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# Measuring Awareness of Waste Management among School Children using Rasch Model Analysis

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***Abstract*—**The enormous amount of solid waste generated poses huge problems in waste management. It is therefore important to gauge the awareness of the public with regards to waste management. In this study, an instrument was developed to measure the beliefs, attitudes and practices about waste management of school children as an indication of their waste management awareness. This instrument has showed that a positive awareness towards waste management refers mainly to attitudes. However it is not easy for people to practice waste management as a reflection of their awareness.

***Keywords*—**Awareness, Measurement, Rasch Model, Waste Management



## I. Introduction

SOLID waste is generated whenever there are humans. In 1997, there were 0.49 billion tonnes of municipal solid waste generated globally. In Malaysia, the total waste generated in 2006 is 7.34 million tons [1]. Studies on municipal waste identified residential areas as major contributors, with food waste making up the bulk of the waste, followed by paper and plastic [1] , [2].

With the large amount of waste generated each year, the total amount increasing with increase in the population, Malaysia will be swamped with waste and face a shortage of land to take the waste. There is therefore an urgent need to educate the public about waste reduction as a viable means of solid waste management, in line with the goals of the National Waste Management Policy [3].

The amount of solid waste generated reflects the economic status of a community [4]. The estimated growth rate of this waste was estimated to be 3.2–4.5 % in developed countries and 2–3% in developing nations [3]. In Malaysia, the average waste generated in 2007 is reported to be 0.5-0.8 kg/capita/day. Of this amount, 40% is biodegradable material, 15% is paper and 15% plastic waste [4]. A study by Mohd. Badruddin, Mohd. Razman and Fadil [5] showed that the amount of waste generated by households is influenced by lifestyle, eating habits, length of stay in a particular home, marital status and family size.

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Composting and vemicomposting is a viable way to manage solid waste. Composting is a systematic process of breaking down organic waste by microorganisms in aerobic conditions. This process produces organic material rich in nutrients and can be used as fertilizer and soil amendment. Adding certain types of worms like the African night crawler, *Eudrillus eugeniae* to rotting organic waste allows for vermicomposting to take place. The ingestion of the organic waste by the worms produces worm castings rich in nutrients. The mixture of worm cast or vermicast and other organic material is called vermicompost [6].

In Malaysia, composting is an activity that has long been carried out in this country. Although vermicomposting is a relatively new waste management technique, interest in vermicomposting among the public is growing. It is therefore important to gauge the awareness of the public with regards to waste management, including composting and vermicomposting. As adults of the future, school children are an important section of the public from whom this information should be obtained. A reliable and valid instrument is necessary to measure their awareness about waste management. In this study, an instrument was developed to measure the beliefs, attitudes and practices about waste management of school children as an indication of their waste management awareness. The psychometric analysis of the instrument was carried out using the Rasch Model.

## II. Principles Of Measurement Using The Rasch Model

Reliability of an instrument can be measured based on the Rasch Model [7]. This is a model developed by Georg Rasch [8]-[9]. The assumption of this model is the unidimensionality of items. From this model, person ability and item difficulties can be located. This model is governed by two principles namely item calibration and scaling.

Application of the Rasch model aims to fit the data set to the model. The model is a measurement of the locations of persons and items on a linear scale. As such the model assumes that the measurement is a continuum, with smaller values situated near the bottom and progressively larger values towards the top. The empirical findings should confirm that the variable under study lies within this continuum. It is also the assumption of the model that the respondents' ability order and the items' difficulty order lies on a single, linear scale. Based on this assumption, predictions on the performance of the respondents can be made. A respondent with a higher ability stands a better chance of answering an item correctly compared to a lower ability respondent. In this study, the higher ability respondent refers to the respondent with higher waste management awareness while the items' difficulty order refers to the difficulty order of the awareness items. This means that the

respondent with higher waste management awareness is more likely to select an item that is more difficult to perform. The Rasch Measurement Model assumes that the possibility of one respondent to choose an item correctly depends on the level of waste management awareness and the difficulty of the item. The assumption made is that the success of one respondent to choose an item correctly is due solely on the waste management awareness of the respondent and the difficulty of the item, and not on other factors.

The Rasch Model differs from other item response theory models in terms of its direction in connecting the model with the data [10]. While other item response theory models attempt to maximise the fit of the model to the data, Rasch model works in the opposite way by trying to fit the data to the model's requirement. In applying the Rasch Model, all items are inspected to confirm that they measure a single construct. Initially, the items are predicted to work together in a hierarchy forming a less to more continum but is then tested empirically to check that the data fits with the Rasch Model. This may be done by comparing the order of the items obtained empirically on a single line with the expected order in the theoretical hierarchy, Further investigation will be necessary when there is a discrepancy between the theoretical and the empirical hierarchy. Alternatively, the validity of each item may be determined by examining the fit statistics generated from the Rasch analysis. The value of the fit statistics will inform on whether all items work together to measure a unidimensional construct.

The ability of the Rasch Model to confirm that the data under study works in a "more to less" continuum arranged in a hierarchy is a measure of its strength. In addition, the model can measure objectively an abstract human science variable by placing it on equal interval scales with respect to the data continuum. In this study, the Rasch Model is used to analyse the interval data to confirm that waste management awareness items behave according to the theoretical difficulty level. This will allow the raw data to be converted into abstract, equal interval scales through log transformations of the raw data, another distinctive feature of Rasch Model analysis.

Raw data set at the ordinal level represents a numerical response that has been summed to produce a total score. However, this is not enough to produce a measurement of good quality. Usually this data is analysed and inferences made. However this analysis merely involves analysis of numbers and not the measures [10]. Hence it is important that raw data can be converted into abstract, equal-interval scales. The equal-interval scale is represented by the logit unit on the item-person map produced in Rasch Model analysis. The item-person map shows a straight line on which lies *logit* units at regular intervals with consistent values. The *logit* unit forms the interface between the arrangement of items and arrangement of persons on a single line.

However, the value of *logits* calculated for person ability is independent of that for item difficulty. A respondent located at at the same *logit* value as a particular item has a 50% probability of endorsing this item. The position of the item on this scale determines the difficulty of endorsement of the item by the respondent. An item higher on the scale makes it difficult for the respondent to endorse this item whereas an item lower down on the scale is easier to be endorsed by the respondent.

## III. Methodology

This study is a survey using a 91 item questionnaire with a four point Likert scale answer selection. The items refer to waste management including composting and vermicomposting. The items are divided into sections. The first section focuses on beliefs, the second section consist of items on attitudes and the last section consists of items referring to practice related to waste management. A total of 456 secondary school children responded to the questionnaire. A Rasch analysis was carried out to ensure this instrument can measure the beliefs, attitudes and practice about waste management. The first part of this analysis involves calibration of the instrument which is carried out in two phases. In the first phase, items that do not fit the criteria set will be removed. In the second phase, other items that do not fit the criteria will also be removed. This leaves an instrument that contains items that all fit the criteria. This instrument is thus suitable to be used to measure the beliefs, attitudes and practices about waste management. In measurement, scaling of the items is carried out where an item person map is produced. This map locates persons based on ability and also locates items based on difficulty on a scale.

## IV. Item Calibration

Item calibration involves the screening of items to identify those that do not fit with the Rasch Model. Items that fit the model must fulfill the criteria of polarity, infit and oufit. After screening, summary statistics will be reported which consists of item reliability, person reliability, item separation index and person separation index.

Polarity of items refers to the point measure correlation generated from the analysis. A positive measure indicates an acceptable item while a negative measure indicates a problematic item. Such items can be safely removed from the instrument to improve its validity.

## V. Findings

In this analysis, the polarity of five items was found to be negative. Their point measure correlations are as follows:

TABLE I
Polarity Of Items

| No | Item code | Point Measure Correlation |
|---|---|---|
| 1 | d21 | - 0.36 |
| 2 | d19 | - 0.27 |
| 3 | d30 | - 0.20 |
| 4 | b42 | - 0.18 |
| 5 | d9 | - 0.03 |

Items are also checked based on the Mean Square (MNSQ) values of the infit and outfit measures. Items that are acceptable should be in the range of 0.6 to 1.4. Items outside this range will be excluded. This analysis identified the following items as unsuitable:

TABLE II
ITEM MISFIT

| No | Item code | INFIT MNSQ | OUTFIT MNSQ |
|---|---|---|---|
| 1 | d19 | 2.11 | 2.71 |
| 2 | d21 | 2.15 | 2.59 |
| 3 | d10 | 1.67 | 1.73 |
| 4 | b52 | 1.38 | 1.59 |
| 5 | d5 | 1.45 | 1.54 |
| 6 | d13 | 1.51 | 1.49 |
| 7 | d24 | 1.50 | 1.48 |

Based on the polarity and misfit data, a total of 10 items are now excluded from the instrument. Next, a second phase of analysis was conducted to identify if there are any more items to be excluded. The value of point measure correlation for all items obtained from this analysis is positive. Thus all items are retained in the instrument. Similarly, analysis of infit and outfit MNSQ values showed that all values occur within the range of 0.6 and 1.4. All items qualify this criterion and none are excluded from the instrument.

Based on the first and second phase of calibration, a total of ten items were excluded from the instrument. This leaves 81 items in the instrument. The revised instrument was then analysed to place the items on a scale. This scale places items that are difficult to agree to at the top of the scale. Items that are easy to agree to are placed at the bottom of the scale. These items are displayed as a map, as shown in Figure 1. The scale is a logit scale. All items and persons are given a value in logits. Their position on the scale has a specific, scalar value. Based on visual inspection, in general the distribution of the respondent ability match with the difficulty of item distribution. Therefore the instrument is suitable to measure awareness about waste management.

From Fig. 1, items that are higher up on the scale means that there is a lower probability of persons who will agree to these items. However, several items placed at the highest level do not have persons mapped at the same level. These are items that nobody agrees with. Towards the bottom of the scale are items that there is a higher probability of persons who will agree with these items.

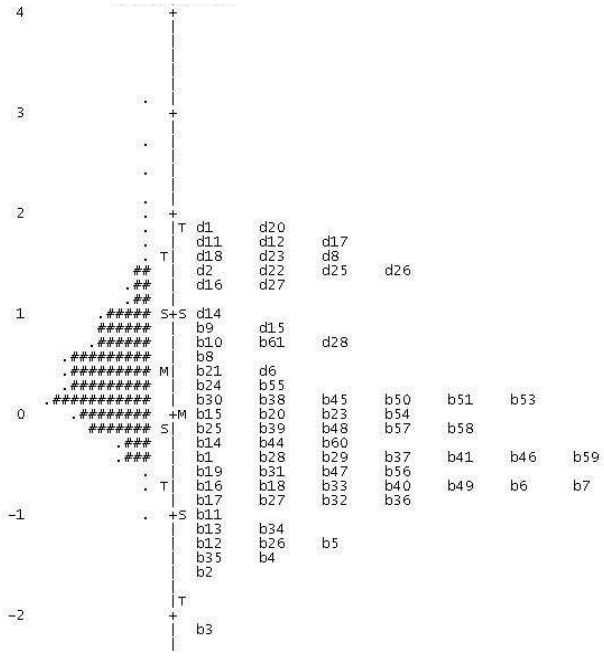

Fig. 1 Person map of items

The summary statistics shown in Table III revealed that the item reliability and the person reliability is high. This indicates that the instrument has high reliability and validity to measure awareness of waste management.

TABLE III
SUMMARY STATISTICS

| No | Item | Value |
|---|---|---|
| 1 | Item reliability | 1.00 |
| 2 | Person Reliability | 0.92 |
| 3 | Person Separation | 3.30 |

A good instrument can differentiate between two groups for example a high ability group and a low ability group. The Rasch Model analysis can produce an index which indicates the number of groups that respondents can be divided into. This refers to the person separation index with the minimum cutting point of two. The person separation value of 3.30 in this study suggests that the respondents can be categorized into three distinct groups.

In this study the degree of awareness about waste management is measured along a continuum. This continuum extends from 'difficult to be aware' to 'easy to be aware'. The findings of this study demonstrated that separating waste and using compost in planting is the most difficult manifestation of awareness. Belief about proper waste disposal is the least difficult form of awareness.

There is a distinctive gap at the lower end of the continuum. This gap occurs between the least difficult form of awareness 'belief in proper waste disposal' and 'belief in separating waste to recycle' which is the next least difficult form of awareness. This gap may be due to families commonly teaching their children about proper waste disposal. However separating waste to recycle is not a common practice in many

Malaysian households. Therefore there is lesser tendency to believe in separating waste. Nevertheless belief about waste management practices is relatively easier than the actual practice about waste management. Examples of such belief are separating, recycling and reducing waste. Respondents also believed that the responsibility of raising awareness lies in the hands of government and school. It appears that there is a lack of internalization of awareness among the sample. The driving factor for awareness appear to come from external factors like school and government. Another distinctive gap is also shown at the upper end of the continuum in the item person map. The cluster of practice above this gap, which is positioned at the higher end of the continuum, refers to actions that must be taken by the person himself. The cluster below this gap includes actions conducted by others such as advising canteen operators to compost food waste. The gap between these two clusters reflects the difficulty in self-internalizing waste management awareness through practice. The first cluster represents self-internalization of waste management awareness which requires more effort compared to the second cluster.

The data showed that self-internalization of waste management awareness that do not require much effort as it is the easiest form of awareness which is reflected in the attitude of respondents. Such attitude refers to action carried out by others for example provision of recycling services and awareness activities. On the other hand, the most difficult form of waste management awareness refers to actions that the person has to perform. Examples include separating waste, using compost in planting and making compost from food waste. In general it is easy to profess attitude towards waste management but it is difficult to practice waste management. Thus awareness of waste management is easily achieved through attitude of people but not necessarily through their practice.

## VI. Implications And Recommendations

This study demonstrated that a new and reliable instrument has been developed that can measure awareness about waste management of secondary school children. This instrument has showed that a positive awareness towards waste management refers mainly to attitudes. However it is not easy for people to practice waste management as a reflection of their awareness. This is because such actions need external intervention for example by school or government. It is recommended that any research in a similar area can use this instrument. This instrument has been shown to be able to measure waste management awareness based on items referring to belief, attitude and practice.

Based on the findings an intervention program is necessary to improve practice about waste management. Such intervention program should include school children to inculcate awareness from a young age. This intervention program can be part of research project to identify any increase in awareness as a result of the intervention. The research can include interviews with the participants before and after intervention. Such interviews can identify reasons why there is high awareness about certain issues and not others. Similarly reasons for performing certain waste management practices and how such practices can be increase will be identified.

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