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# A Confirmatory Factor Analysis of Malaysian Primary School Students' Energy Saving Practices

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## ABSTRACT

This paper purposed to validate Malaysian primary school students' energy saving practices via confirmatory factor analysis. The sample of the study was a total of 401 primary school students, who were selected with randomly cluster sampling method. To collect data, a five-point Likert scale was used. Data were exposed to descriptive analysis (Cronbach's alpha values for reliability) and a confirmatory factor analysis for testing measurement models for each of the constructs through AMOS software. The results showed that Cronbach's alpha coefficient was higher than 0.70. The results of the first and second order confirmatory factor analyses (CFA) ensured that the collected data fit with the model. It was also found that the measurement model satisfied specified measurement criteria. Overall, it can be deduced that the extracted components are useful guidelines to increase Malaysian primary school students' understanding of energy saving practices. Further, this research recommends some implications for future research and practitioners.

**Keywords:** Confirmatory factor analysis (CFA), energy saving practices, measurement model, primary school students.

## INTRODUCTION

Nature is a source of nutrition, oxygen, water, energy and production for human beings. Because raw materials come from natural environment, humans attain them for daily needs, i.e., nutrition and energy. Hence, this production process yields a product; however, a waste then pollutes natural environment (Hilal, 2011). In other words, even though nature recycles and transforms some wastes into raw materials, a greater amount of wastes pollutes natural sources (Invergard, 1976).

Air and environmental pollutions, which are well-known ones, result from the use of fossil fuels, e.g., coal, petroleum and natural gas, which are mostly used in industries, vehicles and domestic purposes (Sims et al., 2007). These fossil fuels particularly emit carbon dioxide and sulfur dioxide, which trigger air with environmental pollutants (i.e., lead). These gases

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react with water in the air and fall back to the earth as acid rain. Acid rain, which damages flora, fauna and buildings/infrastructures, causes water and environmental pollutions (Alpdogan, 1996). Furthermore, since the use of fossil fuels potentially brings about environmental pollution, energy production and consumption processes lead to destructive environmental pollution (Ayvaz, 1991). For these reasons, the consumption of energy sources not only emerges environmental problems but also threatens sustainable environmental development. Population growth, economic growth and high living standards have resulted in a steady increase in global energy consumption (approximately by two percent annually) (United States Department of Energy, 2016). By the end of the 21st century, this increase seems to be double.

A gradual increase in the technological use of energy makes energy an important issue. Thus, society is faced with energy consumption pressuretoday due to global energy crisis, climate change, and environmental degradation. Indeed, producing electricity through fossil fuels or using them for domestic heating are mainly responsible for half of pollution resulting in global warming. As a matter of fact, numerous national and international reports point to the importance of enacting immediate, dramatic and disaster coming from energy problem (Intergovermental Panel on Climate Change, 2013). In 2017, NASA published a study uncovering how fast Antarctica's ice sheets were flowing into the ocean. Based on seven years of images (from 2008 to 2015), scientists found that glaciers were accelerating Antarctica's Getz ice shelf into the southwestern part of the continent (NASA, 2017). This stems from an increase in the worldwide use of energy triggered by the sustained economic growth.

Energy consumption has been growing in such Asian countries as China, India, Indonesia, Malaysia or South Korea (Enerdata, 2017). For example; in Malaysia, a citizen's home consumes approximately 251 kilowatt hours (kWh), which is equivalent to RM60.63 of electricity per month, releasing close to 171.68 kg of carbon dioxide (Malaysian Green Technology Corporation, 2015). To solve this problem, the Malaysian government has been made significant efforts with Go Green campaigns to address the importance of green behaviour and energy saving to society (Golnaz, Masoum, Mad Nasir, Ismail & Juwaidah, 2015). The Malaysia Energy Efficiency Action Plan was also framed to promote the efficient use of energy and minimize energy waste. Thus, this has contributed sustainable development and increased welfare and competitiveness (Ministry of Energy, Green Technology and Water Malaysia (KeTTHA), 2014). Therefore, the use of sustainable energy has been suggested for equatorial climate in Malaysia. All stakeholders have responsibilities to resolve energy consumption issues. This can be achieved by starting with the home and early childhood education.

Therefore, environmental education for energy issues may help students to cope with present and future energy needs and to shape their own attitudes, lifestyle practices and behaviors. The purpose of this paper was to validate the Malaysian primary school students' energy saving practices via a confirmatory factor analysis.

## Energy Saving in School

Environmentally preferable products, sustainability, green terms, and a decrease in the environmental footprint are a part of everyday life . Since energy efficiency is a very popular concept in the public and private sectors recently, environmental strategies and tactics have been designed to reduce its impact on the environment and human health (National Association of State Boards of Education, 2012).

Energy and its usage, one of the most important environmental issues, substantially affect economic and social development and qualified life in developing countries (Ntonaa, Arabatzis & Kyriakopoulosc, 2015). The risk of climate change and environmental degradation are in a parallel with globalized developmental processes and human interventions. The same thing is valid for educational institutions around the world even more at school (Nevzat, 2016).

School management is effectively in charge of the use of energy, although most of them have historically given little attention to control energy costs. Reducing wasted energy offers an excellent chance for minimizing a school's environmental footprint. For instance; turning unneeded lights off and decreasing other sources of wasted energy, students, staff and faculty may have an immediate impact on energy saving. Reducing electricity consumption is especially a ripple meaningful effect for the footprint of coal and gas-fired power plants, which is exaggerated by inherent system inefficiencies (Gülüzar, 2016). That is, approximately half of the fossil fuel consumed in power plants goes to production loss (Kate, 2013). Schools, which help students become environmental conscientious stewards and environmental friendly citizens, also have a very unique role in environmental protection. Any school-based environmental effortneed to maximize their roles in environmental protection (Anne, 2012).

Additionally, young students and children act as the true leaders in forging the way to attain a positive change for energy saving and reduce the financial and environmental burdens that accompany wasteful energy consumption. Thereby, students may find creative and innovative ways to engage their schools, families, peers and the community in disseminating energy awareness (Jo, Jennifer, Lani, Lorraine & Thach, 2012). Since children are decision-makers of the future, this population remains understudied for making any contribution to energy consumption. Schools can also equip students with conceptualizing and inspiring the importance of their reactions on environmental issues. Schools have an environmental footprint and generate trash. They use energy for heating, lighting, photocopying and so on. Schools are also cleaned using chemicals that have environmental impacts (Ikerne, 2013).

To encourage the implementation of an energy-saving eco school, an award called 'Sekolah Lestari' has been introduced by the Malaysian government. This award (addressing four main elements – management, greening activities, co-curriculum and curriculum) is hinged on an integrated approach that involves the school community, families, communities, government, private sector and non-governmental organizations. . This programme encapsulates current and planned environmental activities, such as the Wira Alam Project, Eco-Youth Programme, Renewable Energy and Energy Efficiency, Landscape and Beautification Programme, 3K Programme (Safety, Cleanliness and Beautification), Environmental Awareness Camp and other environmental activities (Ministry of Natural Resources & Environment, 2016). The Sekolah Lestari programme has possessed a transformative effect on Malaysian students' behaviors of towards environmental sustainability (Hanifah, Shaharudin, Mohmadisa, Nasir & Yazid, 2015).

Energy saving practices are theoretically related to the Social Practice Theory concentrating on the analysis of human behaviors , i.e., the use of energy and its consumption. Moreover, studies of sustainable energy saving practices refer to conceptual knowledge or conceptual understanding of environmental issues under investigation (Richmond & Morgan, 1977).

Therefore, this research deployed questionnaires to measure the Malaysian primary school students' knowledge of environmental sustainability regarding energy savings (e.g., electricity saving practices, water saving practices, nature-loving practices and 3R--reuse, reduce and recycle-- practices).Thus, this research measured the Malaysian primary school students' energy saving practices using a confirmatory factor analysis.

## METHODS

### a) Participants

Data were collected from 401 students (aged 10 to 12 years), which were selected from ten primary schools in the district of Batang Padang, Perak thourh a random cluster samplingmethod. A five-point Likert scale was administered by the researchers. Also, if necessary, they clarified any unclear issue in each item.

### b) Developing the Questionnaire

The researchers firstly reviewed the related literature on the 'energy saving' concepts. Based on the literature review, an originally item pool was developed. The first draft of the scale consisted of four sub-factors – electricity saving practices, water saving practices, nature-loving practices and 3R practices. The sub-factors comprised of eight modified items from the energy saving practices outlined by the Ministry of Energy, Green Technology and Water Malaysia (KeTTHA) and the Association of Water and Energy Research (AWER). Then, the draft version was undergone an expert validity by four lecturers from the Universiti Pendidikan Sultan Idris dan Universiti Kebangsaan Malaysia. Further, its face validity was ensured with five Form 3 students.

A five-point Likert scale ranged from Strongly Disagree (one point) to Strongly Agree (5 points). Its Cronbach's alpha values for all sub-factors clearly indicated acceptable levels (see Table 1) suggested by Cohen and Manion (1989). Further data were analyzed using SPSS 22.0™.

Additionally, the data were evaluated for unidimensionality of the items and the sub-scales through CFA using AMOS (Analysis of Moments Structure) (Arbuckle & Wothke, 1999), which is a statistical programme designed for performing structural equation modelling (SEM), a form of multivariate data analysis that can test for goodness-of-fit between research data and hypothesized models. AMOS calculates maximum likelihood (ML) estimates from a covariance matrix using several goodness-of-fit indices between the data and the specified model. Besides, Hair, Black, Babin, Anderson and Tatham (2006) recommended a number of goodness-of-fit indicators to test a hypothesized model. Assessment of model fit was based on multiple criteria, including both absolute misfit and relative fit indices.

The absolute misfit indices included the root mean square error of approximation (RMSEA), and the relative goodness-of-fit indices were the comparative fit index, the Tucker Lewis index and the incremental-fit index (CFI, TLI, IFI) (Hair et al., 2006). In view of Arbuckle and Wothke (1999), a model fits if the value of CMIN/df is between 1 and 5. Also, the CFI, IFI and TLI indices are acceptable fit for 1.00; a RMSEA index of 0.08 or less indicates a reasonable error, which is acceptable. The present study followed Hair et al.'s (2006) recommendations on the use of five indices at model fit: $\chi 2$/df, CFI, IFI, TLI and RMSEA. Table 1 shows the first order measurement for model fit of energy saving practices.

**Table 1**. Fit Indices for the Measurement Model

| Fit Indices | Recommended values | Source |
|---|---|---|
| $\chi^2 / df$ | $\leq 5.00$ | Hair et al. (2006) |
| TLI | $\geq 0.90$ | Hoyle (1995) |
| IFI | $\geq 0.90$ | Chau & Hu (2001) |
| CFI | $\geq 0.90$ | Bagozzi & Yi (1988) |
| RMSEA | $\leq 0.08$ | Browne & Cudeck (1993) |

## RESULTS and DISCUSSION

### a) Reliability

Reliability is the accuracy and stability of the currency or marks of the scale of measurement (Hair, Anderson, Tatham & Black, 2010). In view of Sekaran and Bougie (2009), the higher the value is, the higher the alpha internal reliability is. This study set the value of Cronbach's alpha coefficients at 0.70 offered by Pallant (2010), Babbie (2007), and Hair et al. (2006). As seen in Table 2, the reliability values are are higher than 0.70. This demonstrates that the scale was acceptable. A confirmation factor analysis (CFA) was conducted on the four-construct-structure model using the Analysis of Moment Structure (AMOS 20.0$^{TM}$).

### b) Fit Indices

As can be seen from Figure 1, the first order measurement model included a total of 401 Malaysian primary school students. The overall fit analysis for the measurement model showed the following values: Chi-square / df=1.558, CFI=0.889, TLI=0.888, GFI=0.923 and RMSEA=0.37. This indicated that the model was not fit for CFI, TLI value ≤ 0.90. Therefore, revisions were made for the model given guidelines by previous scholars (see Table 2).

**Table 2.** Revisions steps

| Indicators | Cut-off | Description | Source |
|---|---|---|---|
| **Normality** | | | |
| • Univariate kurtosis and skewness values | ± 2 | Data do not violate the univariate normality assumptions | Garson (2012b) |
| • Mardia's coefficient/ multivariate kurtosis | 1.96 or less | Nonsignificant kurtosis reveals significant normality. Thus, data do not violate the multivariate normality assumptions | |
| **Outliers** | | | |
| • Univariate outliers: standardized z score for large sample | ≥ 4 | Cases are outliers | Hair et al. (2010) |
| • Multivariate outliers: Mahalanobis distance ($D^2$) | Highest $D^2$ values (significant) *( $\alpha$ ) is 0.001 or 0.005 | $D^2$ values indicate significant for outliers at 0.005 level while those show extreme outliers at 0.001 level . | Hair et al. (2010) and Kline (2011) |
| **Multicollinearity** | | | |
| • Inter-construct correlation | >0.9 | Multicollinearity problem exist | Hair et al. (2010) |
| • Standardized regression weight (factor loading) | Close ti 1 | Multicollinearity problem exist | Garson (2012b) |

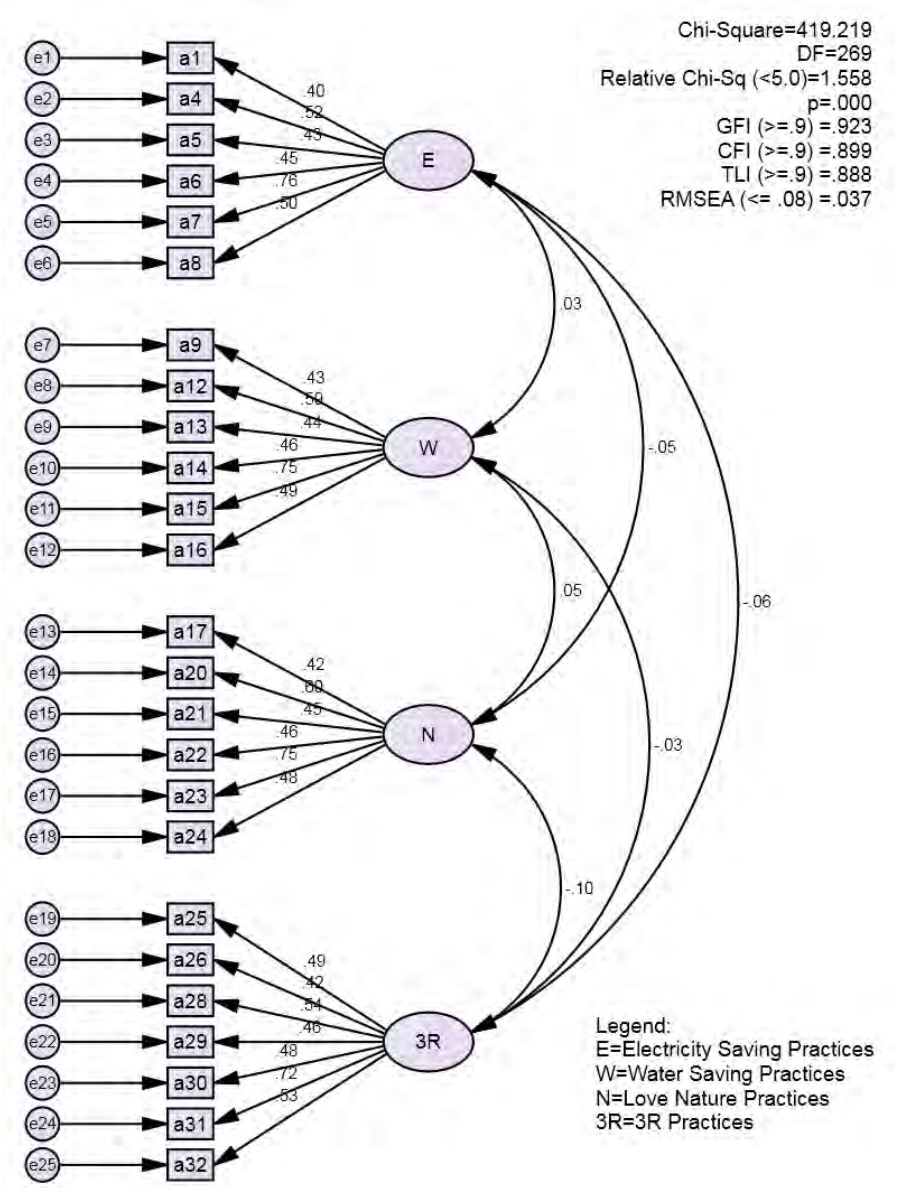


**Figure 1:** First Order Measurement Model before Revision

After revision, four items were dropped (see Figure 2). The revised model was tested again and the results of the CFA indicated a better fit. The goodness-of-fit indices for this model were as follows: Chi-square/df = 1.439, CFI=.935, TLI=.925, GFI= 0.941 and RMSEA=.034. This means an excellent model fit for the observed data. All paths between the latent sub-factors were statistically significant. The excellent model fit provided further evidence of the scale's validity.

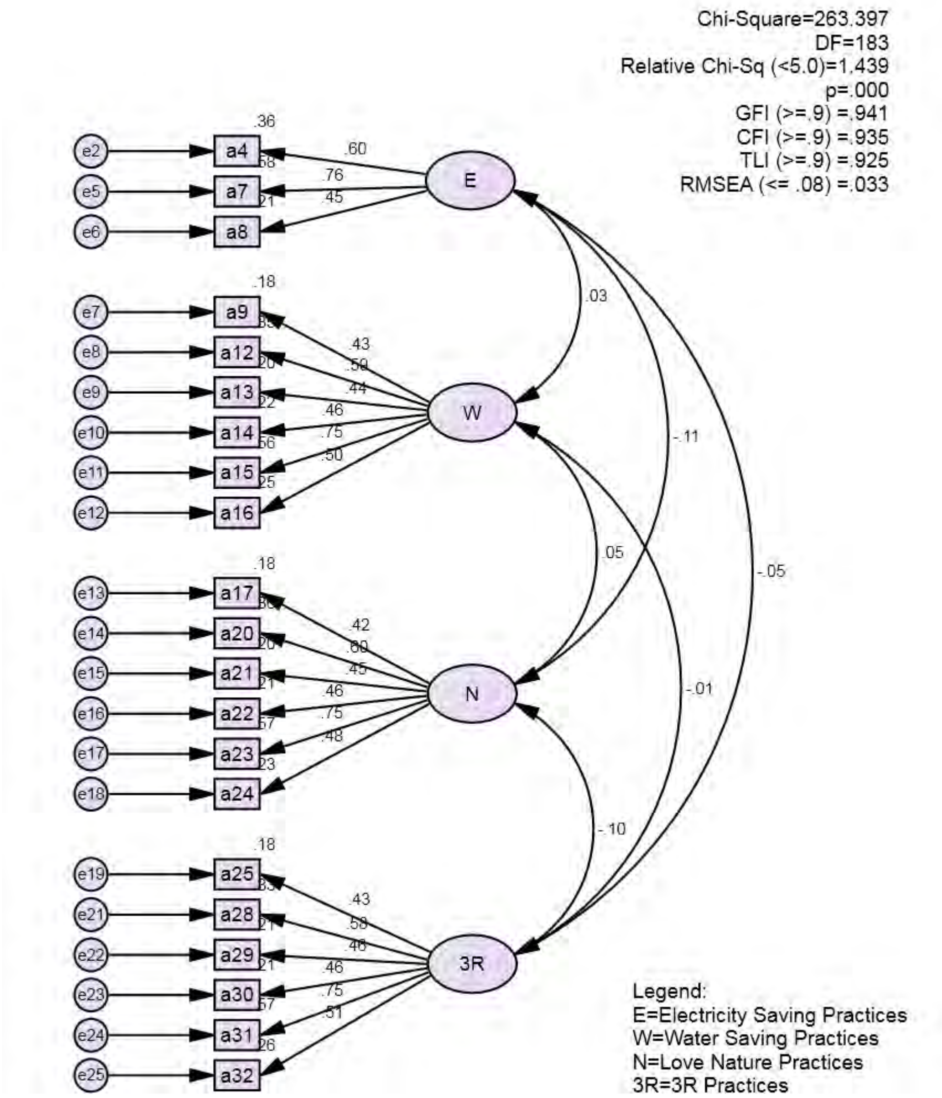


**Figure 2:** First Order Measurement Model after RevisionModification

As observed in Table 3, the correlations between all items were less than 0.90. This means no multicollinearity between constructs (Hair et al., 2006).

**Table 3.** Correlations between constructs

| Constructs | Electricity Saving Practices | Water Saving Practices | Love Nature Practices | 3R Practices |
|---|---|---|---|---|
| Electricity Saving Practices | 1 | 0.03 | -0.109 | -0.048 |
| Water Saving Practices | | 1 | 0.052 | -0.014 |
| Love Nature Practices | | | 1 | -0.097 |
| 3R Practices | | | | 1 |

Note: All correlations were significant at the 0.05 level.

Furthermore, convergent validity and discriminant validity were checked. Convergent validity is the degree to which multiple attempts to measure the same concept are in agreement. Convergent validity was assessed based on factor loading, composite reliability, and variances extracted (Hair et al., 2006). As can be seen from Table 4, the factor loading values for all items exceeded the recommended level of 0.50, which indicates categories of greater importance (Hair, 1998; Steven, 2003). Composite reliability values depicting the degree to which the construct indicators indicate the latent construct from 0.64 to 0.71 (see Table 4). The composite reliability of all latent constructs exceeded the recommended level of 0.60 (Hair et al., 2006). The extracted average variances were between 0.29 and 0.38. Moreover, discriminant validity is the degree to which the measures of different concepts are distinct. Discriminant validity can be examined through the squared correlations between constructs and the extracted variance for a construct (Anderson & Gerbing, 1988; Fornell & Larcker, 1981; Hair et al., 2006).

**Table 4.** Result of CFA for the measurement model

| Construct | Item | Factor Loading | Composite reliability values | Extracted Average Variances |
|---|---|---|---|---|
| Electricity Saving Practices | a4 | 0.602 | 0.84 | 0.58 |
| | a7 | 0.761 | | |
| | a8 | 0.455 | | |
| Water Saving Practices | a9 | 0.426 | 0.75 | 0.49 |
| | a12 | 0.592 | | |
| | a13 | 0.445 | | |
| | a14 | 0.464 | | |
| | a15 | 0.747 | | |
| | a16 | 0.495 | | |
| Love Nature Practices | a17 | 0.425 | 0.77 | 0.59 |
| | a20 | 0.601 | | |
| | a21 | 0.448 | | |
| | a22 | 0.462 | | |
| | a23 | 0.753 | | |
| | a24 | 0.483 | | |
| 3R Practices | a25 | 0.429 | 0.71 | 0.53 |
| | a28 | 0.578 | | |
| | a29 | 0.459 | | |
| | a30 | 0.455 | | |
| | a31 | 0.753 | | |
| | a32 | 0.514 | | |

Afterwards, the second order measurement models were conducted to convert the constructs into indicators for measuring energy saving practices. The results (see Figure 3) came from a total of 280 Malaysian primary school students for the second order measurement model. The goodness-of-fit indices were as follows: Chi-Square/df=1.431, CFI=0.935, TLI=0.926, GFI=0.940 and RMSEA=0.33. This means that the model was fit (Figure 3).

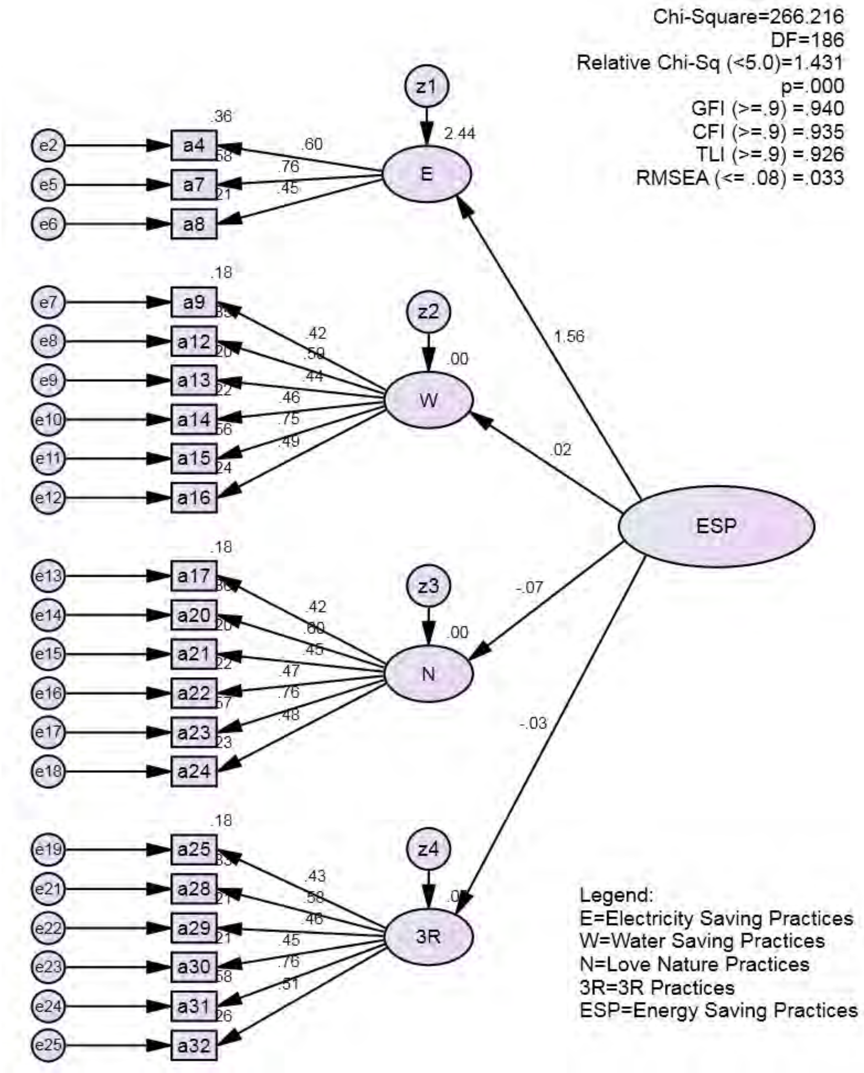


**Figure 3:** Second Order Measurement Model

As observed in Table 5, standardised loading, composite reliability and extracted average variance for all four indicators of energy saving practices exceeded the acceptable level (0.70) suggested by Hair et al. (2006).

**Table 5.** Standardised Loading, Composite Reliability and Extracted Average Variance

| Construct | Item | Standardized Loading | Composite Reliability (CR) | Extracted Average Variance (EAV) |
|---|---|---|---|---|
| E | Electricity Saving Practices | 1.562 | 0.75 | 0.51 |
| W | Water Saving Practices | 0.02 | | |
| N | Love Nature Practices | 0.07 | | |
| 3R | 3R Practices | 0.033 | | |

## CONCLUSION

This paper validated the Malaysian primary school students' energy saving practices via a measurement model. The results showed that the Cronbach's alpha value, which was higher than 0.70, was high and acceptable. This instrument had high reliability. The final model indicated four sub-factors of energy saving practices: electricity saving practices, water saving practices, nature-loving practices and 3R practices. Each item revealed a satisfactory loading value (more than 0.40). Also, the measurement model showed an adequate goodness-of-fit. The final model excluded five original items from 'electricity saving practices' sub-factor after the factor analysis. Similarly, a total of six items (two items per 'water saving practices, nature-loving practices and 3R practices' sub-factors).

Thus, the model developed was suitable for probing the Malaysian primary school students' energy saving practices. The preliminary results of the scale may shed more light on future comprehensive research eliciting students' energy saving practices. To generalize its validity and applicability, future studies should be conducted with larger samples. Also, further study can correlate the results with demographic features (i.e., gender, socio-economic level, type of school management).

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Appendix

**SCALE**

**Malaysian Primary School Students' Energy Saving Practices**

**PART A: DEMOGRAFIC FEATURES**

INSTRUCTIONS:
Please fill in the blank.

**Name** : ______________________
**School** : ______________________
**Year** : ______________________
**Gender** : ______________________
**Ethnics** : ______________________

**PART B: ENERGY SAVING PRACTICES**

INSTRUCTIONS:
For the following questions, please rate the items on a scale of 1-4.
1 for 'never', 2 for 'sometimes', 3 for 'frequently' and 4 for 'very often'.
Round on your preferred answer.

**Electricity Saving Practices**

| | | | | | |
|---|---|---|---|---|---|
| a1 | I switch off the light when not in use | 1 | 2 | 3 | 4 |
| a2 | I switch off the fan when not in use | 1 | 2 | 3 | 4 |
| a3 | I switch off the fan when it rains or cold weather | 1 | 2 | 3 | 4 |
| a4 | I let the television open even if not used * | 1 | 2 | 3 | 4 |
| a5 | I switch off the hand phone charger when not in use | 1 | 2 | 3 | 4 |
| a6 | I shut down the computer when not in use | 1 | 2 | 3 | 4 |
| a7 | I switch off the bedroom light before going to bed | 1 | 2 | 3 | 4 |
| a8 | I leave the refrigerator door open even if it does not take any items * | 1 | 2 | 3 | 4 |

**Water Saving Practices**

| | | | | | |
|---|---|---|---|---|---|
| a9 | I close the tap water while washing my hand | 1 | 2 | 3 | 4 |
| a10 | I close the tap water when brushing teeth | 1 | 2 | 3 | 4 |
| a11 | I close the tap water during hair shampoo | 1 | 2 | 3 | 4 |
| a12 | I let the tap water drain when washing plates / cups * | 1 | 2 | 3 | 4 |
| a13 | I take a shower for a long time* | 1 | 2 | 3 | 4 |
| a14 | I flush the toilet when it is necessary only | 1 | 2 | 3 | 4 |
| a15 | I let the tap water flow while brushing school shoes * | 1 | 2 | 3 | 4 |
| a16 | I use rain water to help my family member wash their cars / motorcycles | 1 | 2 | 3 | 4 |

**Love Nature Practices**

| | | | | | |
|---|---|---|---|---|---|
| a17 | I swept if there was a garbage in school or at home | 1 | 2 | 3 | 4 |
| a18 | I dump trash everywhere * | 1 | 2 | 3 | 4 |
| a19 | I love planting trees | 1 | 2 | 3 | 4 |
| a20 | I use soap and shampoo that is shared with family members | 1 | 2 | 3 | 4 |
| a21 | I help watering the trees in the morning and evening | 1 | 2 | 3 | 4 |
| a22 | I like to burn rubbish * | 1 | 2 | 3 | 4 |
| a23 | I did not step on the grass in the area that was prohibited by the school | 1 | 2 | 3 | 4 |
| a24 | I do not pick leaves / flowers at will | 1 | 2 | 3 | 4 |

**3R Practices**

| | | | | | |
|---|---|---|---|---|---|
| a25 | I store food in recyclable containers | 1 | 2 | 3 | 4 |
| a26 | I use handkerchief instead of tissue | 1 | 2 | 3 | 4 |
| a27 | I remove waste that can be recycled into the recycle bin | 1 | 2 | 3 | 4 |
| a28 | I sell or donate unnecessary clothing | 1 | 2 | 3 | 4 |
| a29 | I use a rechargeable battery | 1 | 2 | 3 | 4 |
| a30 | I use old note books that are still good for school use | 1 | 2 | 3 | 4 |
| a31 | I sell or donate old books that are not used anymore | 1 | 2 | 3 | 4 |
| a32 | I use the pencil until shortest size | 1 | 2 | 3 | 4 |

Thank you for responding to this questionnaire