A RASCH MODEL ANALYSIS OF CRITICAL THINKING PROBLEM SOLVING TEST

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DEDICATION

To my beloved grandfather, father and mother

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ABSTRACT

Rasch measurement model is used in many researches to determine the validity of the instrument. This study measure the validation of items and performance among first year undergraduate students in Universiti Teknologi Malaysia (UTM) by using the Rasch model. A sample of 981 students took part in the study. The research instrument used was Critical Thinking and Problem Solving Test (CTPST). Collected data were analyzed using the Winsteps 3.81 and Statistical Package for the Social Science (SPSS) 16.0 for Windows. The results are presented in logit values and mode respectively. The finding shows that the CTPST are suitable to all first year undergraduate students as it only involves non-routine questions that capture CTPS skills and do not follow any specific mathematical problems. Students from Faculty of Electrical Engineering (FKE) have the highest achievement in CTPST. However, the overall achievement shows that the students have low critical thinking skills in solving problems. The items in CTPST also show unidimensionality and fit to the model although there is a misfit items.

ABSTRAK

Model Rasch telah banyak diaplikasikan dalam penyelidikan bagi menentukankan kesahan instrumen. Justeru, kajian ini membincangkan sebab model Rasch diaplikasikan dalam mengkaji kesahan soalan dan pemikiran kritikal dalam kalangan siswazah tahun pertama di Universiti Teknologi Malaysia (UTM). Seramai 981 orang siswazah telah mengambil bahagian dalam kajian tersebut. Instrumen kajian yang digunakan adalah *Critical Thinking and Problem Solving Test* (CTPST). Data yang diperolehi dianalisis dengan menggunakan perisisan *Winsteps* 3.81 dan *Statistical Package for the Social Science* (SPSS) 16.0 for Windows. Hasil kajian dipersembahkan dalam bentuk logit dan mod. Keputusan daripada *Winsteps* dan SPSS menunjukkan bahawa CTPST hanya melibatkan soalan bukan rutin yang sesuai dijawab oleh semua siswazah tahun pertama, tahap pemikiran kritikal pelajar di Fakulti Kejuruteraan Elektrik (FKE) adalah paling memuaskan tetapi pencapaian keseluruhan kurang memuaskan. Item dalam CTPST juga menunjukkan keseragaman dimensi dan sesuai diaplikasikan dalam model walaupun terdapat item yang tidan sepadan.

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CHAPTER 1

INTRODUCTION

1.1 Introduction

Physical traits, such as height, the process of assigning numbers can be done directly using a ruler. However, psychological traits such as ability or proficiency are constructs. They are unobservable but can be measured indirectly through a test by using a tool (Khairani and Razak, 2012). Therefore, for the test that relate to observable traits (such as test score) with unobservable traits (such as ability or proficiency) researchers apply Rasch model.

Rasch model is new to the field of counseling psychology. However, several of the advantages appear promising. For example, it has the benefit in identifying unexpected results. In classical test models, outliers are identified by extreme scores, but we take scores in the middle ranges to be acceptable, as long as the instrument has generally been shown to be reliable. On the other hand, Rasch model would identify a research participant who had responded randomly to the instrument.

Rasch model is a psychometric model for analyzing categorical data, such as answers to questions on a reading assessment or questionnaire responses. In addition to psychometrics and educational research, the Rasch model and its extensions are used in other areas, including health industry (Williams *et al.*, 2012) because of the general applicability in it. It also plays as a function of the trade-off between the

respondent's abilities, attitudes or personality traits such as evaluate critical thinking problem solving skills and the item difficulty.

Critical thinking is a major educational outcome required for higher education institutions. Today, more than ever, educational programs are challenged to develop students' critical thinking skills. In light of the shifting scope of practice in various problem solving settings, every graduated students must be capable of adapting to these ever-changing demands. Because of the demands placed on education institutions to deliver quality skills in an interdisciplinary environment, the development of critical thinking skills among university students is essential.

As stated in Malaysia Education Blueprint 2013-2025 (Ministry of Education, 2013), thinking skills is one of the attributes and aspirations that needed by every student. The three elements mentioned in thinking skills are critical thinking and innovation, problem solving and reasoning, and learning capacity. This is to promote students for being innovated, approach issues critically and able to cope with the value of lifelong learning.

Students nowadays tend to have negative attitudes towards problem solving questions in their studies. Thus, it is very important to consider the factors affecting the quality of understanding, and to assess the validity of the assessment being carried out. An appropriate assessment tools in teaching and learning process is required to measure students' understanding and ability fairly and equally. Moreover, in the process of constructing these problem solving questions, it is crucial to have equally distributed problem solving examination questions based on Bloom's critical thinking skills, the level of students' ability and level of questions (items) difficulty (Bloom, 1956).

Therefore, lecturers must gather, analyze and process information to make logical decisions. The decisions need to be complex and require multiple levels of decision making. Regardless of the magnitude of the decisions to be made, it is essential that lecturers have the clinical reasoning and critical thinking skills to make

good decisions. However, do these students have critical thinking skills and the abilities to apply those skills in many different contexts? Do deans or program directors at colleges and universities can ensure that graduate students are able to think critically in complex situations?

In short, although Rasch model measures an abstract construct (latent trait), it has the same measurement properties as a ruler. Its mathematical characteristics allow a transformation from binary or ordinal answer patterns. This ensures the analysis to be more accurate.

1.2 Background of the Study

From several applications of Rasch model to rating scales, various benefits of Rasch analysis have been defined. First, the Rasch model is able to construct linear measures from any ordered nominal data by providing a simple and practical way to construct so that subsequent statistical analysis can be applied without a concern for linearity. Moreover, parameter estimations are independent from the individuals and items used. Third, since both item difficulty and individual ability are located on the same scale, therefore, the testing results can be interpreted in a single reference framework. Due to these features, it has been reported that the application of the Rasch model is advantageous to construct objective and additive scales (Bond and Fox, 2001).

Rasch (1960) cited in Othman *et al.* (2011) also declared that Rasch model is one of the reliable and suitable way in assessing student' ability. Ghulman and Mas'odi (2009) declared that Rasch measurement is beneficial with its predictive feature to overcome the missing data.

Study done by Saidfudin *et al.* (2010) proved that Rasch model can categorize grades into learning outcomes more accurately especially in dealing with small number of sampling units. Aziz *et al.* (2008) also applied Rasch model to

validate the construct of measurement instrument. Meanwhile, Osman *et al.* (2012) stated that person and items distribution map (PIDM) can give a clear overview on the students' learning effectiveness based on the data on a linear scale of measurement.

Therefore, this study focuses on using Rasch model as an assessment tools that would enable researchers to measure general problem solving competences. It can be used to evaluate the reliability and quality of the Critical Thinking Problem Solving Test (CTPST) questions and check whether these questions calibrated with students' abilities.

1.3 Problem Statement

Rasch model agrees the generalizability across samples and items, allows for testing of unidimensionality, produces an ordered set of items, and identifies poorly functioning items as well as unexpected responses. In this study, solving problems involving critical thinking skills is evaluated. Due to the problems, the study is proposed to determine the effectiveness of Critical Thinking Problem Solving Test (CTPST) in developing this ability and the level of critical thinking problem solving abilities based on faculties.

1.4 Objectives of the Study

In the view of the above stated requirements and problems, the present research aims at the following main objectives:

(i) To validate Critical Thinking Problem Solving Test (CTPST) by using Rasch model.

(ii) To identify the critical thinking level in solving problem for each faculty through Winsteps 3.81 and Statistical Package for Social Science (SPSS) version 16.0.

1.5 Significance of the Study

This study focuses in developing the reliability and validity of the questions and students' performance. Computer software, Winsteps will be able to solve large sample size of respondents and items with less computational effort. The main contributions of the research are summarized as follows:

(i) Analyze the reliability and validity of the problems using Winsteps.

(ii) Evaluation of the students' and faculties' performance.

1.6 Scope of the Study

In this study, routine and non-routine problems are taken into account as an assessment tool. The respondents will be the first year undergraduate students from selected faculties in UTM. There are a total of 981 students where 441 of them are male respondents and 540 of them are female respondents. In the study, the sample is chosen randomly to gain more accurate results.

The instrument for this study is Critical Thinking Problem Solving Test (CTPST). Data collected will be performed from the output of Winsteps software version 3.81.0 which will be used to interpret the validity and reliability of the CTPST in term of person and item separation respectively, misfit item and unidimensionality. In addition, Statistical Package for the Social Sciences (SPSS) version 16.0 will be used to determine the critical thinking level for each faculty.

1.7 Definition of Terms

In this study, there are a few terms being used that are related to Rasch model. They are being defined as below:

1.7.1 Latent Trait

This term refers to certain human attributes that are not directly measurable. In the theory of latent model, a person's performance can be quantified and the values are used to interpret and explain the person's test response behavior. Frequently, trait and ability are used interchangeably in the literature. (Andrich, 1978)

1.7.2 Logit

Logarithm of odds, logit is the unit of measurement when the Rasch model is used to transform raw scores obtained from ordinal data to log odds ratios on a common interval scale.

When the function's parameter represents a probability p, the logit function gives the log-odds or the logarithm of the odds as equation (1.1).

$$\frac{p}{1-p} = log\left(\frac{p}{1-p}\right) = logit\ p \qquad (1.1)$$

A logit has the same characteristics of an interval scale in that the unit of measurement maintains equal differences between values regardless of location. The value of 0.0 logit is routinely allocated to the mean of the item difficulty estimates (Bond and Fox, 2001).

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