Rasch Analysis

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Abstract: - Leniency in marking is always been an excuse when students performances are different and unexpected from our anticipation. A way to find the solution, a Rasch Model is used to give a better explanation for this matter. Two subjects namely Circuit Theory I and Circuit Theory II are studied to compare the teaching methodology on students’ performance using the Rasch Model. The findings show that questions difficulty levels and students maturity have been identified among factors contribute to the students’ unsteadiness abilities and performances.

Keywords: Students Performance, Rasch Model, Circuit Theory, difficulty levels, students' abilities

Performance,  

1 Introduction

Teachers play a pertinent role in society and acted as an instructor who adds knowledge to students with enthusiasm towards their subjects and towards improving learning [1]. Teacher is also an evaluator or a rater in assessing the students’ answer through the questions set by them. For questions using multiple choices, it is easy for the evaluators to mark it, but what about the subjective questions which need students to explain more details and their answers are varied. Some teachers are labelled as lenient and some are very strict in marking the students’ papers.

Leniency is not the only factor influenced the students’ performance but other factor such as environment, maturity, parents, background are among factors contribute the students behaviour. Even though leniency is the most factor in determining the scores for the overall students but maturity is one of the important elements in determining the students’ abilities. University students entered the university at the young ages which are after secondary schools, and have to spend at least three years in the university. Within this period, the students have faced a lot of experiences and students grow more mature and can think more widely. This is important as the students will be entered another cycle of life starting their careers in the real working world.

Coniam [2] reported that training has been given to a group of evaluators how to mark the public exam of English Language in Hong Kong with a uniform and fair judgement; it is to make sure marks are given equally among the students or candidates. The author used two approaches: by averaging the scores and two is using multifacet Rasch Measurement. There are also other researchers reported using Rasch Model in measuring students’ real ability in all levels such as primary school [3], Secondary school [4].

Rasch analysis can be used as measurement tools to determine the students results with a better explanation. Rasch analysis is an outcome scale which used logit unit against a mathematical measurement. This model has been developed by the Georg Rasch [5] Hence, Rasch Analysis has been widely used and proves its effective and accuracy in giving results and prediction.

2 Methodology

Circuit Theory I and II are fundamental courses that offered to all first year EES students for understanding and analyzing AC and DC circuit using circuit theorems. Circuit Theory I was handled by three lecturers BB, MMM and NAA while
Circuit Theory II was taught by BB and RN. These two subjects will be used to predict students’ performance and observe teaching methodology where exam questions are set and marked by the corresponding lecturers. In this study, BB is the only lecturer that teaches both courses and leniency studied has been conducted on BB exam only.

Examination for Circuit Theory I (1114) was conducted in the first semester of four-years of program while Circuit Theory II (1124) examination in the second semester. The responses from the exam were tabulated and run in WinSteps, a Rasch Analysis software; to obtain the logit values.

Since the student’s ability is latent and cannot be observed directly, the Rasch Rating Scale Model, the dominant measurement that estimates the person measures and item difficulties based on the same linear scale in standard units (logits) is used. There is a good agreement between all persons about the difficulties of the items along the scale and that a single measure (technically the person parameter) can accurately predict each person’s response to each item [6]. Rasch Measurement Model is expressed as the ratio of an event being successful as;

$$P(\theta) = \frac{e^{(\beta_n - \delta_i)}}{1 + e^{(\beta_n - \delta_i)}}$$  \hspace{1cm} (Equ. 1)

where;
- $e$ = base of natural logarithm or Euler’s number; 2.7183
- $\beta_n$ = person’s ability
- $\delta_i$ = item or task difficulty

Rasch Model also connects the likelihood a person $v$ of an ability $\beta$ on the latent trait is to response to an item $i$ of difficulty $\delta_i$, by simple separation correlation expressed as:

$$\beta_v - \delta_i$$  \hspace{1cm} (Equ. 2)

If the logit value of $\beta_v$ is greater than $\delta_i$ then the person is likely to be able to respond to an item correctly. The degree of a person’s ability is indicated by the separation of the item against the person’s location on the map: the further the separation, the more able a person likely to respond correctly to the said item. Similarly, the extent of an item difficulty is reflected by the spread of the item over the logit scale; a higher item is perceived to be more difficult as compared to an item at lower location [7]. Responses from the students’ exam results were analyzed using rating scale in which the students were rated according to their achievement by topical area of study.

3 Results & Discussions
The responses of Person-Item Distribution Map (PIDM) in this case, the ‘person’ is referring to the Students and the ‘item’ is referring to the exam topics/questions that are plotted on the same logit scale. Figure 1a is the PIDM of Circuit Theory I while Figure 1b describing the distribution of Circuit Theory II. The PIDM gives a quick overview to estimate the person ability; for example student cm02 obtained 1.2 logit in Circuit Theory I however in Circuit Theory II his achievement is on the 0.3 of logit scale. The decrement in this student’s ability is perhaps due to the item complexity in Circuit Theory II as can see from the PIDM shows that item distribution is higher than the students’ abilities.

Some of the contents in Circuit Theory II have been exposed to students namely mnn1, mnn2, mnn2 and mnn1 during their diploma studies. Student mnn1 of logit 0.3 shows that he does not have a problem in grasping the concept since he discovered some of the topics twice. It is proved that maturity has given the student mnn1 an additional benefit. On the contrary, students’ mm08, im01, mf12, im02, mm14, mf19, mf14, mf08, mm13 and mf09 have lower logit in Circuit Theory II compared to Circuit Theory I. They are listed in department weak students and definitely in trouble that need more attention from the lecturer. The weak students have serious difficulty on understanding these two courses where they are located well below all items.
Figure 1: (a) PIDM Circuit Theory I shows blue box is top student in this course and red boxes are for weak students in the department’s weak students list (on the left side) while items with red boxes are questions set by BB and green & purple boxes are set by other lecturers (on the right side), (b) PIDM Circuit Theory II depicted yellow boxes indicate students with Diploma and red boxes indicate good and poor students selected in this study(on the left side) while red boxes are questions set by BB and green boxes are set by other lecturers (on the right side)
Teacher’s influence in student ability can be observed in Figure 2 which clearly illustrates that the logit for every student is not consistent in both subjects. From the same figure depicted that students in the top rank are almost the same persons likewise the bottom students are also the same persons for both of the subjects. It is found that these two groups of students are listed in the department’s dean list students and weak students. Hence, it is also shown that leniency in marking is not the main factor why students can perform better or worst. From the Figure 2 also one can see that the distribution of student’s mark assessed by BB are linear and uniform which cover logit -2 to logit 2 and not bias to any particular logit.

The summary measurements for Circuit Theory I and Circuit Theory II are displayed in Figure 3 and 4 respectively. Generally the students were found below the expected performance since the Person Mean, μPerson for subject Circuit Theory I is –0.22 and -0.51 for Circuit Theory II. The item summaries of
Circuit Theory I and Circuit Theory II presented good analysis where the Separation, equals to 3.61 and 3.44 respectively while a very high Reliability of 0.93 for the Circuit Theory I and 0.92 for the Circuit Theory II.

Since the person’s Separation is 1.55 and 1.23 for both courses, the analysis clearly identify that there are only two groups of students profile in each course i.e weak/poor and good. Figure 5 clearly shows several unexpected responses from several students. Student cm02 only scored 1 for a ‘fair’ question in both courses nevertheless ‘Rasch’ expects him to get 4. Expecting that easy question will not come out in the final is one of the reasons of this peculiar situation.

4 Conclusion
Rasch Rating Scale Model has been used to estimates the students’ ability and the teacher’s influence in students performance. It can be concluded that lecturer is not always the main factor in determining the students’ scores during the examination. The study has shown that maturity and the ability of the students themselves contribute the most in their performance. Student with good result shows the better performance than the weak student.

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