INITIAL IMPACT ANALYSIS OF STEM EDUCATIONAL MODEL BY INNOVATIVE SUSTAINABLE HOME (iG-HOME) USING THE RASCH MEASUREMENT MODEL

MUHAMMAD IMRAN MOHD JUNAIDI\textsuperscript{1,2}, SHAHROM MD ZAIN\textsuperscript{1,2,*}, ROSZILAH HAMID\textsuperscript{1,2}, NOOR EZLIN AZHAD BASRI\textsuperscript{1,2}, FATIHAT SUJA\textsuperscript{1,2}, SITI AMINAH OSMAN\textsuperscript{1,2}, RUHIZAN MOHAMMAD YASIN\textsuperscript{2,3}

\textsuperscript{1}Department of Civil and Structure Engineering, Engineering Education Research Centre,\newline\textsuperscript{2}Faculty of Engineering and Built Environment,\newline\textsuperscript{3}Department of Learning and Teaching Innovation, Faculty of Education, Universiti Kebangsaan Malaysia, 43600, Bangi, Selangor, Malaysia\newline*Corresponding author: smz@ukm.edu.my

Abstract

Twenty undergraduate students from the Department of Civil and Structure Engineering (JKAS) implemented a STEM Educational Model by innovative sustainable home (iG-HOME) with 40 pupils from Sekolah Menengah Kebangsaan Bandar Tasik Kesuma, Selangor, Malaysia. iG-HOME was introduced as a novel approach in the effort to nurture students' interest in STEM knowledge and to increase awareness of the environmental in their homes. A combination of STEM and environmental awareness education has given rise to a new approach which will be implemented in schools whilst at the same time passing the knowledge and awareness to the students’ families at home. Students will be exposed to real world problems and how they could use the STEM solutions they learned at school could use to solve these problems. iG-HOME comprises six key components of sustainability in which STEM solutions are to be nurtured and implemented at home. Students’ initial perception towards science and mathematics was encouraging. Perhaps: Based on initial Rasch model assessment, student’s motivation and academic self-concept play important roles in determining their interest in STEM subjects. Students’ perception towards STEM education improved after attending the first series of the iG-HOME program. Their feedback on the developed iG-HOME model is encouraging based on the value of Cronbach Alpha (KR-20) for the first and second series of 0.59 and 0.93, respectively.

Keywords: iG-HOME, STEM education, Sustainable Home, Innovation.
1. Introduction

Malaysia’s economy is shifting from manufacturing-based to a service-based economy, and this has led to the high demand for a labour force highly educated in science, technology, engineering, and mathematics (STEM). The success of a country depends on the quality and quantity of STEM education received by students who choose to study in this field [1]. STEM could be one of the factors, but it is quite aggressive to generalise it this way, this is too strong a statement, may be relax the tone and add a few more factors and reference without losing author’s intention. Thus, it is crucial to strive to improve students’ achievement and participation in STEM-related subjects in order for Malaysia to remain competitive in a challenging global economy. Moreover, international approach which is supported by adequate development in science and technology to deal with global challenges such as In addition to the global economic challenges, climate change, over population, management of natural resource, agricultural production, health, biodiversity, and the decline of in energy, and water resources is require urgently [2]. However, many education-related researchers have found that students’ interests to pursue STEM subjects have been declining [3]. In western countries and leading Asian economic countries, this is also true with regards to students’ motivation to learn science [2]. Hence, many countries are becoming increasingly concerned with improving STEM education and skills.

In an era where science and technology play an important role in our daily lives and in the economy, the decline in the number of students who choose to pursue their studies in the science stream as they begin their form four (16-year-old teenagers) is very alarming. Prof. Datuk Dr. Hamdan Halimaton of the Academy of Sciences Malaysia reported that the target ratio of 60:40 science to non-science students is not being met; the 21:79 ratio in 2014 shows that a declining interests in the field of science has resulted in a shortage of STEM talents [4]. 500,000 students who sat for the SPM each year, only 90,000 students are from the science stream [5]. Therefore, it is crucial to build a solid foundation in STEM amongst primary and secondary school students as a catalyst to their interest in this subject so that they will fill the demand of the industrial sectors and future labour forces.

Environmental education, along with STEM education, plays an important role at the global level. Public awareness regarding the need to conserve the environment can be improved with environmental education. However, environmental education in Malaysia is not a core subject in school and it is only taught as a part of other core subjects. Due to this practice in the Malaysian education system, environmental education has not only been unable to increase awareness of the environment, but it is also not effective in changing the habits and behaviour of students [6]. Students do not have the motivation to make a change for a more sustainable life because they only are given the knowledge and awareness of the best way to take care of the environment without being taught how to apply them in their lives [7]. Same goes to the STEM education where the education system doesn’t emphasize on it in the classroom. Therefore, the education system should be improved by giving focus to the methods of delivering knowledge to students and the Ministry of Education needs to take proactive measures to assess the effectiveness of the present education system.
The objective of this paper is to assess the students’ interest and inclination towards science and mathematics at the lower secondary school level. This can be done by the analysis the development of STEM Education Model by Innovative Sustainable Homes (iG-HOME). This paper also demonstrates the effectiveness of the second series of the Model iG-HOME.

2. Methodology

2.1. Respondent

The targeted participants of the iG-HOME program are junior high school students from Kajang, Selangor. Forty lower secondary school students from Sekolah Menengah Kebangsaan Bandar Tasik Kesuma (SMKBTK) were selected as respondents in this study. Participants went through three series of iG-HOME program at different times and different topics. The first series was an introduction to a sustainable environment while the other two series focused on the iG-HOME model itself. However, this paper will only present the results for analysis of the first and second series which were held in November 2015 and March 2016 respectively.

2.2. Research instrument

The questionnaire was distributed immediately after the iG-HOME program Series 1. Forty students completed the program in November 2015. The questionnaire was used to assess students’ interest based on their perception of science and mathematics (part B and C), student anxiety with regard to science and mathematics (part D), the importance of science and mathematics in everyday life (part E), self-concept in science and mathematics (Part F), and motivation in science and mathematics (part G).

The questionnaire for the second series of the iG-HOME program was also distributed as soon as the program ended. A total of 37 students completed the program which was held in March 2016. The questionnaires focused on three components in the iG-HOME Model, namely respondent background (Part A), respondents’ view of 3Rs and waste separation module (Part B), respondents’ view of the Biogas module (Part C), and respondents’ view of the Compost module (Part D) respectively.

2.3. Rasch measurement analysis

Analysis was done to ensure that the data meet the assumptions of the Rasch model in assessing the quality of measurement items. The psychometric characteristics of this test item was examined using several indicators, such as index point corresponding statistical items, reliability and individual items. Data were analysed using the Winsteps software, unidimensional Rasch Measurement Model computer program to ensure that all difficulties of the items were ordered linearly on the same scale which is individual score.
3. Results and Discussion

Based on the summary statistics for the questionnaire iG-HOME Series 1, the Cronbach-Alpha value for parts B and C is 0.55. This means the value is not within the range of good reliability and should be improved. Nonetheless, the value is still above the acceptable level of 0.50. Several items should be added to the instrument to improve reliability. Figure 1 presents the results of the statistical summary, which shows the reliability of the item instrument and person/respondents in this study. The reliability of person is 0.52, which is in the poor range, while the item instrument is 0.91, which is within a good range. The analysis shows that the respondents are not very reliable whereas the listed items are trustworthy. The low person reliability indicates that such instruments may not be sufficiently sensitive to distinguish between respondents ‘views of science and mathematics. However, results show that respondents’ views on the subjects of science and mathematics is fair. This is due to the fact that the respondents’ views are related to either teaching methods, student involvement, environment, facilities, or teacher’s attitude. It should be noted, however, that the instrument item is not specific to the item, but is only specific in principle.

![Fig. 1. Statistical summary for Parts A and B.](image)

Further analysis is done for parts C, D, E, and F. This analysis is done separately from parts A and B because the answers to the item instrument is on a Likert scale. Figure 2 shows a summary of the analysis for Parts C to F. The Cronbach alpha for reliability is 0.59. This value is falls within the poor range but is still above the acceptable level. The summary statistics also show a more detailed reliability of person and the item instrument, namely 0.54 and 0.91, respectively. In this study, reliability of person is poor. In order to increase person...
reliability, the students’ ability range should be widened [8] and more items should be added. The low reliability of Cronbach Alpha is due to inadequate number of questions and a poor relationship between the items.

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\begin{array}{|c|c|c|c|c|c|c|}
\hline
\text{SUMMARY OF 40 MEASURED PERSONS} & \text{MODEL} & \text{RAW} & \text{INFIT} & \text{OUTFIT} \\
\hline
\text{MEAN} & 107.0 & 29.0 & .66 & .20 & 1.02 & .0 & 1.00 & -1.1 \\
\text{S.D.} & 32.0 & .6 & .32 & .02 & 1.37 & .1 & 1.34 & 1.3 \\
\text{MIN.} & 92.0 & 9.0 & .1 & .18 & .49 & .24 & .48 & 2.4 \\
\hline
\text{REAL RMSE} & .22 & ADJ.50 & .24 & & & & & \\
\text{PERSON RELIABILITY} & .64 & & & & & & \\
\text{S.T. OF PERSON MEAN = -.05} & \text{PERSON RAW-SCORE TO MEASURE CORRELATION = 1.00} & \text{Cronbach Alpha (KR-20) PERSON RAW SCORE RELIABILITY = .90} & \text{Cronbach Alpha (KR-20) ITEM SCORE RELIABILITY = .90} \\
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\begin{array}{|c|c|c|c|c|c|c|c|}
\hline
\text{SUMMARY OF 29 MEASURED ITEMS} & \text{MODEL} & \text{RAW} & \text{INFIT} & \text{OUTFIT} \\
\hline
\text{MEAN} & 547.6 & 48.0 & .08 & .17 & 1.00 & .0 & 1.00 & .0 \\
\text{S.D.} & 22.2 & .0 & .62 & .03 & .25 & 1.2 & .25 & 1.2 \\
\text{MIN.} & 97.0 & 48.0 & .21 & .15 & .54 & .25 & .55 & .25 \\
\hline
\text{REAL RMSE} & .18 & ADJ.50 & .59 & & & & & \\
\text{ITEM RELIABILITY} & .90 & & & & & & \\
\text{S.T. OF ITEM MEAN = .12} & \text{ITEM RAW-SCORE TO MEASURE CORRELATION = 1.00} & \text{Cronbach Alpha (KR-20) ITEM SCORE RELIABILITY = .90} & \text{Cronbach Alpha (KR-20) ITEM SCORE RELIABILITY = .90} \\
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\end{array}
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Fig. 2. Statistical summary for Parts C to F.

The distribution of students’ ability and item difficulty is demonstrated by a variable map on a same logit scale. Students’ ability is listed on the left side of the map while item difficulty is on the right side of the map. Student with higher ability (left side) and more difficult items are represented at higher logits and vice versa [9]. The variable map allows for the determination of whether the items match the ability of students. Figure 3 shows that items D3 and D8 are easy while items C1 and C5 are difficult. For person, P25 and P16 did not face any problems in giving feedback to the items compared to the remaining respondents. The items can also be categorised based on the factors that affect respondents’ interest in science and mathematics. Figure 3 also shows that students’ motivation and academic self-concept are the most critical factors in determining their interests in science and mathematics. Both factors have a positive connection with the strongest driving factor for students’ motivation, namely academic self-concept [10-12]. Hence both these factors were taken into account when implementing the program.

Figure 4 presents the statistical summary for the analysis of the data collected from the second series of the iG-HOME program. The Cronbach Alpha of 0.93 shows that the reliability score for this questionnaire is excellent. This means that the instrument is valid and can be used to measure what it was intended to measure. The person and item reliability also show excellent values of 0.91 and 0.92, respectively. These values show that the item instrument is able to sufficiently measure respondents’ opinion regarding the implemented iG-HOME model and that they were able to distinguish between the respondents answering the questionnaire. In addition, the statistical summary shows that the respondents gave a positive feedback regarding the program implemented with them.
Fig. 3. Variable Maps for Parts C to F.

Fig. 4. Statistical summary based on the questionnaire of the second series of the iG-HOME program.
The increasing Cronbach Alpha values indicates that the instrument distributed to the respondents have successfully measured for intended objectives. The reliability index shows that some items are retained since they show good quality and usability in measuring the effectiveness of the model. They are ready for use as customized by the user test. However, improvements could be made to the first questionnaire by adding more questions to each section as well as by using a Likert scale questionnaire as opposed to the Guttman scale.

4. Conclusion
Based on the Rasch model analysis, we can observe that students’ perception of science and mathematics is fair. The main factors to be taken into account in increasing students’ interest in STEM subjects are motivation and academic self-concept, which must be nurtured in students. After undergoing the iG-HOME program, students have shown better involvement, interest, and inquisitiveness; they have also implemented the activities that were taught along with the knowledge. This shows that the model is able to change students’ habits and thus are proven to be effective. However, data regarding students’ interest and inclination towards science and mathematics was only taken after the participants have undergone the entire iG-HOME model. This is necessary to ensure that students appreciate and understand the knowledge delivered, as well as have better awareness regarding in preserving the environment. The exposure is also necessary to motivate to broaden their knowledge in STEM subjects.

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