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Abstract

This study was conducted to verify a measuring model of climate literacy knowledge among future teachers in Malaysia. Respondents consisted of 500 final semester students from nine faculties at Universiti Pendidikan Sultan Idris, Perak, Malaysia, who had been selected by using the stratified sampling technique. The variables examined in this study include climate change literacy knowledge in terms of environment, economy and social values. The data were analysed descriptively to get the reliability of Cronbach's Alpha values, and Confirmatory Factor Analysis (CFA) was used to get the three-factor solution, using SPSS 22 and AMOS 20 software. The results of the analysis showed that Cronbach's Alpha value was at a high classification of more than 0.80. The CFA analysis results of the measuring model showed that the three-factor solution was appropriate and acceptable based on the suggested indicators. Therefore, the measuring model developed were appropriate to be used for the measuring of climate literacy knowledge of future teachers in public university in Malaysia and other developing countries.

Keywords: *Knowledge, Climate Literacy, Environment, Social, Economy*

Introduction

The issue of dealing with environmental problems, that is, in the implementation of mitigation and adaptation of climate change, is becoming the main agenda these days. This issue is very important to be addressed since climate change has led to natural disasters and drastic changes in global climate (United Nations, 2009). In addition, this problem has also caused a change in human, plant and animal life ecosystems (World Health Organisation, 2016). The major contributors to this climate change have resulted from daily human activities, such as through emissions of gas from carbon elements, either from vehicles, electricity consumption or

industries, which cause the earth to heat up and increase the average temperature of the earth, known as the global warming phenomenon (Ahmad & Nour, 2015). Also, electric power generation is the largest single source of CO_2 emissions through fossil fuel combustion, such as coal, oil and natural gas (Hammond, 2007).

The effect of uncontrollable global climate change has led to natural disasters, such as hurricanes and unpredictable, heavy rains that contribute to the occurrence of huge floods. Besides affecting the environment, this phenomenon has also affected human health and caused discomfort. Various diseases, such as damaged eye lens, skin cancer, and even mutations in the human chromosomal system, are due to the consequences of this event (World Health Organisation, 2016). This can be seen more clearly when humans contract Down syndrome and Turner syndrome as a result of chromosomal mutations (Gioconda, Denisse, & Alfredo, 2016).

In addition, phenomena, such as global warming, El Nino and La Nina, are the main factors that are causing climate change (Malaysian Meteorological Department, 2009). This change has become a major problem in the Asian and Southeast Asian regions. According to experts, some of the countries in Asia are expected to experience an increase in rainfall frequency and also an increase in hot temperatures. The Intergovernmental Panel on Climate Change (IPCC; 2014) states that, in 2050 and 2080, the weather in Asian countries will change to a warmer temperature and will be experienced during winter and summer. The climate change in Southeast Asia is strongly influenced by the global warming phenomena, El-Nino and La-Nina (Hayrol, Bahaman & Jeffrey, 2013).

Therefore, research on climate change is needed as climate change is often closely related to human actions. However, most of the research on climate is based more on pure science. Therefore, this study, which examines the issue from the perspective of social science, aims to study human knowledge on climate change that has an impact on our lives. Due to the need, this study seeks to validate the measuring model of climate literacy knowledge of future teachers in Malaysia, involving the students from Universiti Pendidikan Sultan Idris (UPSI), Tanjong Malim, Perak.

The results of this research will produce a new climate literacy instrument for educational purposes at the university level so that students are exposed to more precise climate literacy elements. The creation of this instrument is in line with the National Climate Change Policy (NCCP), suggesting that the public should be exposed to integrated and comprehensive adaptation and mitigation actions (Ministry of Natural Resources and Environment, 2009). Therefore, the creation of a climate literacy knowledge instrument among UPSI student respondents is appropriate because this is the group that will share the climate literacy information as administrators, scholars, educators and so on. In fact, this literacy model will help people to take proactive measures to face various natural disasters resulting from climate change.

Climate Knowledge and Literacy

Knowledge can help individuals, groups and communities to gain experience and acquire the basic understanding that is needed to create and ensure environmental sustainability (UNESCO-UNEP, 1978). According to Palmer and Neal (1994), the knowledge of environmental education can be defined as the concepts and information that are related to the environment. The knowledge of environmental issues refers to the knowledge or understanding of the concepts and facts that are related to climate change mitigation and adaptation in this study. Knowledge of the concept refers to the knowledge or understanding, as well as ideas, relating to strong support in writing. Knowledge about facts is knowledge of the events that have occurred or existing situations that can be ascertained (Richmond & Morgan, 1977).

The knowledge component in this study is based on a statement by Brown (1991), which suggested an environmental-based knowledge concept comprised of three components, namely, environment, economy and social values (Figure 1). The environmental pillar is about the use of resources, whenever necessary, and about environmental protection. The economic pillar encompasses several processes involving environmental costs and benefits, which emphasise the use of sensitive natural resources during economic development, and storing the capacity for reforms by using all natural resources economically. The social sustainability pillar emphasises topics such as engagement, independence, unity, security, equality and justice, all of which significantly affect the continuity and quality of life for people and future generations. Priority should be given to the people so that knowledge from aspects of environment, economy and social are emphasised in order to achieve sustainability.

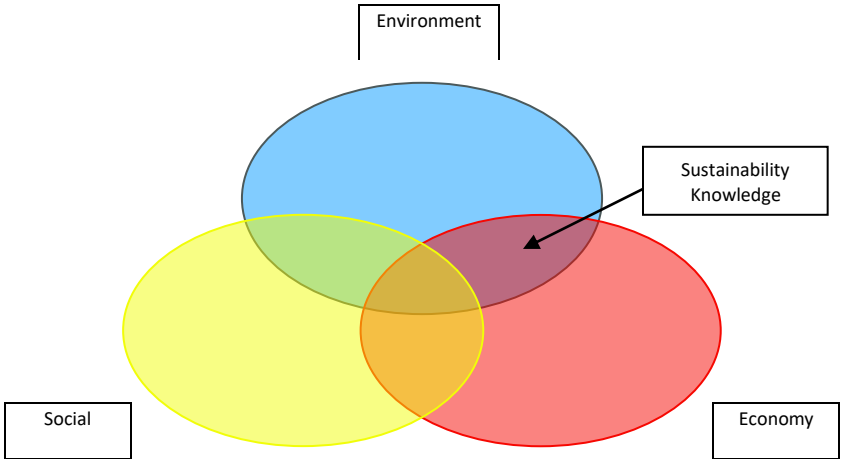

Figure 1: Three Components of Sustainability Knowledge

Source: Brown (1991)

Climate literacy requires an understanding of three basic concepts, which include the studies about the system of the earth so that the understanding of the earth's climate system is still being given attention and that the empirical evidence of the studies is shared (Niepold,

Herring, & McConville, 2007). This suggests that climate-literate individuals understand the important principles of the earth's climate system, know how to find true scientific information regarding climate, meaningfully discuss climate issues and climate change and are able to make responsible and prudent decisions with regard to actions that affect the climate (Ahmad & Nour, 2015).

Climate literacy knowledge will produce individuals literate in climate science who can provide information pertaining to decisions that can improve the quality of life. They should possess basic knowledge of the climate system, whether it occurs naturally or even when caused by human actions. Individuals who are literate in climate science also understand that scientific knowledge about climate can be gained from observations, records and computer models. They are also aware of the basic relationship between climate and human life and the way in which climate affects human health. They are able to assess the validity of a climate argument and use information to support the decisions made (Harrington, 2008).

In general, climate change involves nature with certain components, such as atmosphere, hydrosphere and biosphere. However, these changes are interrelated with human actions that make climate change have an even bigger impact. The impact of this climate change will eventually return to the people on earth. Due to that, most scientific research focuses on the occurrence of climate change and its impact on the environment. However, research that examines the human aspect--particularly human knowledge of climate change that impacts their lives, especially people who are considered educated, such as those with higher education--still does not get the attention of researchers. Based on this lack, the main focus of this research is on aspects of knowledge, skills, attitudes and actions regarding climate literacy of future societies which will be found in the country's leadership, administrators and everything else. The lack of such elements will possibly result in future societies that are unprepared to face the worsening climate change situation.

The need for climate-literate individuals is important as a critical skill, especially with regard to knowledge in areas closely related to the environment and interactions constructed based on their knowledge of climate literacy. General communities should also have knowledge regarding climate change and the actions to be followed to show that climate literacy has been understood because of human actions that have resulted in climate change (Kahan et al., 2012). Communities should also have the knowledge and skills to influence actions and decisions (Dupigny-Giroux, 2010). Each individual has his or her own role, but, to ensure effective solutions, approaches need to be taken to mitigate the effects of extreme climate change. In fact, the adoption of climate literacy should vary according to the age group so that the actual meaning of climate literacy can be disseminated among the community.

In the context of Malaysia, the policy regarding climate change has been explained in the National Climate Change Policy-NCCP (2009). Thus, in line with the third objective of NCCP, which is to reinforce institutional and implementation capabilities to capitalise on new opportunities in reducing the negative impacts of climate change, the best target group is students from among the future teachers. The need for building an instrument of climate literacy knowledge among

future teachers serves as a complete guide for future researchers to study the level of climate literacy among future teachers in Malaysia.

Methodology

Study Location

The study was conducted at Universiti Pendidikan Sultan Idris (UPSI) in Tanjong Malim, Perak, Malaysia, involving the final semester students of bachelor degree programmes. The selection of this study location was made because the university is an educational institution that provides future teachers to become professional teachers at schools in Malaysia. Apart from that, UPSI is also one of the public universities in Malaysia. UPSI, which is situated in Tanjung Malim, Perak Darul Ridzuan, has two campuses, namely Sultan Abdul Jalil Shah Campus (KSAJS) and Sultan Azlan Shah Campus (KSAS).

Study Population and Sample

This study involved 500 final semester students from nine faculties at Universiti Pendidikan Sultan Idris, who were selected using stratified sampling. Table 1 descriptively shows the frequency and percentages of respondents' background according to faculty and course of the 500 students involved in this study.

Table 1: Respondents' Background by Faculties

Faculty	Number of Population	Percentage (%)	Number of Sample
Faculty of Language and Communication (FBK)	1860	15.9	80
Faculty of Music and Performing Arts (FMSP)	475	4.1	20
Faculty of Management and Economics (FPEK)	1491	12.8	64
Faculty of Education and Human Development (FPPM)	1245	10.7	53
Faculty of Human Sciences (FSK)	1684	14.4	72
Faculty of Art, Computing and Creative Industry (FSKIK)	1757	15.0	75
Faculty of Science and Mathematics (FSMT)	1074	9.2	46
Faculty of Sports and Coaching (FSSKJ)	1303	11.1	56
Faculty of Technical and Vocational Education (FTV)	801	6.9	34
Total	11690	100	500

Data Analysis Method

Reliability tests were performed for each variable, and it was discovered that the reliability values exceeded 0.7, while Confirmatory Factor Analysis (CFA) was carried out to determine construct validity. Confirmatory Factor Analysis (CFA) was conducted on the measuring model based on the hypothesised factors, using Analysis Moment of Structure - AMOS 18. The programme uses maximum likelihood estimation to generate an estimate in a full-fledged measuring model. In order to examine the suitability of the measuring model, compatibility indices such as: (i) the

minimum value of discrepancy between the observed data and the hypothesised model divided by the degree of freedom (CMIN/df), (ii) Comparative of Fit Index (CFI), (iii) Tucker Lewis Index (TLI), (iv) Incremental-Fit-Index (IFI) and (v) The Root Mean Square Error of Approximation (RMSEA), were examined. Arbuckle (1997), Hair et al. (2006), and Arbuckle and Wothke (1999) explain that a model is compatible when the compatibility index shows:

(i) CMIN/df with a value between 1 and 5 is considered acceptable or acceptable fit between the model and data;

(ii) CFI, IFI and TLI indices approaching 1.00 indicates a suitable match; and (iii) RMSEA .08 or less index indicates a reasonable and acceptable estimated error.

Next, the following points are checked if the model is found to be incompatible.

(i) Checking that the load factor of each item must exceed the recommended value according to the number of samples. Factor loading represents the relationship between latent variables and items or indicators (Hair et al., 2006; Kline, 2005). (ii) Reviewing that the residual standards and values between 2.58 and 4.00 are considered to be maintained or dropped, while values greater than 4.00 must be dropped.

(ii) Checking the index modification so as to repair the model (Hair et al., 2006; Bryne, 2010; Kline, 2005). In order to establish the constructs in the model, convergent validity and discriminant validity tests are performed.

Convergent validity is based on construct reliability of above 0.70 (Hair et al., 2006). Convergent validity is also evaluated based on the study on the coefficient of each significant load item and also the average variance extracted for a certain latent variable (Hair et al., 2006; Anderson & Gerbing 1988; Fornell & Larcker, 1981). Meanwhile, discriminant validity is evaluated by comparing squared correlations of two constructs and average variance extracted respectively. If the average variance extracted exceeds the squared correlation, then discriminant validity is achieved (Hair et al., 2006). In this study, CFA was used to examine the construct validity of the study instrument.

Instrument

This study used a questionnaire as a research instrument, consisting of two parts, namely part A and part B (Table 2). Part A contains the respondents' demographic information, while Section B covers information on the study variables, which is climate change knowledge.

Table 2: Respondent Questionnaire Information

Part	Details	Constructs	Number of Items	Source of Items
A	Background of Respondent	Age	1	Self-built according to the needs of the study
		Semester	1	
		Gender	2	
		Races	7	
B	Climate Literacy Knowledge	Environment	18	Retrieved and modified from Stacy (2016), The Office of the United Nations High Commissioner for Human Rights (OHCHR) (2015), The United Stated Global Change Research Program (USGCRP) (2014), UK Environment Change Network. (2016), Global and Region Climate Change (2014), Kristen (2016), Subramaniam (2014) and Hanifah Mahat, Nasir Nayan, Yazid Saleh & Mohmadisa Hashim (2015)
		Social	28	
		Economy	38	

Instrument Reliability

Table 3 shows the reliability of climate literacy knowledge element with Cronbach's Alpha value, which measures the internal consistency of the variables. According to Babbie (1992), Cronbach's Alpha value is classified based on a reliability index classification where the 0.90-1.00 value is very high, 0.70-0.89 is high, 0.30-0.69 is moderate and 0.00-0.30 is low. The results of the analysis showed that Cronbach's Alpha value was at a high and very high classification, which exceeded 0.80. This study instrument has high reliability, according to Babbie's classification (1992).

Table 3: Study Questionnaire Reliability

Variables	Sub Variables	Number of Items	Alpha Cronbach Values
Climate Literacy Knowledge	Environment	18	0.953
	Social	9	0.846
	Economy	10	0.922

Study Findings and Discussion

Respondents' Background

Table 4 shows demographic background of the respondents, which consisted of respondents' semester, sex and race. As for the semester of the respondents, 49 students (9.8%) were comprised of semester six students, 90 persons (18.0%) consisted of semester seven and 361 persons (72.2%) were in the eighth academic semester. As for respondents' sex, 120 (24.0%) male respondents were involved in this study and the rest were female students of 380 persons (76.0%). The fraction of races of the respondents consisted of four ethnic groups, namely 357 Malays (71.4%), followed by 48 (9.6%) Chinese, 34 (6.8%) Indians, 50 (10.0%) Sabah Bumiputera and Sarawak Bumiputera made up a total of 11 (2.2%) persons.

Table 4: Respondents' Demographic Background

Background of Respondents		**N**	**%**
Semester	Semester 6	49	9.8
	Semester 7	90	18.0
	Semester 8	361	72.2
	Total	**500**	**100**
Gender	Male	120	24.0
	Female	380	76.0
	Total	**500**	**100**
Races	Malay	357	71.4
	Chinese	48	9.6
	India	34	6.8
	Bumiputera Sabah	50	10.0
	Bumiputera Sarawak	11	2.2
	Total	**500**	**100**

Exploratory Factor Analysis (EFA) for Climate Change Knowledge Constructs

The result of Exploratory Factor Analysis (EFA) on the measuring instrument of climate change knowledge explained that the anti-image correlation analysis procedures had shown that the coefficient value of the correlation was greater than 0.5, and this indicated that the factor analysis can be continued. Measurement adequacy of Kaiser-Meyer-Olkin sampling (KMO) and Bartlett's Test of Sphericity obtained showed that the KMO value was 0.900, while Bartlett's Test Sphericity was significant with its Chi-square value of 21184.252 at 703 degree of freedom (Table 5).

Table 5: Suitability Test on the Use of Factor Analysis and Uniformity of KMO and Bartlett's Test Items towards Climate Change Knowledge Variable

Kaiser-Meyer-Olkin	Measure of Sampling Adequacy	0.900
Bartlett's Test of Sphericity	Approx. Chi-Square	21184.252
	Spherecity	
	df	703
	Sig.	.000

The factor analysis was done by determining the number of factors to be extracted into three as categorised in the questionnaire. Table 7 shows the component matrix with varimax rotation. The varimax rotation method was performed as it can reduce the number of complex variables and increase the expected yield. The results found that the items p3, p22, p25 and p29 had been dropped for having an anti-image correlation matrix value of less than 0.5. While the values of p1, p2, p4, p5, p6, p7, p8, p9, p10, p11, p12, p13, p14, p15, p16, p17 and p18 were in component 1, which was environment, p19, p20, p21, p23 , p24, p26, p27 and p28 were accumulated in component 2, which was social and p30, p31, p32, p33, p34, p35, p36, p37 and p38 belonged to group 3, which was economy. The values shown in Table 6 are the coefficient or the load factor for each item that tends to each accumulated factor. These values show the correlation between the items and the factors formed, and this is the key to understanding the nature of these factors.

Table 6: Component Matrix with Varimax Rotation of Climate Change Knowledge Variable

Item	**Component**		
	Environment (A)	**Social (S)**	**Economy (E)**
p1	.705		
p2	.686		
p4	.745		
p5	.727		
p6	.705		
p7	.728		
p8	.542		
p9	.678		
p10	.759		
p11	.802		
p12	.750		
p13	.695		
p14	.740		
p15	.792		
p16	.794		
p17	.658		
p18	.757		
p19		.842	

p20	.546	
p21	.866	
p23	.596	
p24	.878	
p26	.798	
p27	.733	
p28	.536	
p30		.557
p31		.643
p32		.617
p33		.613
p34		.715
p35		.821
p36		.788
p37		.695
p38		.693

Confirmatory Factor Analysis (CFA) for Climate Change Knowledge Constructs

Once the Exploratory Factor Analysis (EFA) had been carried out for the accumulation of items of the climate change knowledge constructs, the Confirmatory Factor Analysis (CFA) was conducted, using AMOS 20 software to determine the first and second level of the confirmatory factor analysis model of climate change knowledge. Figure 2 shows the first level of CFA model for climate change knowledge constructs that have achieved good matching accuracy. Figure 3 is the second level of the CFA model in which this model is a combination of all dimensions of climate change knowledge constructs maintained in the first stage analysis.

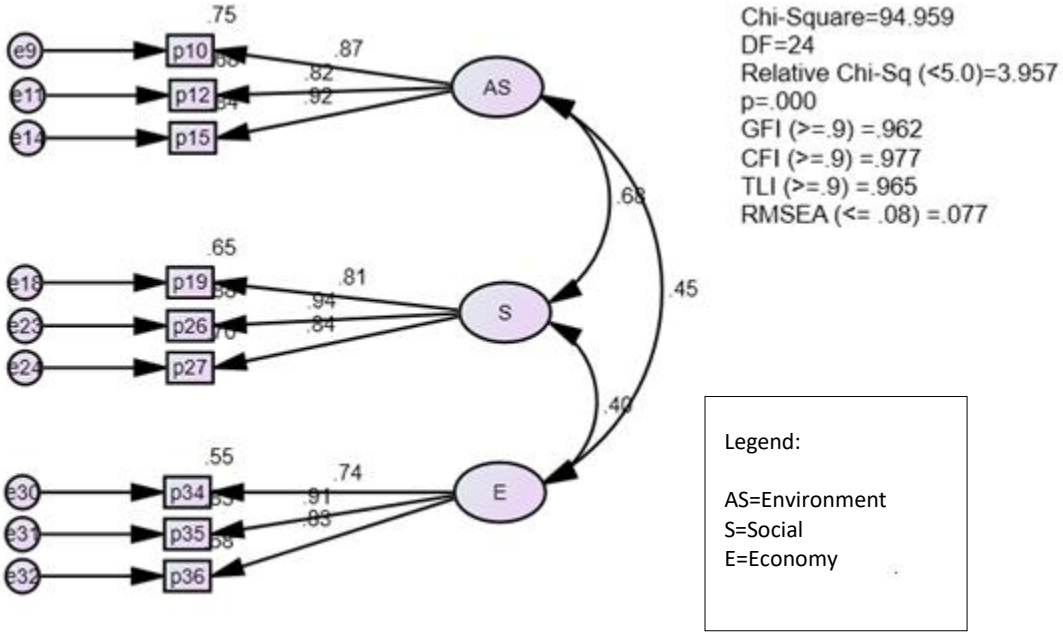

Figure 2: First Level Confirmatory Factor Analysis Model of Climate Change Knowledge

The model analyses in Figure 2 and Figure 3 show that the model formed has reached a good level of compatibility based on the determined indicators (CMIN=94.959, DF=24, CMIN/DF=3.957, p=.000, GFI=.962, CFI=.977, TLI=.965, and RMSEA=.077). Therefore, the second stage items (p10, p12, p15, p19, p26, p27, p34, p36, p37) and confirmatory factor analysis model of climate change knowledge can be used in measuring the level of climate change knowledge as well as in constructing a structural equation model of climate literacy among future teachers in Malaysia according to the conditions set forth by Hair et al. (2006), Anderson and Gerbing (1988) and Fornell and Larcker (1981).

Conclusion

The EFA and CFA results showed that the convergent validity and discriminant validity have been achieved in this study. The EFA results showed that three components of climate literacy knowledge have been generated, which were the economic, social and environmental components. In addition, through this analysis, several items had been dropped in which, out of 38 initial items constructed by the researchers, nine items were accepted to get a good matching index, while 29 more items were dropped. The corresponding values of CMIN=94.959, DF=24, CMIN/DF=3.957, p=.000, GFI=.962, CFI=.977, TLI=.965 and RMSEA=.077 were in accordance with the determined conditions. Overall, the climate literacy knowledge model generated from this CFA process can be used to measure the level of climate change knowledge of the future teachers. The creation of climate literacy knowledge instruments through the model generated in the CFA process among UPSI student respondents is also timely as this group will share climate literacy information as administrators, scholars, educators and so on. In fact, this literacy model will help communities to take proactive steps in facing various disasters through mitigation and adaptation of climate change.

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Legend:

AS=Environment
S=Social
E=Economy

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