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Factor analysis on energy saving knowledge among primary school students in Malaysia: A case study in Batang Padang district, Perak

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Abstract

This article verified the key elements for the determinants of students' knowledge in sustainable practices of energy saving. This study involved 423 students from ten primary schools in Batang Padang district, Perak, Malaysia. A five-level Likert scale was used as an instrument to record the responses. Overall, the questionnaire achieved reliability, with Cronbach alpha values for each variable being greater than 0.7. The data obtained were processed using exploratory factor analysis to observe the factors' structure of energy saving knowledge. Next, confirmatory factor analysis was conducted to validate the pre-determined constructs. The findings from both analyses identified and validated the four key elements of students' knowledge of sustainable energy conservation practice as: (i) electricity saving; (ii) water saving; (iii) maintaining environmental practice; and (iv) practice of the 3Rs (recycle, reuse and reduce).

Introduction

The advancement of living standards alongside Malaysia's economic growth has increased the use of energy sources like petroleum, electricity, water and coal to generate economic growth in the country (Selamah & Rizaudin, 2005). However, the rise of global warming problems has caused the various parties to reduce their energy consumption, which was contributing to greenhouse gases. The Malaysian government initiated a number of actions to support the sustainable use of resources, as can be seen in the Tenth Malaysia Plan, 2011–2015. In the draft plan, the growth of renewable energy as an alternative energy source has been enhanced, in addition to the promotion of energy efficiency, which has been implemented to support the continued growth of energy demand. In fact, this has been implemented in conjunction with the fourth strategy of the National Green Technology Policy which was launched in August 2009 (MAMPU, 2012).

Without exception, education is recognized as a most powerful agent of change in society in enhancing sustainable development and improving human capacity in dealing with environmental issues and development (Hanifah, Mohamad Suhaily Yusri, & Shaharudin, 2013; Noraziah & Latipah, 2010). In fact, most researchers—Hopkins and McKeown (2002), Joshi (2009), Moroye (2005), Scoullos and Malotidi (2004), Sterling (2003)—clearly stated that problems that may be due to environmental issues can be solved through education. This is mainly due to education being perceived as a major way of changing society to better achieve sustainable development (Doost, Sanusi, Fariddudin, & Jegatesan, 2011; Fielding & Head, 2012; Foo, 2013; Hazura, 2009). Apparently, educational institutions such as schools have become the main channel for promoting environmental education to the public by providing knowledge, skills, practices and values, and also by guiding society with regard to appropriate actions to address environmental issues (Hanifah, Yazid, Mohmadisa, & Nasir, 2016; Nurul Hidayah, 2012). There is no doubt that teachers, as educators, act as vital role models for their students in practising the values which directly influence their behaviour towards environmental issues (Domka, 2004; Hanifah et al., 2013; Higgs & McMillan, 2006).

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Thus, this article aims to discuss the factors and items of students' knowledge on sustainability practices in relation to the energy saving element that needs to be determined at an early stage.

Literature Review

As part of creating a lasting and sustainable development, knowledge about sustainable practices should be introduced in the early stages of pre-school and primary school. The active involvement of children in environmental education for sustainable development is recognized at the international level, with young ages exposed to the important parts of business and the implementation of education for sustainable development (UNESCO, 2012). Children should not be neglected in the vital goal of environmental sustainability because being a child involves a phase that allows the acquisition of a range of information through observation or learning (Ozdemir & Uzun, 2006). The curiosity of children about their surrounding environment is very high. Thus, the foundations of the construction of knowledge, attitudes and values in respect of sustainable development must be constructed from an early age in childhood, because the child is seen as an efficient model for individual identity and life itself (Hagglund & Samuelsson, 2009).

Since 1996, environmental education has been one subject—along with other important subjects, such as Bahasa Melayu, English, art education, Islamic education, music and mathematics—on the Malaysian curriculum for both of primary and secondary schools (Hanifah, 2014). Nevertheless, an assessment of students' knowledge of sustainability in Malaysia shows that it is still low at the children's level in terms of understanding the issues surrounding environmental sustainability (Amir Hamzah & Chee, 2012). Similarly, Nurul Hidayah, Haryati, and Seow (2013) explained that students' knowledge about the environment based on the method of delivery by science teachers using a science textbook with six year old students is not sufficient for a young learner to react positively to the environment. An early awareness of efforts in sustainable practices should be focused more on obtaining results in environmental education than on convergence, which is clearly parallel with efforts to implement green growth, as suggested in Malaysia's Eleventh Plan (2016–2020).

Theoretically, knowledge about preservation has been discussed by Palmer and Neal (1994), whereas knowledge in environmental education is defined as understanding concepts and information related to the environment. Moreover, knowledge of environmental issues refers to knowledge or understanding of the concepts and facts related to the environmental issues selected in this study. Knowledge of a concept refers to knowledge or understanding or ideas regarding strong support (authoritative support) in writing (literature). Knowledge of facts is the knowledge of particular events that have occurred or circumstances that exist (Richmond & Morgan, 1977). The individual's level of awareness is affected by the amount of knowledge possessed and applied (Meager, Tyers, Perryman, Rick & Willison, 2002). Awareness is related to incorporating knowledge of contemporary issues and discovering which actions can make a difference to an individual's surroundings (Schmidt, 2007). In this research study, knowledge was measured through questionnaires and gauged by reference to the respondents' knowledge of sustainability in relation to energy savings awareness, which covered:

i. Saving electricity
ii. Water conservation
iii. The issue of care for the environment
iv. 3R (reduce, reuse and recycle) practices

Methodology

Participants

The population consisted of primary school pupils in the Batang Padang district, Perak, Malaysia. In total, 423 pupils returned completed questionnaire papers.

Data Collection

A questionnaire was used as the instrument for this study to measure primary school pupils' knowledge about practicing energy saving. The questionnaire contained 32 items on knowledge of practicing energy saving. Items in the questionnaire were constructed based on existing items from previous studies and energy saving practices outlined by the Ministry of Energy, Green Technology, and Water, Malaysia (KeTTHA, 2015). The items were measured on a five-point Likert scale (1: strongly disagree; 2: disagree; 3: neither agree nor disagree; 4: agree; and 5: strongly agree). The number of items and the questions are summarized in Table 1.

Data Analysis

The data used in this study were analyzed using the Statistical software. Data analysis involved three stages. The first stage was reliability analysis, which was performed for each variable to ensure the level of reliability of the obtained data. The demographic information of the respondents for this research study was analyzed descriptively, as it is important to determine the frequency and percentage of respondents' demographic factors (Zainol, Wong, & Mohd Rashid, 2013). Additional analysis involved exploratory factor analysis of the items to see how the items were used and classified according to the structure of certain factors (Hair, Anderson, Tatham, & Black, 2010). Furthermore, the hypothesis model was verified based on structural equation modelling through confirmatory factor analysis (CFA).

Analysis of reliability

Generally, it is important to measure the reliability of a test and the ability of items in the instrument. Reliability is the accuracy and stability of the currency or marks of the scale of measurement (Hair et al., 2010). According to Sekaran and Bougie (2009), the higher the value, the higher the alpha internal reliability. This study set the value of Cronbach's alpha coefficient at .70, as suggested by Babbie (2007), Hair et al. (2010) and Pallant (2010). The reliability of all items in this instrument was more than .70 (Table 2), indicating that the reliability of items that were built into the questionnaire was acceptable.

Table 1 Items and questions on the questionnaire

Item	Item Question
p1	Electricity can be saved if I switch off the lights when not in use.
p2	Electricity can be saved if I switch off the fan when not in use.
p3	Electricity can be saved if I switch off the fan when it's raining or in cold weather.
p4	Electricity can be saved if I leave a television on (negative item)
p5	Electricity can be saved if I switch off phone chargers when not in use.
p6	Electricity can be saved if I switch off the computer when not in use.
p7	Electricity can be saved if I switch off my bedroom light before going to sleep.
p8	Electricity can be saved if I leave the fridge door open even if I do not take any food.*
p9	Water can be saved if I turn off the tap while soaping hands.
p10	Water can be saved if I turn off the tap while brushing teeth.
p11	Water can be saved if I turn off the tap while shampooing.
p12	Water can be saved if I shower quickly.
p13	Water can be saved if I use the bathroom shower to save water.
p14	Water can be saved if I flush the toilet only when necessary.
p15	Water can be saved if I use a bucket of water to help wash the car.
p16	Water can be saved if I use rainwater for watering plants.
p17	The environment can be maintained if I sweep when there is waste in school or at home.
p18	The environment can be maintained if I do not throw garbage everywhere.
p19	The environment can be maintained if I like planting trees.
p20	The environment can be maintained if I share soap and shampoo with family members.
p21	The environment can be maintained if I help water the plants in the morning and evening.
p22	The environment can be maintained if I like burning trash.*
p23	The environment can be maintained if I do not step on the grass in an area prohibited by school.
p24	The environment can be maintained if I do not pick leaves/flowers on a whim.
p25	Waste can be reduced when I store food in containers that can be reused.
p26	Waste can be reduced when I use handkerchiefs rather than tissues.
p27	Waste can be reduced when I put garbage that can be recycled into the recycle bin.
p28	Waste can be reduced when I sell or donate clothes that I do not need.
p29	Waste can be reduced when I use rechargeable batteries.
p31	Waste can be reduced when I use old books that are still good for school use.
p32	Waste can be reduced when I sell or donate old books that are no longer used.

Table 2 Alpha Cronbach values for questions

Section	Variables	Number of Items	Alpha Cronbach value (pupil)
Knowledge to practice sustainable energy conservation	Electricity savings	8	.706
	Water conservation	8	.717
	Protect the environment	8	.712
	3R practices	8	.716

Factor analysis

Factor analysis is a statistical method used to analyze the relationship between several variables and to explain variables in the form of certain latent factors (Chua, 2009; Hair et al., 2010). It is a statistical approach used to summarize the information found in the original number of variables to smaller dimensions or a general nature. Factor analysis can be grouped into two different approaches, namely exploratory factor analysis (explanation, EFA) and confirmatory factor analysis (confirmation, CFA).

Exploratory factor analysis

EFA can be described as summarizing the variables that are interrelated. It is a technique of reducing the number of variables that indicate latent constructs and the structural factors that underline a set of variables (Chua, 2009; Hair et al., 2010). According to Child (1990), EFA is used to explore the structure of factors that may underlie a set of variables studied without imposing any structure formed before conducting any further analysis. Through EFA, the number of constructs and structural factors underlying the variables studied can be identified. Structural factors can give rise to findings based on responses taken from a sample survey. This study assigned four constructs based on previous studies.

Confirmatory factor analysis

CFA is a statistical technique used to verify the factor structure of the set of variables studied (Byrne, 2010; Hair et al., 2010). Analysis factor authentication allows researchers to test the hypothesis involved in the relationship between the variables studied with loading factors which may or may not exist (Byrne, 2010; Hair et al., 2010). The researchers used

theoretical knowledge, empirical research or both to arrive at the relationship between the priorities and then tested the hypothesis using statistical methods (Byrne, 2010; Hair et al., 2010). In order to build latent variables and observed variables, a measurement model was used. The measurement model is a model that defines the relationship between the observed variables with the latent variables. The latent variables are also known as factors or constructs and the variables are known as indicators. Indicators were items (questions) used in the questionnaire designed to observe latent variables or constructs (Byrne, 2010; Hair et al., 2010). The resulting after-weighting measurement or analysis is called a loading factor.

Results and Discussion

Descriptive Analysis

Table 3 shows the distribution of backgrounds of respondents from ten different schools in Batang Padang district, Perak. In total, 423 students participated in this study, with 76 respondents (18.0%) from urban areas and the remaining 347 respondents (82%) from rural locations. A total of 198 (46.8%) pupils were in year six, followed by 121 (28.6%) pupils in year five and 104 (24.6%) pupils in year four. The number of females was 253 (59.8%), while the rest were male. The racial breakdown of respondents was 251 Malays (59.3%), 89 Indians (21.0%), 48 Chinese (11.3%) and 35 Aboriginals (8.3%).

Table 3 Demographics of respondents

	Parameter	N	%
School Location	Urban	76	18.0
	Rural	347	82.0
	Total	423	100
Year	Year 4	104	24.6
	Year 5	121	28.6
	Year 6	198	46.8
	Total	423	100
Gender	Female	170	40.2
	Male	253	59.8
	Total	423	100
Race	Malay	251	59.3
	Chinese	48	11.3
	Indian	89	21.0
	Aboriginal	35	8.3
	Total	423	100

Factor Analysis

Two major tests of EFA and CFA were conducted to test the validity and consistency of the questionnaire. Both tests were performed to determine whether the items in the questionnaire represented a construct of knowledge in the practice of energy saving among the respondents.

Exploration factor analysis

The results of the EFA analysis were used to gauge knowledge about electricity-saving practices and explained more than 0.5 of the correlation. The Kaiser-Meyer-Olkin (KMO) test had a value of 0.803 and Bartlett's sphericity test was significant with a chi-squared value of 2,720.755 with 496 degrees of freedom.

Table 4 Kaiser-Meyer-Olkin (KMO) and Bartlett test

Adequacy of the sample for measurement (KMO)		0.803
Barlett sphericity test	Chi-squared	2,720.755
	Degrees of freedom	496
	Significance	.000

Factor analysis was conducted by the researchers as the set number of factors was extracted into four parts as had been categorized in the questionnaire. Table 5 shows the matrix component with varimax rotation. Varimax rotation was performed because it can reduce the number of variables that are complex and can increase the yield expectations. The results showed that the items p8, p12, p13, p14, p15, p16, p19, p21, p22, p24, p29, p30 and p32 could be dropped because the anti-image correlation matrix values were less than 0.5. The values of p1, p2, p3, p4, p5, p6 and p7 belonged to one component, electricity saving knowledge; p9, p10 and p11 were in the second allotment of water saving knowledge; p17, p18, p20 and p23 accumulated in the third component, namely knowledge of the environment; and p25, p26, p27, p28 and p31 belonged to the fourth group, knowledge of the 3Rs. The values shown in Table 5 are the coefficients or factor loadings for each item that were used to allocate each factor. Each value indicates the correlation between the item and the form factor and is key to understanding the nature of these factors. Furthermore, CFA was conducted to confirm the results obtained from the EFA.

Confirmatory factor analysis

According to Hair et al. (2010), a model is said to meet the characteristics of the corresponding model if it has at least one index matching. Hair et al. (2010) added that it is necessary to assess the suitability of the model through the statistical measurement of the relative chi-squared test, comparative fit index (CFI) and root mean square error of approximation (RMSEA). To achieve a suitable model, the relative value of the chi-squared should be less than 5.0, while the CFI and TLI must exceed 0.90, while the RMSEA values must be less than .08 to allow the data to be adopted (Schumacker & Lomax, 2004).

Based on Figure 1, the CFA analysis showed that the students' knowledge about sustainable energy saving practices reflects an appropriate model based on index matching, with an index equal to p = .091, e relative value of chi-squared at 1.196, .982 for the CFI and .978 for the TLI, while the RMSEA was .022. Assessment of the multiple correlation squared (SMC) also found it was more than 0.50, except for items p1, p5 and p25. This showed that more than 50 per cent of the variance of each item can explain these constructs. In addition, it was found that all four constructs were correlated with on another (Table 6).

Table 5 Matrix of components with varimax rotation variable energy saving knowledge

Item	Component			
	PE	PA	PAS	P3R
p1	.528			
p2	.646			
p3	.550			
p4	.621			
p5	.536			
p6	.516			
p7	.656			
p9		.585		
p10		.633		
p11		.654		
p17			.522	
p18			.604	
p20			.539	
p23			.617	
p25				.503
p26				.626
p27				.519
p28				.517
p31				.588

Key
PE: Knowledge about electricity saving
PA: Knowledge about water saving
PAS: Knowledge about pampering environment
P3R: Knowledge about 3R practice

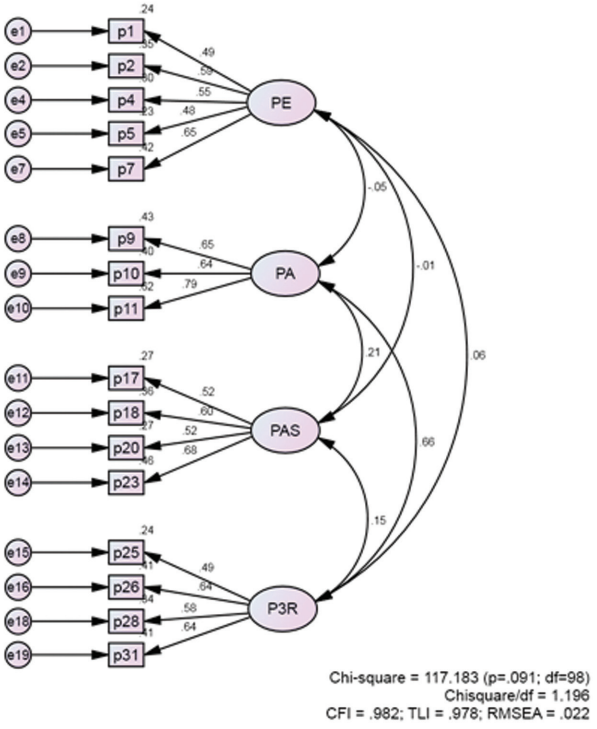

Figure 1 Model of confirmatory factor analysis for the energy saving practices

Table 6 Correlation between the four constructs

Construct	PA	PAS	P3R
PE	-0.049	-0.009	0.065
PA		0.214	0.660
PAS			0.147

Conclusion and Recommendation

This study was conducted to verify the constructs and items influencing knowledge about energy saving practices and to assess the reliability and the validity of the instrument in acceptance of knowledge about energy saving practices by pupils at primary school based on EFA and CFA. The a nalysis showed that there were four factors that affected the knowledge to practice energy conservation and energy saving. These four factors were: knowledge about electricity saving, knowledge about water conservation, knowledge about the environment and knowledge about the 3Rs (reduce, reuse and recycle). Correlation analysis between variables carried out to examine the existence of relationships between the constructs showed the correlation coefficient between variables was less than .85. This provided an early indicator that the variables are measuring different things.

Therefore, it can be concluded that this measurement model meets the characteristics of a good suitability model for identifying and confirming the important aspect of verifying knowledge about energy saving practices in pupils at primary school. However, this research can be improved in future by considering other aspects that encourage knowledge on energy saving practices in students at home within these four elements.

Conflict of Interest

There is no conflict of interest.

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